Post-Disaster Opportunities:

An Assessment of Reconstruction Activities following the 1999 Debris Flows in Vargas State, Venezuela

by

Heather Stager

A thesis presented to
the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Master of Environmental Studies
in
Geography

Waterloo, Ontario, Canada 2009

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Acknowledgements

I would like to thank all my respondents from Venezuela for the generosity they showed me with their time, knowledge and assistance for this thesis. During my very short visit, facing insecurity and uncertainty at times, I was appreciative to all the professors who welcomed me into their homes and willingly shared their stories of the tragedy and resilience they experienced through recent disasters.

Secondly I would like to thank my advisor, Dr. Brent Doberstein, for his on-going kindness, guidance and support throughout my time at Waterloo. I owe him a debt of gratitude for challenging me to get my Masters and providing me with a great project to learn from! I especially appreciated his encouragement, and the research and conference opportunities that he shared with me. He has taught me so much both at UW and elsewhere. He has become a good friend by frequently emailing job opportunities and being my travel buddy – I have now been to three countries with him! I would also like to thank my committee member, Dr. Johanna Wandel, for her positive comments and many contacts for both my thesis and in career search.

Finally, I need to thank my family for always supporting me in my international adventures and believing in my abilities. I am grateful for all the opportunities I have had so far and with the support and encouragement of my family, I tried things I never thought possible. A special thank you also goes to my friends, who served as a very necessary outlet for release during this sometimes trying process. Thank you to Britta Ricker and Jana Jedlic who read over and edited my draft and offered helpful comments and supportive encouragement. Last but not least, I am forever grateful to “my roomie”, Emily Smit. She acted as a sounding board for my ideas and frustrations. Our chats over tea (or wine!) always made me feel better just knowing that I was not the only one struggling through the thesis process was reassuring and offered me the motivation to keep going!

Abstract

Disaster impacts have grown significantly in the last half century. Additionally, in 2007 the number of urban residents surpassed that of rural populations generating a struggle for resources, inevitably leading to increased challenges in the achievement of reduction in both urban poverty and disaster vulnerability. Although the literature on disaster recovery suggests that a 'build back better' approach is now the accepted norm, there are still many cases worldwide where the reconstruction process actually *rebuilds* rather than *reduces* vulnerabilities. The literature on disaster risk reduction provides some basic principles for sustainable hazard mitigation, however, evaluation criteria for effective post-disaster response and reconstruction have yet to be developed.

This research will enrich the ongoing debate about what 'sustainable hazard mitigation' entails and how it fits into broader development goals in less developed countries (LDCs). A case study examination of a socio-ecological system allows for the identification of the ways in which planning, policy, partnerships, and the like, can be used to reduce vulnerabilities in a post-disaster setting, thus, improving outcomes in future disastrous events. In the absence of a framework for evaluation of disaster risk reduction effectiveness in the literature, an Assessment of Post-disaster Risk Reduction Effectiveness (PDARRE) was created. Thirty three criteria were derived from the literature and 'good practices' to address common challenges and necessary actions for successful post-disaster reconstruction which results in reduced vulnerability.

The selected case study is a debris flow disaster which decimated the northern coastal state of Vargas, Venezuela in 1999. Torrential rainfall exceeding 900mm fell on the *Sierra El Avila* Mountains over three days. The results from the PDARRE evaluation found an overwhelmingly poor response to the Vargas disaster, although some positive actions were also noted. Individual community members were not well-informed of the risks they faced living in Vargas and have still not been provided adequate capacity to reduce their vulnerability, nine years after the disaster. The creation of new institutions immediately following the debris flows led to slow decision-making and weak governance as new managers struggled to adapt to their new positions. In addition, poor communication across government institutions, lack of enforcement of zoning policies and an incomplete system of early warning compounded vulnerability and governance concerns.

Long-term monitoring of post-disaster recovery and reconstruction has typically been left to local governments that often get distracted by economic pressures and changes. To assist with post-disaster efforts, PDARRE was created to monitor and evaluate effectiveness. The criteria for this assessment were derived from many sources and were organized into categories to assist local governments to see which areas of their disaster response system are weakest, and enable effective adjustments to their activities, consequently improving the entire disaster management system. Though other checklists and tools for post-disaster response activities do exist, I argue that these over-emphasize the immediate response activities and time-frame. The post-disaster context provides an opportunity to harness funding that can be directed at-risk and vulnerability reduction efforts.

Consistent with the perspective of prominent international NGOs, this research is based on the prevailing belief that disaster management can be more successful if mainstreamed into broader sustainable development goals and activities. Similar to other disasters, the Vargas debris flow disaster was a convergence of unfortunate and dangerous circumstances. As disasters continue to grow in magnitude and increase in frequency, the importance of strong disaster management plans will be reinforced the world over. With a synthesis of poverty and vulnerability reduction strategies, disaster-affected communities can use the post-disaster context as an opportunity to achieve more sustainable livelihoods, increased equity and improved safety.

Table of Contents

Table of Figures

List of Tables

Terminology

Disaster: "a complex mix of natural hazards and human actions" (Wisner, Blaikie, Cannon, & Davis, 2004, p. 5); "an event, concentrated in time and space, in which a community experiences severe danger and disruption of its essential functions, accompanied by widespread human, material or environmental losses, which often exceed the ability of the community to cope without external assistance" (Smith, 2004, p. 13).

Hazard (cause): "a naturally occurring or human-induced process, or event, with the potential to create loss, that is, a general source of future danger" (Smith, 2004, p. 12).

Risk (likely consequence): "the actual exposure of something of human value to a hazard and is often regarded as the product of probability and loss" (Smith, 2004, p. 12).

Vulnerability: "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, and resist and recover from the impact of a natural hazard (an extreme natural event or process)" (Wisner et al, 2004, p. 11). "the pre-event, inherent characteristics or qualities of social systems that create the potential for harm. Vulnerability is a function of exposure… and sensitivity of system (Adger, 2006; Cutter, 1996 cited in Cutter et al. 2008, p. 599).

Resilience: "the ability of a social system to respond and recover from disasters [including] those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat" (Cutter, et al., 2008, p. 599)

Sustainability: defined as the ability to ''tolerate—and overcome—damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance" (Mileti, 1999, p.4 – cited in Cutter et. al. 2008, p.601).

Disaster Risk Reduction: The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development (ISDR, International Strategy for Disaster Reduction, 2004).

Sustainable Hazard Mitigation: This concept links wise management of natural resources with local economic and social resiliency, viewing hazard mitigation as an integral part of a much larger context which includes: Land use planning, insurance, warnings, engineering and building codes, new technology, & emergency preparedness and response (Mileti, 1999).

Alluvial Fan: "Fan-shaped fluvial landform at the mouth of a canyon. …The fan is produced by flowing water that abruptly loses velocity as it leaves the constricted channel of the canyon and therefore drops (sorted layers) of sediment along the base of a mountain block" (Christopherson, 2003, p. A 13 & 476).

Debris Flow: Debris flows are characterized by fast movements in which the displaced mass behaves as a highly viscous fluid (Guidicini and Nieble 1984; IPT 1991). Debris flows displace a significant volume of material. They reach siginficant distances, velocities, and transport capacities, including large boulders (Gramani and Augusto Filho 2004 cited in Gomez et al., 2008, p. 198).

Acronyms

BBB – Key Propositions for Building Back Better

CBNRM – Community-based Natural Resources Management

CBO – Community-based Organization

DFID – Department for International Development (United Kingdom)

DROP – Disaster Resilience of Place Model

DRR – Disaster Risk Reduction

FEMA – Federal Emergency Management Agency (USA)

HFA – Hyogo Framework for Action

IDB – Inter-American Development Bank

IDNDR – International Decade for Natural Disaster Reduction

IFRC/IFRCS – International Federation of Red Cross and Red Crescent Societies

ISDR – International Strategy for Disaster Reduction

LAC – Latin America and the Caribbean

LDC – Less Developed Country

MDC – More Developed Country

MDG – Millennium Development Goals

NGO – Non-governmental Organization

PAR – Pressure and Release Model

PPP – Public Private Partnerships

SoVI – Social Vulnerability Index

UCV – *Universidad Central de Venezuela*

UN – United Nations

UNDP – United Nations Development Programme

UPEL – *Universidad Pedagogica Experimental Libertador*

USA – United States of America

VCA – Vulnerability and Capacity Assessment

Chapter 1: **INTRODUCTION**

Newspapers and television programs report on disasters on almost a daily basis. Emergencies where thousands of people have been evacuated from their homes and images of tearful women and children become embedded in our minds as we contemplate the distress and sadness they feel from having lost literally everything. These stories come from both developed and developing countries since disastrous events do not discriminate. Likewise, the number of disasters[1] globally has been rising exponentially for approximately four decades (see Figure 1).

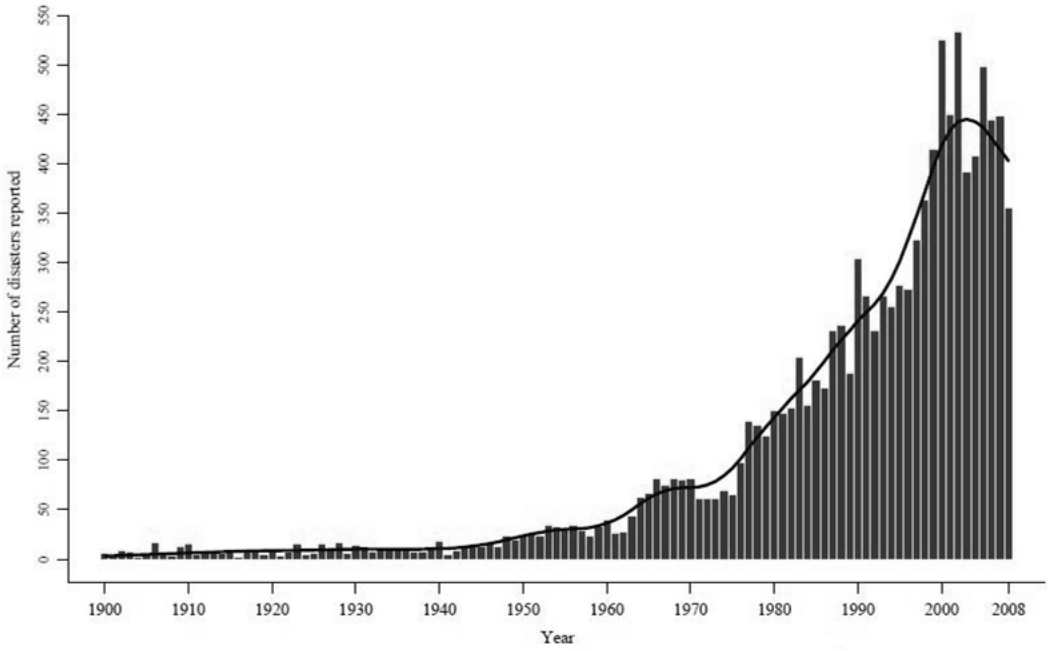


Figure 1: Global Trend in Natural Disasters reported 1900-2008
Source: (CRED, Centre for Research and Epidemiology of Disasters, 2008)

As recent severe storms such as the 2004 Asian Tsunami and Hurricane Katrina in 2005 have illustrated, a strong emergency management plan is becoming increasingly more important for saving lives and minimizing losses.

Disaster impacts have grown significantly in the last half century. In 1975 fewer than 100 disasters were reported, compared to over 400 in 2005 (Independent Evaluation Group (IEG), 2006). This means that not only are hazardous events becoming more frequent, but, with the

[1] See Terminology on p. xi for the interpretation used in this thesis. Note that no threshold number of deaths, costs or spatial impacts are included. However, from Figure 1, all of these impact measures must also be assumed to be rising when viewed at the macro level.

larger population on this earth, more disasters have also led to greater losses. Disaster costs from 1990-1999 were fifteen times greater than in the decade starting in 1950 (Independent Evaluation Group (IEG), 2006). Greater economic impacts have social costs as well. In the ten year period starting in 1983, 6.1 billion people were *affected* by disaster. Compare that to the 290,000 *fatalities* and five million *displaced* people in 11 countries in the Asian Tsunami and it becomes very clear the great potential for loss from a single disaster (Wisner & Walker, 2005). It is cases like these that demonstrate that disaster preparedness, mitigation, response and recovery need clearly defined actions, as part of an interconnected system, to successfully counteract the growing impacts and losses from catastrophe.

In addition, the global population is now more urban. In 2007, the number of urban residents surpassed that of rural areas unleashing a struggle for resources, inevitably leading to poverty for some (Ahmed Obaid, 2007; Kulikowski, 2007). The concentration of people in urban areas is accompanied by health and sanitation problems, not to mention infrastructure challenges. Nevertheless, urbanization is directly correlated with economic prosperity in this industrial age. Sustainable development has encouraged planned growth with consideration of environmental features for quite some time. Uncontrolled and unplanned growth in urban areas, however, has led to construction of unsafe buildings in perilous landscapes. Until social, political, environmental and economic vulnerabilities are recognized and protected prior to disaster, these urban populations will continue to see losses to life and livelihood.

1.1 Research Gap

Theory on vulnerability is filled with methods which assist in identifying the causes and processes that make communities vulnerable but many of these models were created in the context of *pre*-disaster mitigation. The literature on *post*-disaster reconstruction is limited and prominent authors in the field of disaster management have agreed that "much disaster relief and recovery assistance fails to take account of the need to support livelihoods and future resistance to hazards by reducing vulnerability as well as dealing with people's immediate needs" (Cannon, 2003; Davis, 2003; King & MacGregor, 2000). This type of reconstruction re-creates a situation of vulnerability and wastes the opportunity that arises after a disaster to improve of lives and livelihoods. Furthermore, much of the existing literature on vulnerability was written prior to the

development of such influential documents as the Build Back Better philosophy (post 2004) and therefore requires updating.

Despite extensive cogitation of constitutes effective response and recovery actions, an evaluation framework for measuring the effectiveness of post-disaster reconstruction is lacking; especially with regards to efforts to reduce disaster risk. After the International Decade for Natural Disaster Reduction (IDNDR) in the 1990s, the International Strategy for Disaster Reduction (ISDR) developed the Yokohama Strategy and then further updated the framework in 2005 with the Hyogo Framework for Action (HFA) (ISDR, 2007a). The HFA states that it is a "key instrument for implementing disaster risk reduction" yet evaluation of this instrument is lacking. Other international agreements have instituted evaluations - the Millennium Development Goals (MDGs) have an annual review, the Intergovernmental Panel on Climate Change (IPCC) issues report cards to countries determining their progress toward climate change goals. So far, disaster managers, government officials and non-governmental organizations (NGOs) have escaped this criticism since there is no such evaluation for disaster management activities. Lessons are constantly being identified locally, but due to the complex, unquantifiable phenomena associated with risk and vulnerability, post-disaster reconstruction seems to remain beyond evaluation. The 'Build Back Better' (BBB) framework is a step toward this type of evaluation as it sets out some good concepts that merit inclusion in a disaster risk reduction evaluation. Nonetheless, the BBB framework leaves disaster practitioners with no identifiable indicators of effective vulnerability reduction.

Previous work in the United States identified "six objectives that must simultaneously be reached to mitigate hazards in a sustainable way and stop the national (United States) trend toward increasing catastrophic losses from natural disasters" (Mileti, 1999, p. 5). The objectives are:

- Maintain and enhance environmental quality
- Maintain and enhance people's quality of life
- Foster local resiliency and responsibility
- Recognize that vibrant local economies are essential
- Ensure inter- and intra-generational equity
- Adopt local consensus building

(Mileti, 1999, pp. 5-6)

These objectives apply broadly, but an elaboration on the implementation challenges that less developed countries (LDCs) might face is needed in order to apply these objectives, or other

international governance goals (e.g. MDG, BBB propositions Hyogo Priority actions), to contexts outside the USA.

1.2 Problem Statement

Although the literature on disaster recovery suggests that a 'build back better' approach (see Clinton 2006) is now the accepted norm, there are still many cases worldwide where the post-disaster reconstruction process actually *rebuilds* rather than *reduces* vulnerabilities. The literature on disaster risk reduction provides some basic principles for sustainable hazard mitigation, however, evaluation criteria for effective response and reconstruction must be developed and taken into account in post-disaster activities and then maintained throughout future development activities in order to achieve real reductions in vulnerability and risk.

1.3 Research Purpose

The case study herein will be examined from a socio-ecological perspective, emphasizing social processes that lead to unsafe conditions. It is accepted that the natural environment has, and will always, pose a threat to populations located in hazardous areas. Consequently, rather than simply deciphering which environmental factors that contributed to the disaster itself, the question this thesis addresses is how to create sustainable communities that are resilient to the threats and impacts of natural hazards.

It is recognized that environmental change is taking place and similarly that natural disasters are increasingly seen as more human-caused or 'unnatural' (O'Keefe, Westgate, & Wisner, 1976). An examination of the socio-ecological structures will allow for the identification of the ways in which planning, policy, partnerships, and the like, can be used to reduce vulnerabilities in a post-disaster setting, thus, improving outcomes in future disastrous events.

This research will enrich the ongoing debate about what 'sustainable hazard mitigation' entails and how it fits into broader development goals in less developed countries (LDCs). To demonstrate what is meant by sustainable hazard mitigation, a case study analysis will allow for an in-depth examination of post-disaster reconstruction. The case study to be examined is from Vargas State in Venezuela where an unusual meteorological event led to multiple debris flows in the towns along approximately forty kilometres of the northern coast of the country (Wieczorek et al., 2002).

Venezuela experienced a very wet year in 1999. Several months of higher than normal precipitation leading up to December saturated soils and caused unusual flooding late in the year, which is normally the dry season. Finally, for three days starting December 14th 1999, the rains fell relentlessly and many states across the country began to see massive damages from flooding and mudflows (CEPAL, 2000). Impacts from this rainfall were seen across the country but Vargas State was the worst hit. Towns built on alluvial fans north of the *Sierra el Avila* Mountains were inundated with debris killing upwards of 3,170 people[2] and requiring prompt evacuation of an estimated 300,000 people (CEPAL, 2000, p. 15). This disaster was described as the worst debris flow disaster in Latin America's history and was certainly the most devastating disaster in Venezuela's history (Wieczorek et al., 2002).

The disaster response was a coordinated effort between *Protección Civil* (Civil Protection), the Venezuelan military, and many international aid agencies and foreign assistance funds (field notes, 2008). Victims and survivors were housed in temporary shelters while the debris was cleared and the port and airport were returned to operation. However, delayed decision-making by the government led to the reoccupation of high risk properties by residents anxious to reclaim their homes and continue in their livelihoods. Debris flow hazards are common in this region, although infrequent occurrences seem to have affected the perceived risk levels. Examination of the post-disaster response and, more specifically the reconstruction process, will elucidate opportunities which surfaced through the assessment of post-disaster activities. The adequacy with which the response and rehabilitation phases of this disaster addressed vulnerability reduction is questioned and further investigation into the actions taken is the focus of this research.

[2] The number of deaths was difficult to identify and many sources offered conflicting numbers between as few as 1,000 deaths and as high as 50,000.

1.3.1 *Research Objectives*

This research has four main objectives:

Objective 1: Identify primary and secondary causes for the 1999 debris flow event.

Objective 2: Develop an evaluation framework for assessing post-disaster risk reduction effectiveness by reviewing 'good practices'[3] in disaster management, sustainable livelihoods, urban planning and the like.

Objective 3: Evaluate the extent to which aspects of vulnerability and risk were reduced, perpetuated and/or created through the post-disaster reconstruction efforts in Vargas State based on the framework from objective 2: Post-disaster Assessment of Risk Reduction Effectiveness (PDARRE).

Objective 4: Identify further steps (policies, actions and solutions) which could reduce vulnerabilities and risk in Vargas according to the PDARRE results.

In achieving these objectives, the overall goal of this thesis is to address the need for improved monitoring and evaluation of post-disaster recovery and reconstruction activities so as to elucidate common failures and assist in identifying ways to improve disaster management. Through an improved understanding of threats from hazards and disaster, longer-term development goals can also be achieved and maintained.

1.4 Definitions

Before continuing, it is necessary to clarify the use of some terms because they are used differently in the literature on hazards as compared to other disciplines. Many terms can be used somewhat interchangeably in the literature, while other authors see these same terms as having distinct definitions. The challenge of epistemology crosses disciplines as they investigate vulnerability, and unfortunately this can be an obstacle in multi-disciplinary studies in general. Although the development of a common nomenclature would be helpful, it is beyond the scope of the present discussion and some scholars argue that subtle differences between definitions should not be lost by creating a standardized nomenclature (Davis, 2003; Wisner, 2003). Nonetheless, I will identify the definitions which I follow in this thesis to avoid confusion.

[3] Due to the contextual differences across case studies, the creation of "best practices" which could be applied to all cases near impossible, therefore, 'good practices' is used in place of the usual convention.

For the purpose of this study, vulnerability is defined as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process)" (Wisner et al., 2004, p. 11). Risk will be used interchangeably with vulnerability, however with stronger reference to the physical threats whereas vulnerability is used to refer to the social characteristics that perpetuate and enhance hazard impacts. Wisner et al. (2004) offer a set of distinct terms when referring to different 'unsafe conditions'. People, according to these authors, are *vulnerable*, whereas living and working conditions are better referred to as being *unsafe*. The authors discourage the use of 'vulnerable' for buildings, livelihoods, settlement locations or infrastructure, suggesting that 'fragile', 'hazardous' or other synonyms are better suited. In this document, I too will follow this suggestion because it relieves uncertainties regarding the meaning of vulnerability.

Other terms used in the hazards literature also have conflicting definitions in other disciplines. Resilience, adaptive capacity and vulnerability relate to capacities exhibited by individuals or communities. Definitions of vulnerability in hazards literature include elements of exposure, sensitivity and capacity to adapt (Adger W. N., 2006). While some global environmental change authors (e.g. Smit & Wandel, 2006) argue that exposure and sensitivity are inextricably linked to one another. Resilience, in contrast, started as an ecology concept geared at understanding system stability and multiple stable states (Gallopín, 2006). Movement between stable states, or "basins of attraction", is caused by "perturbations" whose trajectories are limited by the resilience within the system (Gallopín, 2006). Therefore, resilience too involves aspects of "exposure" and "adaptation" to changes. For clarification of these terms, Figure 2, below, represents some inter-connections between these important, yet complex terms.

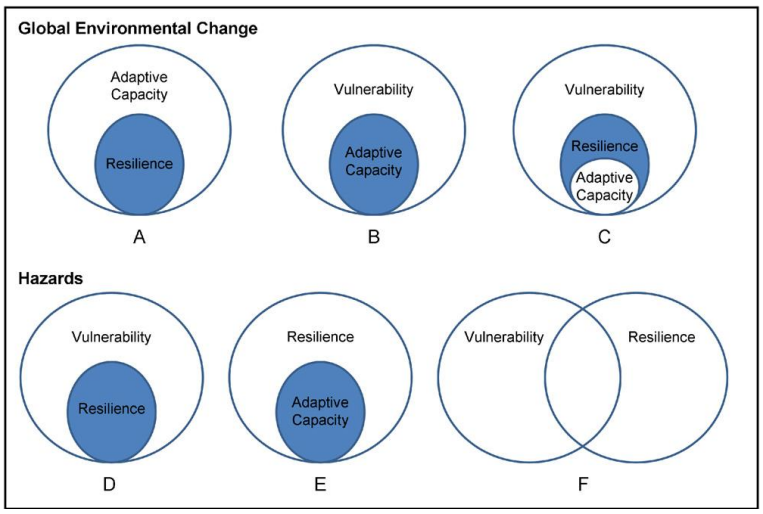


Figure 2: Conceptual linkages between vulnerability, resilience and adaptive capacity
Source: (Cutter, et al., 2008)

The definitions given by Cutter et al. (2008) for vulnerability and resilience (Fig. 4f) have been adopted for the purpose of this thesis. Cutter et al. (2008) define resilience as "the ability of a social system to respond and recover from disasters [including] those *inherent* conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social (sic) system to re-organize, change, and learn in response to a threat" (p.599, emphasis added). It is important to note the similarity of the resilience and vulnerability definitions. Vulnerabilities are the characteristics which expose a system or individual to a given impact, whereas resilience is exhibited through the capacities to adapt and reorganize before, during and after an impact. Thus, there are some overlapping themes in each definition, but the words do not have the same meaning, nor are they opposites.

Next, disaster risk reduction, vulnerability reduction and hazard mitigation are all concepts related to managing the threat of natural hazards with intent to reduce impacts on lives and livelihoods. These terms each have distinct connotation at times, however for the purpose of this study they have been assumed interchangeable due to the common end goal: to reduce the impacts of disaster on a community and socio-ecological system.

Similarly, many terms have been developed to define the activities relating to catastrophe. 'Disaster management' most commonly refers to the stages of the disaster management cycle: preparedness, mitigation, response, reconstruction/recovery. 'Sustainable hazard mitigation' also refers to all parts of the cycle but aims at *sustainability* of actions, rather than simply planning and organizing for disasters (Mileti, 1999). 'Emergency response planning' on the other hand,

has more of a focus on preparatory actions which allow for a solid and organized response during and following a disastrous event (Quarantelli, 1995).. Literature on these cyclical, interconnected actions does not depict them as distinct but authors argue these conceptual definitions as improvements on previous thinking. For this thesis, these activities will be discussed for their contributions to understanding vulnerability and loss reduction. Nonetheless, disaster management and sustainable hazard mitigation are broadly used interchangeably because both the concept of a cyclical process and a need for sustainability in actions are seen as imperative to vulnerability reduction.

1.5 Organization of this thesis

This thesis is organized into six chapters. This first chapter has outlined the research question, objectives and the gap in the literature that will be addressed. Chapter 2 chronicles scholarship from a breadth of disciplines which relate to post-disaster risk reduction in less developed countries (LDCs). Chapter 3 describes the case study specific to this research and the methods used for data collection and analysis. Chapter 4 details the results of my research of this study. Chapter 5 is a discussion of implications identified through the analysis of the case study, addresses research limitations and also offers recommendations for future research and action. Finally, Chapter 6 concludes the thesis by summarizing key findings and objectives for this research and placing the research within the context of mainstreaming disaster risk reduction.

Chapter 2: **LITERATURE REVIEW**

Disasters interrupt human lives and livelihoods in a variety of ways and at multiple scales. Interruptions occurring in social, environmental and economic systems have stimulated research across many disciplines. Scholarship on disasters crosses into at least six disciplines, including: geography, sociology, anthropology, development studies, ecology, the physical sciences, and engineering (Alexander, 1993). The disruption caused by disasters often also highlights vulnerabilities. Vulnerability to natural hazards has also been researched in multiple disciplines and fields of study including political ecology, sustainability sciences and other social sciences that investigate the processes that perpetuate socio-ecological systems.

The study of livelihoods and poverty elimination developed in parallel over the past half century. Fundamental characteristics of livelihoods include capability, equity and sustainability, and similar to natural hazards, these are examined at multiple scales (Chambers & Conway, 1992). Likewise, as urban populations have grown, urban planners have become pivotal actors in the evolution of disaster management and loss reduction plans. Consequently, urban-focused research and goals are important considerations for this research as well. All of these bodies of scholarship, from development and livelihood studies to urban planning and disaster risk reduction literature, have goals to conserve and sustain human populations and can make both individuals and communities more resilient to the threats in the natural environment. Although the methodology and research foci may differ across the above mentioned disciplines, integration of all resulting concepts and knowledge, as part of disaster risk reduction in lesser developed countries (LDCs), would serve to enhance results of disaster management activities.

2.1 Lesser Developed Countries and Natural Hazards

The number of disasters across the globe in recent decades has increased significantly. Rare disastrous events, such as the Asian tsunami, in addition to the increasing length and magnitude of perennial hazards, have caused major losses to life, livelihood and infrastructure in both developed and developing countries. An increasing number of people are being impacted by these events, despite the fact that the number of fatalities is decreasing (see Figure 3). Although Figure 1 showed an increase in the number of *disasters*, it is unclear if this also indicates an increase in natural hazard events. Natural hazard events are increasingly more disastrous likely due to growing human settlements which expose more lives and infrastructure to the impacts of these hazards. The improvements to disaster management and lessons learned from previous disasters can likely be linked to a reduction in fatalities, yet further improvements are needed to address the increasing number of people affected by disasters.

On the contrary, without damages to infrastructure or livelihoods, is a flood defined as a disaster, or simply a natural process? Examination of the causal factors that lead to floods can bring up a debate as to whether these, and other types of events, are truly ‘natural’ hazards. Increasingly, disasters are becoming more ‘unnatural’ and the presence of human populations in unsafe land may well explain some of the causes of these events (Abramovitz, 2001). The greater number of people affected can likely be linked to growing human populations in more marginal

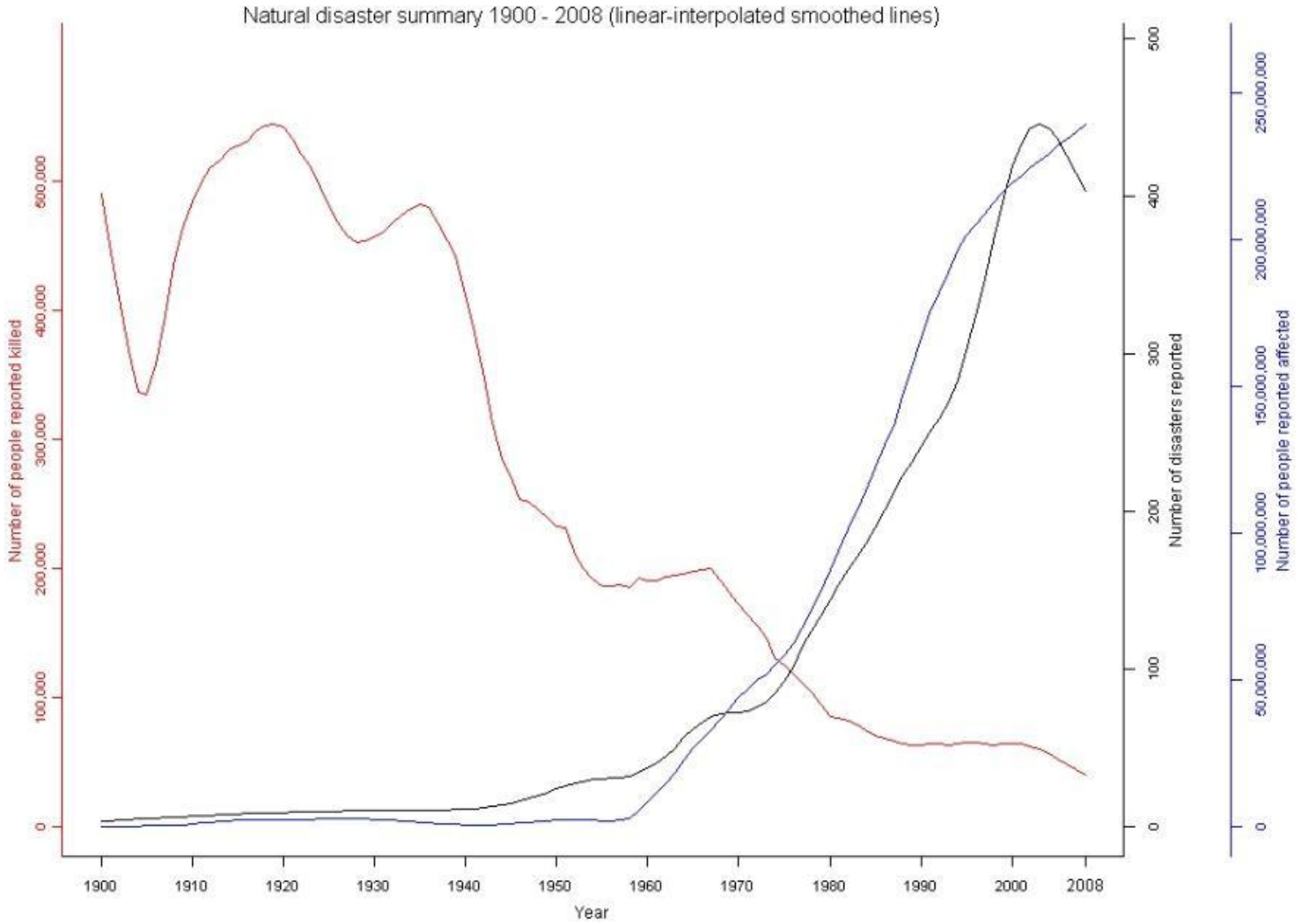


Figure 3: Disaster Summary 1900-2008 (linear-interpolated smoothed lines)
Source: (CRED, Centre for Research and Epidemiology of Disasters, 2008)

lands as "the worst environmental problems are found in marginalized areas of poor or middle-ranking cities" where local wastes, wider urban processes (industrialization, traffic) and global trends (market pressures, global climate change) create a burden of environmental risk on the residents of those marginal areas (Pelling, 2003). The sources of this environmental risk, however, are increasingly more unnatural.

The rate of growth of urban populations in LDCs outpaces that of developed countries. The unplanned and illegal nature of informal settlement growth of urban centres in the developing world exposes many people to the threats of the natural environment (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007; McEntire, 2004). As LDCs compete for economic wealth and sustainable development, the importance of citizen protection and enforcement of land use legislation is often ignored until a disaster strikes. Unfortunately, this creates a cycle of poverty as any real gains in development or economic growth are lost to disaster, especially in countries facing perennial hazards such as hurricanes or cyclones. In recognition of this difficulty, many institutions and regional development banks (e.g. The World Bank or Inter-American Development Bank) offer post-disaster risk reduction assistance intended to build resilience to hazards and increase the long-term success of domestic investments in development (Benson, Twigg, & Rossetto, 2007; DFID, 1999; Clinton, 2006; Independent Evaluation Group (IEG), 2006). Use of this external assistance to create "sustainable patterns of development can…decrease vulnerability" and in turn help to overcome the challenges poverty provoked even before the disaster (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007, p. 210).

2.1.1 *Latin America and the Caribbean*

The case study for this thesis is taken from the region known as Latin America and the Caribbean. Latin America includes all the Spanish-speaking countries of Central and South America, including Brazil and the English-speaking countries in the north of the continent. These countries share comparable histories of colonization and gained independence at approximately the same time. Often this region also includes reference to the islands of the Caribbean because of their proximity, in addition to the similarities in development, climate and culture.

Because of their geographic proximity, the countries of Latin America and the Caribbean (LAC) face similar natural hazards. Natural hazards may account for some of the differences in development across nations, as some countries face perennial damages from tropical storms (e.g. Cuba) while other countries remain outside the typical hazard area (e.g. Barbados). Regardless,

the UNDP considers LAC to be one of the most hazard-prone regions of the world, ranking as the second most prone to extreme flooding, landslides, earthquakes and droughts (UNDP, 2008).

In LAC disaster occurrences have followed the global trend. The number of people affected by disaster has increased in recent decades while the number of deaths has decreased (see Figure 4). While great strides have been made in the ability to save lives, the number of people experiencing the primary effects, loss of home or livelihood, during disaster is expected to continue to grow (Zapata Martí, 2006).

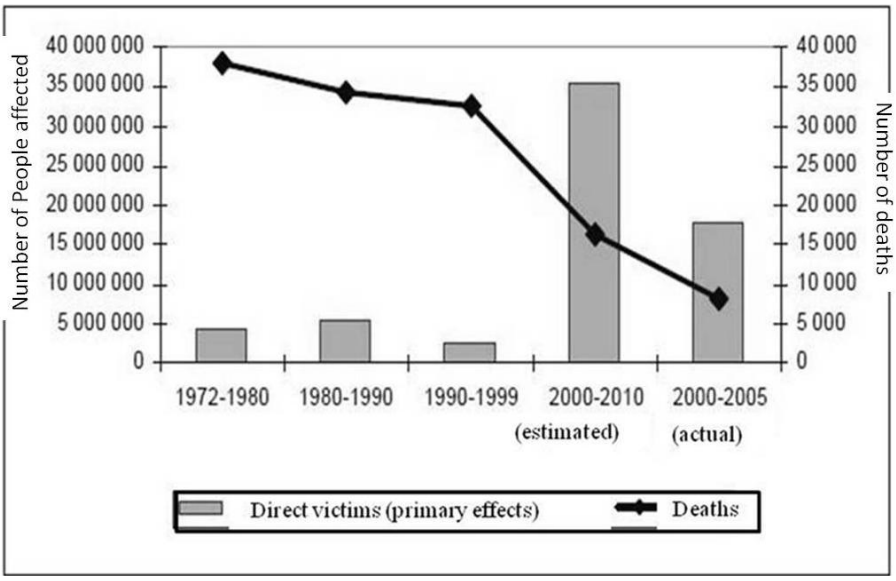


Figure 4: Affected Population and Deaths from Disaster in Latin America and the Caribbean (1972-2005)

Source: (Zapata Martí, 2006)

In addition to the number of people affected, economic impacts are also on the rise. For the first decade of the millennium, average economic costs associated with disasters in LAC were already very close to total costs for all of the 1990s (see Figure 5). Although disasters also impact larger countries with greater resources for recovery, the costs and impacts seem to be concentrated in the insular countries and countries with coasts along the Caribbean Sea (Zapata Martí, 2006).

Date	Total Damages (millions of $, 2004)			
	Total	Direct (impact to common property or capital)	Indirect (loss of flows)	External sector effects
1972-1980	78 085	49 827	28 259	24 198
1980-1990	101 251	71 640	29 611	40 671
1990-1999	31 367	16 801	14 566	7 467
2000-2010 estimation	50 050	29 519	17 531	7 751
2000-2005 Actual	25 025	14 759	8 765	3 875
1972-2005	260 753	167 787	89 966	80 087
Annual average[a]	6 385	166 892	89 435	79 852

Source: CEPAL, based on evaluated events

[a] Simple average taken only from actual registered impacts as per CEPAL, non-scientific, non-exhaustive experiment.

Figure 5: Economic impacts of disaster in Latin America and the Caribbean - 1972-2005
Source: (Zapata Martí, 2006)

Meteorological hazards (e.g. hurricanes) are of disproportionate disaster management focus among the countries of LAC. While other hazards also threaten livelihoods and lives in the region, hurricanes remain the cause of the greatest absolute losses in LAC. The extreme hurricane events of 1998, 2004 and 2005 had devastating impacts in numerous countries of LAC. The causes of vulnerability in this region are diverse and complex, but their study is essential to achieving sustainable development (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007, p. 210).

From extensive disaster research and practical experience in LAC, thirteen interrelated and recurrent factors have been identified to explain vulnerability to hydrometeorological disasters in the region: (a) poverty and socio-economic marginalization, (b) institutional and democratic weakness, (c) rapid, unregulated, and unplanned urbanization, (d) formation of slums and occupation of hazardous areas, (e) population growth, (f) migration from rural to urban areas, (g) increasing population affected by disasters, (h) ecosystem conversion, (i) erosion, (j) increasing intensity of hydrometeorological events causing disasters, (k) increasing economic damage due to disasters, (l) failure to communicate scientific knowledge effectively, and (m) expansion of agriculture" (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007, p. 210). These 'symptoms' occur not only in relation to hydro-meteorological events, nor are they exclusive to LAC.

The remainder of this chapter will chronicle prominent scholarship relating to disaster and hazard management. First, a review of recent international structures, including policy frameworks and principles, depicts the current state of experience-based knowledge. The field of

disaster management, especially emergency response and reconstruction, is carried out by non-governmental organizations (NGOs) who have learned many lessons and created good practices which anchor the current understanding of how best to manage risks and vulnerability. With an improved grasp on good practices the second part of this chapter reviews the historical evolution of vulnerability and hazards. This review will indicate some of the complementary fields of research and practical models which will be relevant to later discussion and analysis in this thesis.

2.2 Landmark International Governance

Natural disasters, and even non-disastrous hazard events, disrupt or distract community members from their regular activities and help to perpetuate poverty because they divert financial resources from development goals at both the community and national level. International governance bodies have created numerous structures which guide and assess performance for innumerable developmental or environmental changes. These structures offer decision makers achievable goals or provide a range of starting points for action on matters of immediate concern. A selection of these international structures will be addressed here because they relate to disaster risk reduction and offer insight into the administration of disaster response.

2.2.1 *Millennium Development Goals*

The Millennium Development Goals (MDGs), designed by 192 UN member country leaders along with the world's leading development institutions to meet the needs of the world's poorest (United Nations, 2008), can be used as motivation and direction when exploring disaster risk reduction or loss reduction strategies. Elaborate discussion is not necessary in this chapter; however, there are eight targets that break down into 21 quantifiable goals, measured by 60 indicators (UNDP, 2006). The goals are:

> Goal 1: Eradicate extreme poverty and hunger
> Goal 2: Achieve universal primary education
> Goal 3: Promote gender equality and empower women
> Goal 4: Reduce child mortality
> Goal 5: Improve maternal health
> Goal 6: Combat HIV/AIDS, malaria and other diseases
> Goal 7: Ensure environmental sustainability
> Goal 8: Develop a Global Partnership for Development
>
> (United Nations, 2008)

These goals, designed primarily for poverty reduction, have similarities with disaster risk reduction objectives. In addition, disasters can greatly hinder development efforts and cause the loss of investment in vital development infrastructure. For that reason, it is worth recalling the MDGs and especially to highlight goals three, seven and eight. These goals: address the need to consider women and the important roles they play in various aspects of society; emphasize the importance of the environment for sustainable development and the environmental risks of un-sustainable development, and; stress the need for cooperation across boundaries, organizations and cultures. The admission that disaster risk management should be included in development programs is not a new concept. Mainstreaming disaster risk reduction into development planning has been encouraged for several years. The obstacle that has yet to be overcome it is in finding a method through which to include these goals in development activities (Benson, Twigg, & Rossetto, 2007).

2.2.2 *Mainstreaming Disaster Risk Reduction*

Hazards pose a serious threat to development investment if, prior to the project execution, environmental hazards are not identified and considered in the planning process. NGOs and development banks have become more acutely aware of the need to mainstream disaster risk reduction (DRR) within wider development projects and programs. Although these disaster risks have been acknowledged as important, governments have been slow to fully integrate DRR into all development activities.

The World Bank and Inter-American Development Bank have each coordinated with academic institutions in an effort to develop methods to integrate DRR into their own selection criterion for project funding (Cannon, 2003; Davis, 2003; Independent Evaluation Group (IEG), 2006). The United Nations Development Program (UNDP) and International Strategy for Disaster Reduction (ISDR) have also developed strategies for DRR within their activities (UNDP, 2005; ISDR, 2009). The United Nations has a Global Facility for Disaster Reduction and Recovery (GFDRR)[4]; but how many international institutions, facilities and partnerships need to be developed independently before clear guidelines and actions can be outlined to truly reduce these risks? Local governments are overwhelmed with options for DRR strategies, while

[4] For more information visit the GFDRR website www.gfdrr.org

standardization of action or clear principles to assist their decision-making have yet to be agreed upon.

The ProVention Consortium, an informal forum for discussion and collaboration on disaster risk management issues, recognized the need to provide governmental ministries and NGOs working in disaster management with some operational guidance on how to deal with both the reduction of risks and common development goals (ProVention Consortium Secretariat, 2009). In 2007 the consortium developed thirteen guidance notes as practical briefs, and each of these briefs is based on the seven accepted steps for success (as shown in Figure 6) (Benson, Twigg, & Rossetto, 2007).

Figure 6: Steps to Successful Mainstreaming

Source: (Benson, Twigg, & Rossetto, 2007)

These steps, along with the guidance notes[5], support many of the themes discussed in this chapter. Concerns about the use of appropriate tools for measuring vulnerability and identifying sources of risk have been noted in practical experiences and models exist that quantify this data. The success of these tools depends greatly on the "environment" in which decisions are made. The importance of good information, open communication and progress monitoring will allow for feedback and continued learning by all actors involved. The cyclical "lessons learned"

[5] Titles of the notes are as follows: 1) Introduction; 2) Collecting and using information on natural hazards; 3) Poverty reduction strategies; 4) Country Programming; 5) Project cycle management; 6) Logical and results-based frameworks; 7) Environmental assessment; 8) Economic analysis; 9) Vulnerability and capacity assessment; 10) Sustainable livelihoods approaches; 11) Social impact assessment; 12) Construction design, building standards and site selection; and 13) Evaluating disaster risk reduction activities (Benson, Twigg, & Rossetto, 2007).

component of the ProVention Consortium "steps for successful mainstreaming" reiterates the significance of social learning that Cutter et al. (2008) and Berkes (2007) have also asserted. The modifications suggested under Step 5: "Change in operational practice", touches on concerns also expressed by the World Bank in its independent assessment of program success (Independent Evaluation Group (IEG), 2006). Cost minimization strategies can be achieved when disaster risk considerations are implemented in the early stages of development (Benson, Twigg, & Rossetto, 2007).

In a similar vein, security is a cross-cutting theme that arises in a range of discussions from land tenure to terrorism. There are obvious disaster management links when you put security alongside hazards, environmental concerns and (sustainable) development. Bogardi and Brauch (2005) identify the UN Commission on Human Security and the Human Security Network in relation to vulnerability by suggesting that in addition to current security objectives operating under the pillars of "freedom from want" and "freedom from fear", a third "freedom from hazard impacts" pillar should also be included (cited in Birkmann, 2006, p. 2-3). As populations expand, new risk and security concerns arise. Growing human populations are increasing the land area they occupy, outpacing planning and development capacities in many countries. This growth has led to new security issues that need consideration in development planning.

A resilient community is one that is aware of the threats and has taken precautions to minimize risk levels, prepare for impacts and protect against known hazards. The issues of human security and safety are crucial to a solid disaster management plan. When mitigation techniques are implemented, less money will be required for post-disaster reconstruction and progress will not be as easily lost. Complementary response techniques, including early warning and evacuation systems, also help to save lives by keeping the population safe from the natural hazards. Rivalry and conflict must be abated as part of sustainable hazard mitigation and protection of development investments. Post-disaster security issues have also been accounted for in a good disaster management plan if resettlement and reconstruction phases are well planned and people are not left destitute in a battle for limited and damaged resources.

From this section of the chapter it is more clear that focusing on development can aid long-term goals but this focus alone lacks detail on disaster specific concerns. There are other frameworks which are geared specifically to disaster concerns; the following section will highlight those most prominent in the field of disaster management.

2.2.3 *International Strategy for Disaster Reduction (ISDR) and the Hyogo Framework for Action (HFA)*

From the International Decade for Natural Disaster Reduction (IDNDR), 1990-1999, much was learned, but more work was needed to reduce vulnerability to natural disasters and improve future management of communities and resources in high-risk areas. To address the residual impediments of the IDNDR, the International Strategy for Disaster Reduction (ISDR) was created. Since the inception of the ISDR, various documents have been created to assist international decision makers in reducing the vulnerability of both people and infrastructure to the threat of natural disasters. The most notable framework document for building resilience to disasters, the Hyogo Framework for Action (HFA), was published at the World Conference on disaster Reduction in Kobe, Japan in 2005. The HFA was created out of lessons learned to fill gaps from the previous Yokohama Strategy for a Safer World, which was adopted in 1994 (ISDR, 2005). These early initiatives culminated in a broad recognition that "development investments are in jeopardy unless precautionary action is taken toward reducing disaster risk" (UNEP, 2007). Therefore, five gaps and challenges are outlined as the starting point for the HFA framework: governance (organizational, legal and policy frameworks); risk identification, assessment, monitoring and early warning systems; knowledge management and education; reduction of underlying risk factors; and preparedness for effective response and recovery (ISDR, 2005). The HFA took the identified challenges and put them into more action-oriented priorities to assist the decision-making process:

> Priority #1: Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation
> Priority #2: Identify, assess and monitor disaster risks and enhance early warning.
> Priority #3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels
> Priority #4: Reduce the underlying risk factors.
> Priority #5: Strengthen disaster preparedness for effective response at all levels.
>
> (ISDR, 2005)

These priorities developed out of real life practice, tragic loss and a hopeful desire to learn from previous errors; the aim being to better maintain prosperous societies and also to better prepare these societies for the recurrent challenges that are very likely to be faced in the future.

Extensive elaboration of each priority is beyond the scope of this literature review, however, there are some key points I would like to discuss before moving forward. Priority #1 can be thought of as the foundation, for hazard and disaster management.

> Given that governance and institutions also play a critical role in reducing disaster risk,…fully engaging environmental managers in national disaster risk management mechanisms, and incorporating risk reduction criteria into environmental regulatory frameworks [are key options for improving how institutions address disaster-related issues] (UNEP, 2007, p. 15).

The Hyogo Framework suggests strengthening effective and flexible institutions for enforcement and balancing of competing interests (UNEP, 2007)

Priority #2 focuses on spatial planning in order to identify inappropriate development zones, appropriate buffer zones, land uses or building codes and the use of technology to model, forecast and project risks (UNEP, 2007, p. 15). The development of technology for mapping, data analysis, modeling and measurement of hazard information offers decision makers a much better understanding of the hazards throughout the decision-making process.

Priority #3 encourages the promotion and integration of hazard education within schools to spread awareness of the risks and vulnerability to the individuals of at-risk communities. This relates to the fact of "[ten] borrowers (who) accounted for 208 of the 528 disaster-related projects, (39 percent) in the (World Bank) portfolio over the 1984–2005 period" (IEG, 2006, p. ix). This borrowing demonstrates how vulnerable countries not only have a trend of repeated events, but also shows that disaster mitigation is not being effectively integrated into longer-term development policies (IEG, Independent Evaluation Group, 2006). By educating children, hazard information will be transferred to adults and basic knowledge about threats and response can help improve community-level resilience.

Priority #4 demands the synthesis of the previous three priorities: governance, education and awareness, and appropriate technologies. "To develop and implement effective plans aimed at saving lives, protecting the environment and protecting property threatened by disaster, all relevant stakeholders must be engaged: multi-stakeholder dialogue is key to successful emergency response" (UNEP, 2007). Not only is this dialogue encouraged here; Goal 8 of the MDGs, along with natural resources management and planning theories (such as Mitchell, 2002; Arnstein, 1969) also advocate for participation and open communication.

The final priority of the Hyogo Framework, Priority #5, is geared toward a more *proactive* plan of action, rather than the reactive method that has, in the past, failed to save lives. All the

disciplines mentioned herein have derived this same *proactive* adjustment from their research on disasters, however finding ways to implement and execute this plan has proven more difficult (Clinton, 2006).

Despite positive efforts, the HFA policy considerations could better incorporate, and should further address, the different contextual issues which occur in LDCs. Academic literature is working to fill these gaps, however, "most of the theory used by hazards specialists has been formulated for the developed world (especially the USA) and is often of doubtful validity elsewhere" (Alexander, 1993, p. 14). For example, in developed nations, insurance is used to protect property rights. "Some observers (e.g., Burby and French, 1981; Platt, 1987) argue that [emphasis on construction standards], coupled with the availability of relatively low-cost flood insurance, has encouraged floodplain development [in the USA] (Burby, 1998, p. 64). Cases such as this are good examples of integrated methods using both structural and non-structural mitigation efforts. However, this method encourages a dependency on physical structures rather than true hazard mitigation. Not to mention, people in LDCs often have no legal right to property, and their limited income making insurance a difficult means of protection.

2.2.4 *Key Propositions for Building Back Better*

Another internationally acknowledged document relating to improving disaster and hazard management is 'Key Propositions for Building Back Better' (Clinton, 2006). The 2004 Asian Tsunami accentuated the need for proper implementation of the HFA and prompted further work to assist decision makers in their disaster response efforts. For over a decade prior to 2004 the focus had been on other parts of the disaster management cycle: preparedness or mitigation. After the Asian tsunami the importance of a strong and planned *response* was clear. Nonetheless, half a century of research on the disaster management indicated that no single part of the cycle could be completely successful without complementary strength in the other phases.

The 'building back better' (BBB) propositions (below and also found in Appendix 1) were developed from the multitude of actors involved in the lengthy recovery process in the Asian Tsunami who conversed and shared experiences, both good and bad, and the report which resulted is aimed at improving humanitarian efforts in the future (Clinton, 2006).

Proposition 1. Governments, donors, and aid agencies must recognize that families and communities drive their own recovery.
Proposition 2. Recovery must promote fairness and equity.
Proposition 3. Governments must enhance preparedness for future disasters.
Proposition 4. Local governments must be empowered to manage recovery efforts, and donors must devote greater resources to strengthening government recovery institutions, especially at the local level.
Proposition 5. Good recovery planning and effective coordination depend on good information.
Proposition 6. The UN, World Bank, and other multilateral agencies must clarify their roles and relationships, especially in addressing the early stage of a recovery process.
Proposition 7. The expanding role of NGOs and the Red Cross/Red Crescent Movement carries greater responsibilities for quality in recovery efforts.
Proposition 8. From the start of recovery operations, government and aid agencies must create the conditions for entrepreneurs to flourish.
Proposition 9. Beneficiaries deserve the kind of agency partnerships that move beyond rivalry and unhealthy competition.
Proposition 10. Good recovery must leave communities safer by reducing risks and building resilience.

(Clinton, 2006, p. 3)

A lengthy discussion of each proposition is not the purpose of this chapter. These propositions are somewhat self-explanatory and have been developed from the given circumstances in the Asian countries affected by the tsunami and threatened by annual cyclones. However, the successes and failures have been openly shared and thus have improved post-disaster efforts in the Asian countries, and will hopefully provide improvements to many other disasters globally.

One noteworthy point to take away from the BBB propositions is the importance of local level actors in maintaining long term sustainability of recovery efforts, in addition to the need for transparency and good information along with cooperation. The first proposition emphasizes the need to understand local customs and consult with the affected communities prior to distributing supplies and assistance – speed cannot be put ahead of local ownership. Caution must also be used throughout the response phase in order not to re-establish pre-existing patterns of vulnerability and discrimination in the affected community (Clinton, 2006). This is one of the main strengths of the BBB framework; it aims to use the tragedy of a disaster, whether natural or man-made, as an opportunity to create more equity and fairness in a society. In so doing, communities and all actors become better prepared for future disasters, hopefully reducing future disaster losses while, hopefully, simultaneously building strong social capital and improving resilience.

LDCs often require considerations which more-developed countries (MDCs) do not and so contextual factors need to be the starting point of a build back better plan (Clinton, 2006). The BBB framework, having been derived from a major disaster that occurred in the developing world, seeks to incorporate contextual diversity through the empowerment of the local people. The local people and agencies are best suited to find context specific results that improve their resilience to disasters hence concomitantly assisting the advancement of development in their country.

The BBB propositions can serve as the origin for recovery planning in the post-disaster time period and in the face of impending risk. One drawback is that a heavy focus on response and recovery can result due to planning challenges surrounding the uncertain magnitude and frequency of future natural hazards and the characteristics of populations at-risk (Pelling, 2003). Hesitations from governments and individuals regarding mitigation or preparedness investments are common, yet, without these efforts, post-disaster activities may never sufficiently improve broader development efforts (Pelling, 2003). Thus, although the BBB framework informs this thesis, it must not be taken to be an adequate, stand alone DRR tool.

2.2.5 *Governance Conclusion*

These international frameworks illustrate the interaction and overlap of literature on development, vulnerability, sustainable livelihoods and urban planning. For example, each list of objectives or goals includes a point on partnerships, the environment, equity, education and empowerment of local actors. Multitudes of case study research, based on real life events, have influenced these guiding principles. It is now well-known that common failures in development activities, as in disaster management, can be clearly linked to action plans which omitted these points.

In response to the weaknesses of current indices and in an attempt to generate data for the creation of a benchmark for countries to use in their monitoring of DRR initiatives, a Post-disaster Assessment of Risk Reduction Effectiveness (PDARRE) framework was created for this research. To create the evaluation framework, a review of existing international goals for disaster risk reduction, mainstreaming disaster risk reduction and sustainable development informed the criteria selection. Table 1 is organized to show the various existing priorities as suggested by the authors of the structures discussed in this chapter. Key words, concepts and processes have been highlighted for their influence on the creation of a comprehensive and specific evaluation.

Further discussion of the specific criteria and their justification will arise at the end of this chapter; first a discussion of cross-disciplinary concepts of vulnerability will serve to highlight related theory and models used for risk reduction and planning.

Orientation	MDG	Mainstreaming Disaster Risk Reduction	Sustainable Hazard Mitigation	HFA	BBB
Sustainable Development	Achieve universal primary education	**1)Awareness** raising	**Maintain and enhance** people's **quality of life**	1)Use knowledge, innovation and education to build a **culture of safety and resilience** at all levels	1)… recognize that **families and communities** drive their own recovery.
	Promote gender **equality** and empower women		**Foster** local resiliency and responsibility	2) Reduce the underlying risk factors.	2) Recovery must promote **fairness and equity**
	Eradicate extreme poverty and hunger		Ensure **inter- and intra-generational equity**	3) Strengthen disaster preparedness for effective response at all levels.	3) Good recovery must leave communities safer by reducing risks and building resilience.
	Reduce child mortality				
	Improve maternal health				
	Combat HIV/AIDS, malaria and other diseases				
Environment concerns	Ensure environmental **sustainability**		**Maintain and enhance** environmental quality	**4) Identify, assess and monitor** disaster risks and enhance early warning	3) …leave communities safer...
				2)…reduce… **risk factors**	
Partnering	Develop a **Global Partnership** for Development	2) Learning and experience **sharing**			4) Good recovery planning and effective coordination depend on **good information**
					5) The UN, World Bank, and other multilateral agencies must clarify their **roles and relationships**…
Economic Concerns			Recognize that **vibrant local economies** are essential		6) From the start of recovery operations…create the conditions for **entrepreneurs** to flourish
					7) Beneficiaries deserve the kind of **agency partnerships** that move beyond rivalry and unhealthy competition.
Institutional strengthening and governance		**3)Measuring progress**	Adopt local **consensus** building		2) Recovery must promote **fairness and equity**
		4) Change in operational practice		5) Ensure that disaster risk reduction is a national and local priority with a **strong institutional** basis for implementation	8) Governments must enhance preparedness for future disasters
		5)Training and technical support		**4)… disaster risks and enhance early warning**	9) **Local** governments must be empowered to manage recovery …donors must devote greater resources to strengthening government recovery institutions…
		6)Development of tools		2)reduce… risk factors	4)… **good information**
		7) Enabling environment		3) Strengthen disaster preparedness ….	10)The expanding role of NGOs and the Red Cross/Red Crescent Movement carries greater responsibilities for **quality** in recovery efforts
		1)Awareness …			

Table 1: Relevant International Governance Guidance Structures

Sources: (United Nations, 2008); (Benson, Twigg, & Rossetto, 2007); (Mileti, 1999); (ISDR, 2005); (Clinton, 2006)

2.3 Cross-disciplinary Concepts of Vulnerability

Natural features can be interpreted in a plethora of ways depending on the disciplinary perspective taken. A river can be a source of drinking water to a community development specialist; a host for disease to a public health policy researcher; and a source of beauty to the landscape ecologist. Each discipline researches a specific attribute that is more relevant to them. All of this research is valid, yet findings and interpretations can be quite distinct.

Natural processes have changed landscapes by creating new features or developing new processes. These same features (e.g. volcanoes, earthquakes and rivers) also have great potential to damage a landscape and threaten life. For centuries human populations have attempted to avoid the harmful impacts these features cause and protect themselves against damages. Adaptation to the natural environment is one of the strengths of the human race and it has allowed populations to persist for centuries. Nonetheless, natural hazards threaten the existence of human populations worldwide, thus research across many disciplines has been stimulated.

Many scholars (Smith, 2004; Adger, 2006; Hewitt and Burton, 1971; Wisner et. al., 2004; McEntire, 2005 etc.) have traced the literature on natural hazards back to when environmental engineering or 'structural' approaches were the norm in the 1930s and 1940s. Prior to the 1950's the dominant view focused on such responses as dams and levees, which were thought to be sufficient protection from the hazards the environment generated (McEntire, 2005). However, "many mitigation efforts themselves degrade the environment and thus contribute to the next disaster" (Mileti, 1999, p. 3). The presence of protective structures provided the perception of increased safety and has encouraged a greater number of people to settle near these structures. After many tragic experiences, engineered solutions were observed to be inadequate and doubts emerged about their effectiveness in reducing disaster losses. Scholars such as White and Haas (1975) began to explore the human dimensions of hazards in the 1960s.

Literature on hazards and disasters has grown "in close association with the applied natural and social sciences, but has suffered from problems of fragmentation and over-specialization, as well as from insularity that disciplinary studies tend to foster" (Alexander, 1993, p. 12). Even so, the behavioural paradigm maintains followers in many countries still today.

Hewitt (1983) identified three thrusts within the behavioural paradigm: i) the use of "environmental engineering to contain the extremes of nature" ; ii) the use of techniques such as field monitoring, modeling and prediction of damaging events aided by *advanced technology*,

such as remote sensing and telemetry, to provide *scientific* explanations to *geophysical* processes; iii) the prioritization of disaster plans and emergency response by military forces because of its benefits to organization and the authority governments achieved when reinstating order to damaged communities through this regime (cited in Smith, 2004, emphasis added).

In addition, Alexander (1993) addresses six schools of thought, of which five fall into the behavioural perspective of vulnerability. Geographers studied, for example, human-ecological adaptation and adjustment to natural hazards with an emphasis on spatio-temporal distribution of hazards, vulnerability and impacts (Alexander, 1993). As information and technologies changed, so too did the views and understanding of the hazards populations faced. A third school of thought, originating in sociology, examines patterns of human behaviour and the effects of disaster on the function and organization of communities. Dynes (1970) and Quarantelli (1978), prominent thinkers from sociology and psychology, contend that vulnerability and impacts on communities stem from patterns of human behaviour, not just from poverty or environmental processes (Alexander, 1993, p. 13).

Research investigating those people affected by disaster has also been the focus of disaster studies. "Perhaps because of the influence of public health and social work professionals, 'socially vulnerable groups' tended to be treated as 'special needs groups'…passive recipients, 'even victims'" (Hewitt, 1997, p. 167 cited in Wisner et al., 2004, p. 14). Recent studies have identified that those impacted by disaster are capable people who can play an active role in their own recovery. Thus, there is a shifting view, not only of the management actions required for successful resurgence after disaster, but also a new understanding of the affected populations.

During the maturation of the behavioural paradigm critics saw their arguments as "materialistic and deterministic interpretations that reflect[ed] undue faith in technology and capitalism," while ignoring wider socio-economic forces because of an invalidated focus on the role of individual decision-making relating to hazards (Smith, 2004, p. 5). Studies addressing broader time scales and wider geographic processes were included to understand the context and society in which individuals live and operate (Armstrong, 2000 cited in McEntire, 2005; Mileti, 1999; Adger, 2006). Despite this criticism, each of these disciplines made contributions to understanding the various forces and processes which lead to disasters and have therefore been helpful in providing insight for future decision-making processes. Most notably, the need to consider contextual factors at all stages of disaster management was derived from the

understanding that human interactions with their environment can exacerbate hazardous environmental processes.

Understanding human interactions with environmental processes is a significant part of the decision-making process for disaster managers. Etkin (1999) describes a society's response as having three overlapping activities of 'response and recovery', 'mitigation' and 'preparedness' which together affect the community's vulnerability to future hazards. Also, these activities are part of a larger interactive system made up of the physical and social forces (cited in Pelling, 2003, p. 75-56). An important development in the literature from the 1980s arose from the United Nations Disaster Relief Office (UNDRO[6]) (1982) describing disasters as a sequence of events. This chain of events was as follows:

Hazard → Risk → Threat → Disaster → Aftermath

(Alexander , 1993).

This chain coincides very clearly to what is now the universally accepted "disaster management cycle":

→ Preparedness → Mitigation → Response → Reconstruction/Recovery →

This cycle was first developed by the Federal Emergency Management Agency (FEMA) in the United States in the 1980s but has since been adopted by the International Strategy for Disaster Reduction (ISDR) when it was incorporated into the Yokohama Strategy and Plan for a Safer World in 1994 (ISDR, 2005).

Historic management frameworks, as the FEMA name implies, focused primarily on the *emergency response* phase of the cycle. Behavioral scholars have encouraged decision makers to move away from a strictly response-based approach toward a process involving all stages of the disaster management cycle. Similarly, disaster management theory has come to include this integrated way of thinking to address the diversity of actors and risks which require consideration because "prevention of disasters has to come from the bottom up, as well as from the top down" (Wisner, 2000).

The disaster management cycle can be thought of as two smaller cycles which operate together and interact with a socio-ecological system. The success of disaster management activities rely heavily on a strong response and reconstruction phase (relief), however without

[6] UNDRO is now know as the Office for the Coordination of Humanitarian Affairs (OCHA).

proper preparedness and mitigation (prevention), the relief system will be quickly overwhelmed (see Figure 7).

Figure 7: Relationship of Disaster Management System within Socio-ecological System
(Developed for this research)

In addition to the behavioural paradigm, the body of hazards scholarship also includes on-going research in the science and engineering disciplines – this research did continue alongside the "human aspects" school of thought. The sixth discipline, according to Alexander (1993), is the "technocratic" school of thought. Disciplines in this body of scholarship examine, for example, geology, geomorphology, volcanology, and the engineering solutions that can develop from careful measurement of the natural processes that create disasters. New technologies and developments led to breakthroughs in construction techniques that continue to improve structural responses to disaster. The post-disaster context allows engineers to better understand the interactions between the built environment they have designed and the natural processes which provoke disasters. Although disasters result in great losses, they also provide opportunities for learning no matter the discipline.

Ecology research has investigated the system dynamics which produce disaster. Systems ecologists (e.g. Holling, 1973; Adger, 2006; Walker & Salt, 2006) converse over similar concepts, dynamics, and variables as they seek to understand changes and stressors operating within a defined socio-ecological system. Thresholds and stability in a changing environment as a result of human activities are examined within the nested hierarchies of socio-ecological systems to understand driving forces behind change and resilience. Although these authors do

not refer to radical changes as 'disasters', the concepts are related and improved understanding of these systems will indeed enhance decision-making relating to natural hazard events.

Systems thinking, especially the notions of resilience, offers an alternative perspective on the world and contests practices rooted in concepts which predate systems thinking. "Resilience thinking challenges the widely held notions about stability and resistance to change implicit in risk and hazard management policies around the world" (Adger et. al. 2005 cited in Berkes, 2007, p. 287). For example, fire prevention policies can increase vulnerability to large and disastrous fires by inhibiting natural fire cycles. Whereas, policy prescriptions from resilience thinking would favor creating disturbances (small fires) in order to mimic the natural fire regime in the fire-driven landscape mosaic, along with requiring the removal and recycling the fuel load accumulated on the forest floor (Berkes, 2007). This resilience thinking approach to policy is significantly different from the recent policy prescriptions which were based on stability and resistance thinking. As this example explains, resilience thinking examines the entire socio-ecological system and seeks solutions which incorporate interacting processes thus leaving the *entire* system more resilient to stress and change.

Scholars researching disasters in LDCs acquired a slightly different interpretation of the primary challenges for managers by identifying different origins of disaster. "Human vulnerability – a characteristic of the poorest and the most disadvantaged people – emerged as an important concept" for these radical scholars in the late 1980s (Blaikie et al., 1994 cited in Smith, 2007, p. 4). Thus, the link between underdevelopment, poverty and the occurrence of disasters became more disconcerting. These "structuralist" scholars were influenced by dependency theory and economists such as Marx, who "felt that conflict-based relations among economic classes determined development" (McEntire, 2004, p. 194). As a result, it was acknowledged that often the impacts of disaster could be traced to much more deeply-rooted problems in society and, therefore, successful disaster mitigation would require a fundamental shift in the distribution of wealth and power (see Blaikie et al., 1994; Hoffman & Oliver-Smith, 2002; etc). Analyses identified that disasters occurred because of characteristics inherent to society and disaster victims cannot be blamed for their misfortunes when effective responses are limited by access to resources (Smith, 2004, p. 6).

Anthropologists also studied 'marginalization syndrome' and the role of disaster in the socio-economic development and environmental transformation. Marginalization syndrome research

investigates migration and settlement relocation programs (Oliver-Smith, 1991), and the need for the involvement of advocates for the most disadvantaged groups, including elderly, disabled, ethnic minorities, women and children (often worse affected by disaster than men and adults) (Oliver-Smith, 1991; Cutter, 1995; Peacock et. al, 1997 cited in Comfort, et al., 1999). Global socio-economic processes, through time, have a tendency for marginalization of communities, causing environmental change or overexploitation of natural resources (e.g. deforestation) (Batterbury et al., 1997). Poverty in LDCs can encourage marginalized groups to further exploit the resources which also serve as natural protection from hazards. Research on marginalized groups, vulnerability and environmental change now encourages a 'hybrid' model of both sociological and physical research when seeking the sources of environmental transformation in LDCs (Batterbury et al., 1997).

Similarly, entitlements theory is important to the modern understanding of vulnerability (Pelling, 2003). Household entitlement assets include: labour, savings, land, cattle, goods, housing and social support; thus the exchange value for these assets relative to the price of essential market goods (food, water, shelter) can help determine a household's level of vulnerability (e.g. Sen, 1981 cited in Wisner et al., 2004).

> That households can fail in spite of wider economic conditions reveals how individual vulnerability operates with a degree of *independence* from structural conditions such as poverty. However, poverty and vulnerability frequently overlap and it is the poor who are also vulnerable who will suffer the most from environmental stresses and risk (Pelling, 2003, p. 52).

Entitlements theory, also known as sustainable livelihoods, addresses an important factor of vulnerability from the perspective of poverty reduction actions; therefore, a more thorough dialogue about the topic follows later in this chapter.

2.4 Disaster Risk Reduction in Practice

The discussion thus far has summarized some of the major scholarship in the literature on natural hazards and vulnerability. Now practical applications of this literature will be explored.

Scholars have developed systematic methods through which to measure vulnerability and identify differences in coping capacity, adaptation and adjustment in a variety of contexts. Several models for measuring vulnerability, risk and impacts from natural hazard events exist. Birkmann (2006) identifies ten such models within the first chapter of his book *Measuring Vulnerability to Natural Hazards*, and surely there are more frameworks that could be created

with distinct, new areas of focus. Wisner et al (2004) note that although metrics are necessary, "these indicators are not sufficient, and we are aware that they tend to under-emphasise the cultural, the psychosomatic and the subjective aspects of disaster impact" (Perry and Mushkatel 1986; Oliver-Smith and Hoffman 1999; Johns 1999; Tuan 1979 cited on p.15). Nonetheless, models offer useful decision-making tools and generate an increased understanding of possible outcomes by developing scenarios and elucidating trends. Elaboration of specific models for vulnerability analysis, ranging from the Pressure and Release Model through urban risk reduction planning, will identify some of the primary factors that differ across case studies and will enlighten points of consideration for the evaluation framework to be discussed in the next chapter.

2.4.1 *Pressure and Release (PAR) Model*

The Pressure and Release Model is a frequently referenced model in vulnerability analysis (Few, 2006; Adger, 2006; Cannon, 2008; Turner et al., 2003; Smit & Wandel, 2006; etc.). The first version was created in 1994, and in 2004 a second edition updated the original by including criticisms and answering questions other scholars posed to the authors (Wisner, et al., 2004). The Pressure and Release (PAR) Model allows decision makers to identify opposing pressures that together create risk. On one side, the hazard pressures, both natural and human-induced are identified and opposing these are the causes and pressures that interact to make people vulnerable to these hazards (See Figure 8).

Starting with the 'Progression of Vulnerability' side of the diagram, the root causes are spatially or temporally distant factors and are also bound up in the ideology and beliefs within the local society and the world economy (Wisner et al., 2004, p. 52). Many of these root causes developed generations ago based on the values and beliefs of ancestral residents from the country in question. Despite these distant roots, historic values permeate into current cultures and affect present day social practices. For example, "to understand the motors shaping trends in urbanization and disaster risk, it is necessary to look beyond population statistics to changes in the form, composition and governance of human settlements" (United Nations Human Settlements Programme, 2007).

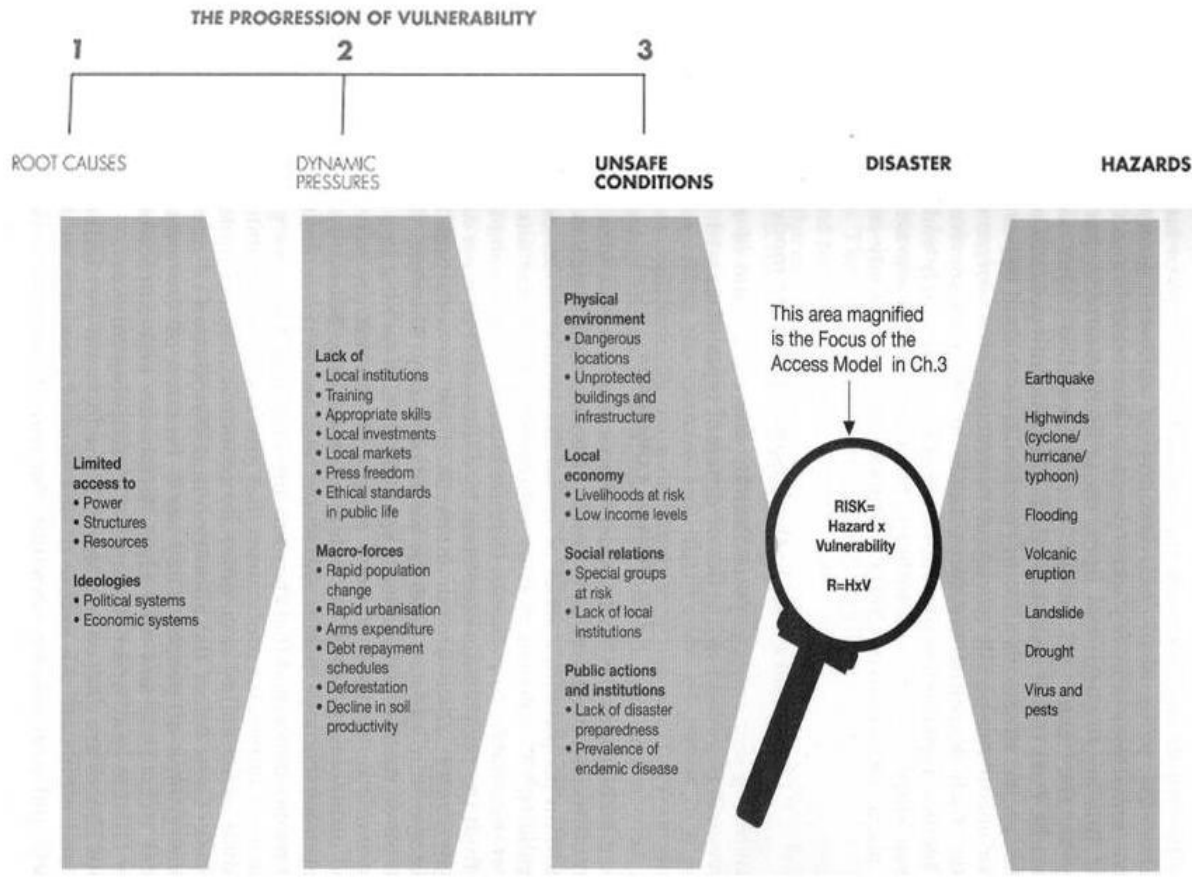


Figure 8: Pressure and Release (PAR) Model

Source: (Wisner et al., 2004)

The PAR model allows decision makers to investigate beyond the superficial cultural traits (e.g. littering or drying young trees for firewood) and better understand how the individuals perceive and respond to the natural threats of their environment. Undoubtedly there are a variety of perceptions of the natural hazards in a region as well as varying views on the severity of the risks. The differing opinions about the risks can vary based on the length of time a person or family has resided in the region or the type of livelihood activities in which one participates.

To better understand the temporal relation between cognition of risk and mitigation efforts, research has been done on social memory. Berkes (2007) discusses adaptive capacity as a function of human agency, including the function of individuals, leaders and institutions as they influence outcomes (p. 287). Collectively, a community's capacity to manage resilience determines thresholds within a socio-ecological system based on their ability create a "social memory" by learning from a society's response to previous crises (Adger et al. 2005 cited in

Berkes, 2007). Thus, root causes of disaster can be linked to a multitude of factors, many of which have long been accepted in a given society.

The research done to create the PAR model determined that government decision makers, NGO practitioners and community leaders cannot improve vulnerability until they better understand the pressures that combine to create a context of risk (Wisner et al., 2004). Social processes, economic goals and political will independently operate in all communities, however, individuals within these groups can act as an obstacle to vulnerability reduction if root causes are not distinguished and understood. Inclusion of community members is acknowledged as an integral part of discerning root causes (Wisner et al., 2004).

Similarly, "unsafe conditions are the specific forms in which the vulnerability of a population is expressed in time and space in conjunction with a hazard" (Wisner et al., 2004, p. 55). This means that the types of work available to the population, food entitlements and initial level of well-being all combine to generate safe, or unsafe, living conditions.

The PAR model is a simple, yet clear, model for identifying sources of risk and vulnerability within individual case studies. The magnifying glass in the centre of the diagram leads to further analysis in what the authors call the Access Model. The Access Model is an assessment tool to improve understanding of the dynamic social relations and structure of a community in order to understand household level decision-making, and is closely related to the 'sustainable livelihoods' approach developed by the United Kingdom's Department for International Development (DFID).

2.4.2 *Sustainable Livelihoods*

Sustainable livelihoods is a concept developed in the early 1990s to better understand and address poverty, especially in LDCs (Chambers & Conway, 1992). Originally it focused on the livelihoods of the rural poor, however, in recent years research in this area has broadened and established applicability for analysis on poverty elimination in *urban* areas as well (Rakodi & Lloyd-Jones, 2002). The link between sustainable livelihoods and disasters is very clear with reference to the sustainable livelihoods framework developed by the DFID (see Figure 9). Not only are there similarities in the vocabulary employed by both the livelihoods and disasters literature (e.g. stresses/pressure, shocks, context), but the objectives, processes and pressures are also often parallel. The objective of the livelihoods framework is to generate resilience to the shocks, trends and/or seasonal shifts that deepen poverty and, thereby reduce their vulnerability

and work toward eliminating poverty (DFID, 1999). Disaster management theory also grapples with preparedness, mitigation, response and recovery from varying natural hazard "shocks" and attempts, where possible, to achieve sustainable development goals.

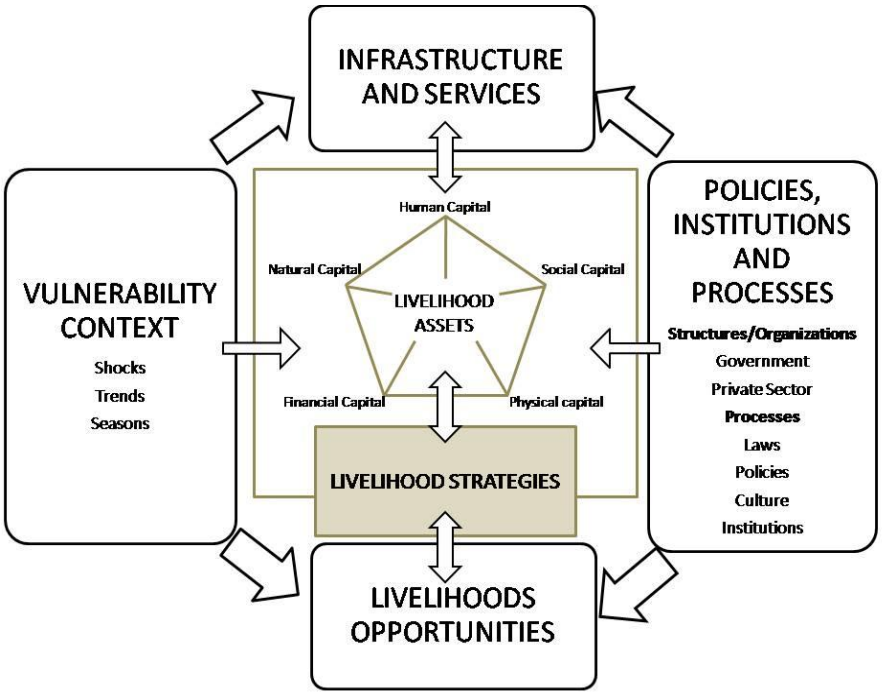


Figure 9: Sustainable Livelihoods Framework

Source: (Rakodi & Lloyd-Jones, 2002, p. 9)

In practice, the sustainable livelihoods framework has some attributes that could be applied in the post-disaster context or to address risks. This framework has been applied by many international development agencies and although each agency developed the livelihoods idea around a different part of livelihoods, the basic concerns are the same (Rakodi & Lloyd-Jones, 2002). Early works on livelihoods came from a discussion paper by Chambers and Conway (1992) where some fundamental characteristics were proposed – equity, sustainability and capability. This document draws on work from several disciplines to discuss measurement of livelihood indicators and quantification of intergenerational equity, and questioned what could make rural livelihoods more sustainable.

The central part of Figure 9 is of specific importance to the study of vulnerability to natural hazards. The division of 'capital' into different categories allows governments or aid agencies to understand the areas where investment would be most helpful, and thus improves the effectiveness of foreign investment funding (Chambers & Conway, 1992). This understanding can also be applied to the application of disaster risk reduction or disaster response funding. With

a greater appreciation for the weaknesses a community has (e.g. what could make them vulnerable) investment monies can be directed to those assets which need strengthening.

An important part of the sustainable livelihoods framework is the involvement of local residents in decision-making. Public participation generates solutions which not only address the problems from the perspective of those affected, but also empowers those affected and ensures their resilience to future events (Rakodi & Lloyd-Jones, 2002; Chambers & Conway, 1992). The argument for participation links to the need for an *integrated* approach as found in many development and natural resources management fields. However, the livelihoods link is specifically useful to the disaster management discussion because, as the PAR model discusses, unsafe conditions are a result of dynamic pressures which serve as catalysts for problems rooted in a social structure. Therefore, understanding the sources of capital, along with the contextual factors that make up a society will improve vulnerability assessments and post-disaster recovery planning efforts. This understanding is best gained in consultation with the community at-risk.

The concept of sustainability seeks to ensure inter- and intra-generational equity. In that way, sustainable livelihoods can consider how disaster risk reduction efforts today impact the individuals and communities of the future. Discounting is one method of cost-benefit analysis, taken from economics. Discounting considers social costs but generally gives a lower present value to benefits and costs the further into the future you look (Chambers & Conway, 1992). In order to maintain inter-generational equity and to account for increasing population numbers and greater pressure and competition for livelihoods (assuming current population growth continues), the future present values *should* be higher than current costs and benefits (Chambers & Conway, 1992). How effectively a manager measures present value in future time periods can greatly affect the outcome of a natural hazard event. Government decision makers are challenged to address current concerns and priorities, while also calculating losses from *unknown* future events. Uncertainty, limited financial resources, and corruption are the reality under which LDC risk reduction programs operate and result in higher present values for current time periods. The fundamental incongruence of economic priorities (those that advocate for future citizens and their livelihoods) and political priorities (where politicians aim to please and appease the current electorate) makes risk reduction planning a difficult balancing act.

Hazards theorists wrestle with the management challenges that arise from a growing global population, especially now that the majority of people are living in urban areas. The competition

for livelihoods feeds a cycle of poverty for some, while assisting others, often those with a good supply of capital resources, to overcome the challenges of poverty (Rakodi & Lloyd-Jones, 2002). The link between vulnerability and capital supply is quite simple. Those with resources are better able to build stronger housing, have the ability to purchase land and resources, work together with neighbours to rebuild their homes after interruption or may simply avoid high-risk areas in the first place because of access to better information (Chambers & Conway, 1992). The research done on livelihoods has allowed disaster managers to better understand who the worst affected are and why they are not able to prevent losses. Although sustainable livelihoods theory is not specific to disasters, is readily applicable to a variety of hazards, even complex hazard events (those where multiple hazards impact simultaneously).

As with other literature on sustainability, there is contention on the effective measurement of 'sustainable' livelihoods. In addition, contextual differences across case studies mean that individual capabilities differ, therefore, a universal prescription to improve poverty levels has been impossible. Despite challenges, international development agencies such as CARE International, the Canadian International Development Agency (CIDA), the World Bank and the United Nations Development Program (UNDP) have all built on the information generated from DFID discussion papers (such as the Chambers and Conway paper of 1992) to run programmes geared at creating more sustainable livelihoods in many LDCs (Rakodi & Lloyd-Jones, 2002, p. xv). Sustainability, when paired with disaster management, can help to inform communities of their risks, strengths and overall better prepare them to deal with the many types of challenges they face.

Sustainability concepts have been debated in the hazards literature as well. The resistance and resilience paradigms of the 1990s proved to be important for the evolution of natural hazards literature and the understanding of vulnerability (McEntire, 2005). The resistance paradigm was created in response to the concern for growing losses, but critics found it to imply that disasters can be *eliminated* and that preparedness, response and recovery would no longer be required (McEntire, 2005). The resilience paradigm was therefore developed to capture these shortcomings as it has a broader, more flexible association within hazard mitigation. However, some concern arose over the use of 'resilient' as well. The dictionary definition of resilient asserts that a community has "the ability to recover from and adjust easily", which implies that a disaster will indeed occur (Geis, 2000, p. 152 cited in McEntire, 2005, p. 209). Because of the

shortcomings of both these viewpoints a substantial following developed in the USA for a new wave of research that combines disaster studies and sustainable development. These schools of thought took valuable lessons from past thinking and informed the popular discourse of Sustainable Hazard Mitigation.

2.4.3 *Sustainable Hazard Mitigation Framework*

Sustainable Hazard Mitigation, as designed by Mileti (1999) was created out of an analysis of disaster response in the USA. The author's evaluation of current practices determined that the current FEMA emergency management plan was inadequate because it focused primarily on the capacity for a strong response in emergency situations. The Integrated Emergency Management plan was cyclical and responsibilities were delegated to local, state and federal actors, however, the Mileti questioned if this framework was truly reducing losses. Other authors (e.g McLoughlin, 1985; Cutter, 2003) also question the loss reduction results FEMA was achieving. Not surprisingly, 'sustainability' came up in this evaluation, as it did in the livelihoods debate, as an important concept that should be part of a disaster management scheme.

Current practice, and specifically sustainable hazard mitigation, calls attention to the early stages of the disaster management cycle and suggests a redirection of the focus away from "ad hoc, disaster-driven, and reactive systems and policies" (Cutter et al., 2008, p. 601). Earlier assessments in the 1970s found that "pre-disaster planning can save lives and injuries, limit property damage, and minimize disruptions, enabling communities to recover more quickly" (Mileti, 1999, p. 10). Along with this viewpoint came a change in the interpretation of what 'recovery' really entails. Recovery went from being a linear process of stages and products to a process of decision-making and interaction among stakeholders (Mileti, 1999).

Mileti (1999) stressed that disaster risks should be considered *prior* to a disaster event where response is needed. He also questioned then-current strategies for managing hazards; which he referred to as "the traditional planning model: study the problem, implement one solution, and move on to the next problem" (Mileti, 1999, p. 2). To improve on current disaster approaches, sustainable hazard mitigation "links wise management of natural resources with local economic and social resiliency, viewing hazard mitigation as an integral part of a much larger context" (Mileti, 1999, p. 2).

Mileti (1999) developed the following guidelines to improve hazard mitigation:

- Adopt a global systems perspective
- Accept responsibility for hazards and disasters
- Anticipate ambiguity and change
- Reject short-term thinking
- Account for social forces
- Embrace sustainable development principles

(Mileti, 1999, pp. 12-13)

These guidelines link back to complementary literature and findings. Complex systems literature allows decision makers to understand multiple processes which take place within a defined system. Much like the PAR model's ability to identify opposing pressures that generate risk, the sustainable hazard mitigation framework chooses to use systems thinking to comprehend multiple processes. Concepts taken from sustainable development include equity and preservation to ensure acceptable quality of life in present and future generations. All of these fields of research are related and by integrating concepts through the above listed guidelines it will be possible to create a hazard mitigation planning model that is sustainable. Mileti's notion for the future will involve all actors working together to generate strong leadership from state and national governments while using local experts and residents to complete the planning process (Mileti, 1999, p. 6).

Hazard mitigation is often done within the bureaucratic confines of a single government body (e.g. the ministry of environment or natural resources). Nevertheless, there are other decisions being made outside that entity that affect vulnerability. Recognition of natural hazards in the early stages of urban development, infrastructure distribution or other construction projects can mediate vulnerability concerns before they threaten lives. For this reason, cooperation and coordination, including clear roles and responsibilities, are strongly encouraged (Clinton, 2006).

2.4.4 *Urban Planning and Hazards*

While contemplating vulnerability and livelihoods in an urban setting one might question how and why these problems began in the first place. Many modern cities in the global South were developed by settlers based on perceived safety and convenient access to specific resources, as was the case during colonization in North America. These distant foundations now face economic and political pressures, as they did historically, although advantages for defense, transportation and political considerations often trump ecological threats (especially if only certain portions of the settlement are at present risk) (Hardoy, Mitlin, & Satterthwaite, 2001). As

populations grew larger, professional urban planners aided in the organization of such settlements, however, if flooding and other threats were not easily mitigated in situ, some communities were left at-risk. With rapid growth from rural-urban migration, the ever-pressing need for effective hazard planning was recognized. Furthermore, "it is in the South that urbanization processes are intensifying at a really disconcerting rate" (Stevens, Coupe, & Mitlin, 2006, p. 1).

Urban planning literature recognizes that "urbanization affects disasters just as profoundly as disaster can affect urbanization" (Pelling, 2003, p. 7). In response, there are recent efforts to address vulnerability concerns from the planning perspective. Nonetheless, "for good reason, a physical science approach is often preferred by urban planners… [because these approaches] are visible and can unambiguously show the electorate and potential investors that the government is responding to risk" (Pelling, 2003, p. 49). As discussed earlier, these physical or structural approaches have been ineffective for loss reduction due to improper hazard risk estimates or changing land values associated with the construction of a protective structure. Consequently, new and creative methods to improve loss reduction, whilst maintaining the status quo, are desired.

Formerly, piecemeal approaches to development were the standard, and inefficiencies in the administrative infrastructure have further exacerbated vulnerability (Pelling, 2003). The manner through which management of urban expansion and development has occurred has a strong correlation with the amount and extent of risk present, and also impacts the groups who are most at-risk (Hardoy, Mitlin, & Satterthwaite, 2001). Therefore, just as other disciplines acknowledge the need for cooperation and multi-disciplinarity, planners have conceded to the need to work together with other actors.

"Most frequently, [urban] disasters are linked to a breakdown or blockage in communication between scientists, politicians, emergency services and the public" (Pelling, 2003, p. 34). Challenges to communication stem from the varying scales at which governments, NGO's and community-based organizations operate. NGOs often mark their "turf" to receive credit and see the fruits of their labour in select communities (Stevens, Coupe, & Mitlin, 2006). For example, hazard education programs may be offered by several NGOs in one country, in addition to an independent government program. This redundant programming can result in uneven, disconnected levels of awareness within and across communities. Thus, best results occur when

boundaries for program delivery match an existing political boundary. Finally, efforts to reduce poverty and improve livelihoods achieve the best results when government support is gained in early stages of planning (Stevens, Coupe, & Mitlin, 2006). This discourages unhealthy competition for the well-being of all parties and the community.

Hazards that threaten urban areas can differ from rural threats, in terms of exposure, scope and type. "Although 'natural' disasters are distinguished from 'human-induced' disasters, in cities, most of the deaths and injuries from the natural disasters are not 'natural' in that they occur because of inadequate attention to disaster-prevention, disaster-mitigation and disaster-preparedness" (Hardoy, Mitlin, & Satterthwaite, 2001, p. 120). This is likely the case in rural contexts as well. Nevertheless, the wider distribution, reduced concentration and lower organization level of settlements and people in the rural context makes it more difficult to develop plans, while simultaneously leaving a greater timeframe for response in times of emergency. High concentrations of people in urban areas, where the landscape and threats are arguably more continuous, accentuates the necessity for a disaster plan which is specific to a mosaic of risk areas and which focuses on the prevention, mitigation and preparedness needs of a diverse population.

Hardoy, Mitlin and Satterthwaite (2001) conclude with six aspects that they feel should be on the "new environmental agenda for urban centres" (p. 384).

> 1) institutional shift within governments and new roles of aid agencies
> 2) a shift from improving urban management to 'good governance'
> 3) a more effective framework of support for citizens' groups and NGOs within more accountable and transparent government structures
> 4) a more explicit linking of 'environmental improvement' with poverty reduction
> 5) locally driven agendas within each urban centre that respond to the specifics of each location, society and culture within national frameworks that reward good 'global' practices and
> 6) new professional attitudes (Hardoy, Mitlin, & Satterthwaite, 2001, p. 384)

These six items have a striking resemblance to the ideas found in the section Landmark International Structures earlier in this chapter. Concerns for "good governance", changing roles of aid agencies to empower local governments and a need to integrate poverty reduction with "environmental improvement" strategies are some items to note (Hardoy, Mitlin, & Satterthwaite, 2001, p. 384). Since the beginning of this century, academics across disciplines, and even those dealing with distinct aspects of life in LDCs, are drawing similar conclusions about the way forward, demonstrates that now is the time to act and put identified lessons into action to start improving the lives, livelihoods and the vulnerability of our world's poor.

Sustainable livelihoods research may be criticized as being too comprehensive – solutions are difficult to find when myriad processes and structures are perpetuating a given circumstance. Integrated Urban Development complements sustainable livelihoods research because it recognizes that poverty in urban areas is multifaceted, but differs in that it concentrates on the relationship between financial, social and physical capital (Stevens, Coupe, & Mitlin, 2006). For example, NGO-supported income generation activities can face a range of external forces (e.g. market prices, economic downturn, etc.), and therefore collective activities (social capital) become vital to the ability of individuals to continue improving their quality of life (Stevens, Coupe, & Mitlin, 2006, p. 6). In the same way, one might consider risk reduction activities to focus on the relationship of natural, social and financial capitals. For example, when the exploration of the natural hazards facing a community are compared to the social and financial resources available to prepare, mitigate and/or respond to potential impacts.

Thus far in this chapter, challenges for decision makers have been identified, methods for distinguishing and understanding the innumerable processes that generate and perpetuate vulnerability and, complementary fields of influence have enlightened the discussion. This chapter ends with a summary of the place-based model for understanding community vulnerability to disasters from Cutter et al. (2003) and other measurement tools for social vulnerability. Recognizing that substantial research attention has been devoted to understanding the biophysical dimensions of disaster vulnerability, Cutter et al. (2003) argue that much less attention has been given to the social conditions that make people and places more or less susceptible to environmental hazards (cited in Myers, Slack, & Singelmann, 2008, p. 272). In response to that gap in the literature, this thesis will investigate the social vulnerabilities at the community level. Although it is recognized that wider socio-ecological systems have many vulnerable elements, it is the social vulnerability that truly determines the economic impacts and number lives lost to a disastrous event.

2.4.5 *Disaster Resilience of Place (DROP) Model*

Even with decades of research on vulnerability and hazards, the creation of metrics, and models for vulnerability identification, significant vulnerability reduction policy commitments are lacking in both developed and developing countries. Cutter et al. (2008) developed the disaster resilience of place (DROP) model "to improve comparative assessments of disaster resilience at the local or community level" (p. 598).

The DROP model has in it several implicit assumptions. First of all, it applies to both rapid onset and slow onset hazards and although it was primarily designed for natural hazards, it can be applied to other crises such as terrorism or technological hazards (Cutter et al., 2008). This model was designed to apply at the community level in contrast to other models which apply to macro, meso- or sectoral scales. Third, this model focuses on the social resilience of places with recognition that other sources of vulnerability are inextricably linked to social processes. This model has integrated resilience thinking by interpreting a community as a socio-ecological system with social and environmental processes inseparable (Cutter, et al., 2008).

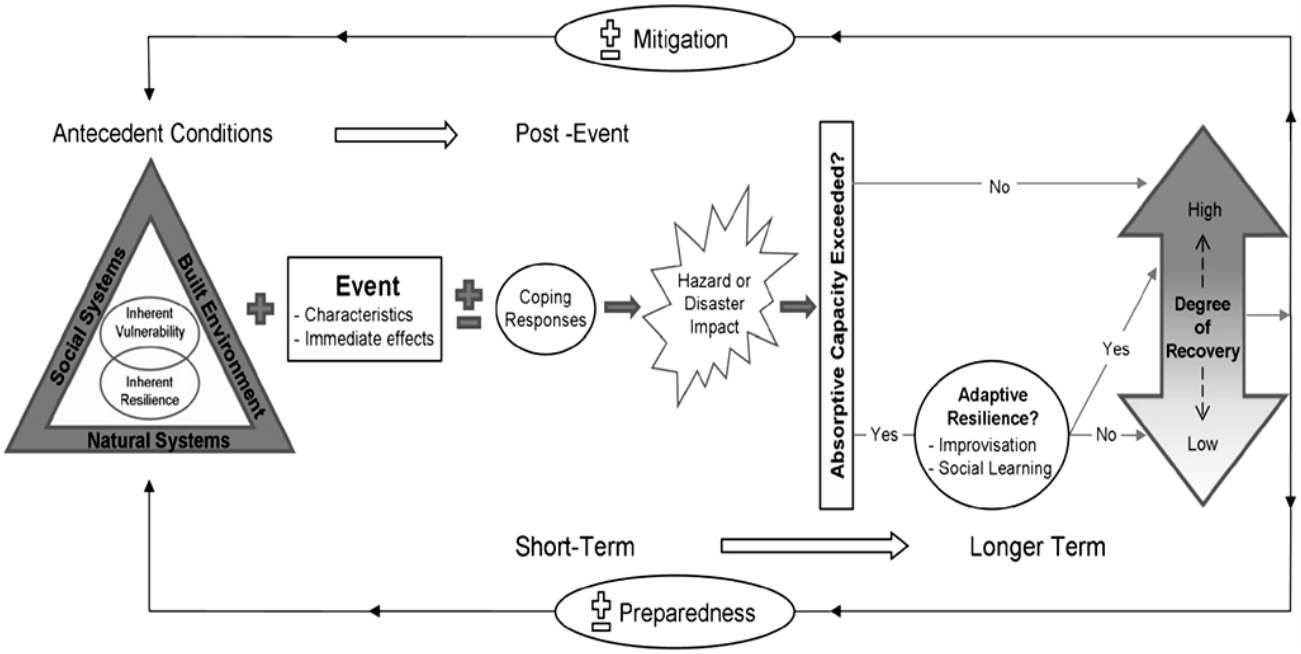


Figure 10: Schematic representation of the disaster resilience of place (DROP) model
Source: (Cutter, et al., 2008)

The DROP diagram begins with antecedent conditions including the internal processes at the local, community scale (smaller triangle) and external factors (larger triangle) that come together to create a given socio-ecological system (Cutter, et al., 2008). These inherent characteristics are then enhanced (represented by the + sign) or attenuated (- sign) based on the actions and event characteristics (frequency, magnitude, rate of onset etc of the hazard). When a community has pre-determined coping responses, the impacts can vary in intensity (i.e. be more or less disastrous). These pre-determined capacities also influence the 'degree of recovery' because a stronger set of coping mechanisms will allow the community to absorb more of the impacts. When the absorptive capacity is exceeded the community may respond by developing adaptive resilience strategies. One such strategy, 'social learning', can be expressed through policy

making and pre-event preparedness improvements which are then incorporated into the next event's "antecedent conditions" and the cycle continues (Cutter, et al., 2008).

The final section of the DROP model determines the range of recovery based on the adaptive capacity threshold. When the threshold is not exceeded, there is high recovery potential. When the absorptive capacity is exceeded, the adaptive resilience will determine whether there is a high or low rate of recovery. Ultimately, "both the degree of recovery and the potential knowledge gained from the adaptive resilience process influence the state of the social, natural, and built environment systems and the resultant antecedent conditions for the next event" (Cutter, et al., 2008, p. 603). There is feedback in the system as well and this is shown through the mitigation and preparedness modifications that occur from one event to the next. Social learning has a positive influence on mitigation and preparedness improvements. Cutter et al. (2008) distinguish between "learning" in terms of social resilience and "lessons learned". "Lessons learned" focuses on what went wrong or right in the debriefings immediately following the event (i.e. identification of lessons), while "learning" is an ongoing process of incorporating changes into a program or institution and includes a monitoring or performance evaluation component.

There are some similarities between the PAR model and the DROP model because both analyze vulnerability. Both require collection of data in order to measure "antecedent conditions" or "root causes of vulnerability". The feedbacks in the PAR model are emphasized in the Access Model under the magnifying glass, but can also be applied to the community level as they are in the DROP model. Most notably, both models assume social, natural and built environments as interconnected and therefore base their analysis on a single socio-ecological system. The DROP model connects complex adaptive systems theory to hazards literature in order to draw connections between adaptation and resilience which has been lumped in with "mitigation" by other hazards scholars. A strength of the DROP model is, consequently, that this linkage improves their model's ability to compare assessments at the local level across time and in similar contextual case studies.

Although the PAR model has a longer history, the DROP model has incorporated some aspects which enhance its appeal. First, the diagram has no underlying parts so analysis is straightforward. Second, although somewhat figurative and not quantitative, the use of scales for absorptive capacity and degree of recovery is a helpful measure for comprehending how pre-disaster resilience affects the post-disaster outcome. This understanding can then aid the

allocation of funding and direct focus in the immediate disaster recovery and for longer term planning. This discussion does not aim to encourage the use of one model over the others, but rather to demonstrate how understanding of socio-ecological systems has changed the interpretation of vulnerability and disaster management.

2.5 Vulnerability Indices

In socio-ecological systems many interacting processes take place simultaneously. Some of these processes are more easily quantified than others. Vulnerability is a complex phenomenon resulting from these interacting processes and is therefore a challenge to measure and monitor. Many authors (e.g. Cutter, 1996; Hewitt 1998; Oliver-Smith 1996; Wisner et al. 2004) have discussed the influence of social and economic stratification on vulnerability. The inclusion of "social vulnerability [into management regimes] encourages the framing of disasters as social phenomena moderated by the existing social structure" (Myers, Slack, & Singelmann, 2008, p. 273). To quantify social vulnerability, a Social Vulnerability Index (SoVI) was developed by Cutter et al. (2003). The outcomes of this evaluation can "facilitate an understanding of geographic contours of regional disasters" in the United States (Myers, Slack, & Singelmann, 2008, p. 273). The SoVI is a place-based model considering a range of variables and demographic data ranging from density of the built environment, housing stock and tenancy, racial and ethnic composition etc. (Myers, Slack, & Singelmann, 2008). As previously noted, resources and assets influence one's ability to maintain their livelihoods and in the wake of disaster understanding the supply of those resources is ultimately helpful for discerning social vulnerability.

Other indicators exist for the measurement of vulnerability; the most common being the vulnerability and capacity assessment (VCA) technique used in the preparation of a disaster response plan, and the needs assessment checklist used immediately following disaster impacts. Some authors feel, however, that social, economic and demographic characteristics, collected via VCAs and needs assessments, do not isolate appropriate variables and characteristics to accurately measure community-level vulnerability (King & MacGregor, 2000). The problem with the use of such characteristics relates to the bias in generating planning and mitigation strategies based on databases constructed by the very government decision makers who will then use them.

A variety of indices have been created to measure vulnerability or humanitarian response (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007; Hidalgo & López-Claros, 2007). While these indices provide a database of information that can identify "hot spots" of vulnerability, they also have their weaknesses, 1) indicator selection is often supported by untested assumptions about the factors and processes leading to vulnerability; 2) it is difficult to measure the complexity and variability of multiple factors and stressors across places; and 3) their focus is often on too small a portion of the human-environment interactions (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007).

Additionally, caution must be taken when comparing rankings across similar indices. There are numerous reasons why an advantaged community according to one index is not necessarily the opposite of a disadvantaged one on a seemingly opposite index. Melick (1996) found this disconnect when comparing rankings from a vulnerability index to those of a resilience index: a highly vulnerable community was not necessarily lacking resilience (King & MacGregor, 2000, p. 53). This brings about the importance of definition – recall that Cutter et. al. (2008) defines vulnerability and resilience as overlapping, not opposing terms.

Regardless which indicator is used, "the census remains the primary source of easily available social indicators" however, even with up-to-date data, these indicators are of limited assistance. While some scholars have advocated for improved indicators and more appropriate use of such indicators, other authors suggest there is "limited development and application of accessible Social Vulnerability tools and methodologies" (Davis, 2003, p. 5). The primary obstacle is one of taking the *"useful"* information from the literature and making it *"useable"* and practical by defining the 'who', 'when', 'where', 'how' and 'why' questions so action can be taken to reduce identified vulnerability (Davis, 2003). Davis (2003) offers a list of hypotheses as to why governments and NGOs seem to avoid applying the SoVI that are available. Some of these explanations include: lack of any agreed set of indicators of social vulnerability, lack of social scientists to conduct assessments, or reliance on hazard mapping as the sum total of vulnerability assessment (p. 5-6). Consequently, social vulnerability seems to be a growing interest among academics and disaster managers alike.

2.6 Monitoring and Evaluation in Disaster Management

Several scholars (Godschalk et al., 1999; Cutter, 2003; McLoughlin, 1985; Mileti, 1999) etc.) have critically assessed disaster policy in the USA. These assesments aim to improve disaster management, reduce losses and increase awareness about the risks of living on fragile or unsafe ground. These authors tend to agree on the need to improve mitigation strategies in the USA. Therefore, much research has been done on the complex processes that underlie one's motivation for adopting and implementing mitigation strategies. "The overwhelming scientific evidence [shows] that people typically are unaware of the hazards they face, underestimate those of which they are aware, overestimate their ability to cope when disaster strikes, often blame others for their losses, underutilize pre-impact hazard strategies, and rely heavily on emergency relief when the need arises" (Mileti, 1999, p. 136-7). Hazard managers and planners have used experimental methods as they developed good practices for disaster management, however, monitoring and evaluation of the use of these techniques is lacking in both the USA and elsewhere.

All types of projects which have goals in the short- and the longer-term require some form of monitoring and evaluation to determine if the project goals have in fact been reached; disaster management projects are no exception. Actually, due to the dynamic nature of the natural and social environment in which disaster projects are executed, the project must become a continuous process where changes can be incorporated easily (Mileti, 1999; Wisner et al., 2004). Specifically in the post-disaster context, disaster risk reduction projects are very much a part of this dynamism and change. Structural design changes to rivers, such as dams or canals, are engineered to have specific effects. However, without any future review of the construction, there is no certainty that the desired effects will indeed result or at least be maintained.

Social programs can also create change in the natural environment or be changed by that environment. Vulnerability to natural hazards, in LDCs, is often a result of ignorance or lack of understanding (Abramovitz, 2001; Alexander, 1993). In addition, individuals do not make decisions in a vacuum, but rather are exposed to others who are weighing out the same cost-benefit analysis and become influenced by group and democratic decisions (Mileti, 1999). Thus, social components of a response and reconstruction program also must be considered when measuring successful reduction of risks.

Similarly, the rural-urban migration that has occurred within LAC in recent years is not based on knowledge of the natural environmental conditions, or at least not those of the new urban

settlement location. Aide and Grau (2004) cite declining agricultural conditions, dwindling forest resources as well as the cultural and economic attraction as some prime motives for urban migration in LAC. Therefore, it is recommended that preparing rural migrants for the urban environment be part of social and conservation policies because it would promote ecosystem recovery in rural areas, but also because it would impact the settlement selection process of migrants in their new urban setting (Aide & Grau, 2004). On-going social phenomena such as migration create dynamic social pressures which are rarely erased by a disaster. Many studies have proven that people prefer to return to their familiar, yet high-risk homes, rather than relocate to a new, safer house elsewhere (Oliver-Smith, 1991; United Nations Human Settlements Programme, 2007; Myers, Slack, & Singelmann, 2008; Wisner et al., 2004). Therefore, monitoring and evaluation of social activities becomes just as important post-disaster, as it is in normal circumstances.

The ISDR has acknowledged the need for on-going studies and research to ensure cost-effective and sustainable reporting of progress on HFA goals and overall DRR (ISDR, 2007b). However, the ISDR has relieved itself of the responsibility of achieving the HFA goals by putting the onus on national governments to ensure they are initiating DRR programs and monitoring their own local and national initiatives. As is well-known, most of the countries at greatest risk of disaster are poor countries which have been impacted by some form of catastrophe recently. LDCs, whether recently impacted by disaster or not, require more concrete assistance than the HFA guidance provides if they are to make real and lasting progress towards the HFA goals.

In summary, this chapter has reviewed literature from a breadth of disciplines and some concerns have repeated themselves throughout history without clear solutions. Great improvements have been made in disaster response due to successful warning and evacuation as a result of lessons learned from previous disasters. However, development in LDCs is still being inhibited by disaster, even in those countries with solid disaster management plans. Integration of the concepts of vulnerability measurement into broader development goals has been encouraged by NGOs working in the field and yet methods for such integration have yet to be initiated.

To address this gap in the literature, a framework for evaluation of DRR effectiveness was created for this thesis. An Assessment of Post-disaster Risk Reduction Effectiveness (PDARRE)

Post-Disaster Assessment of Risk Reduction Effectiveness Criteria Evaluated	Rating	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Socio-economic System					
current vulnerability and capacity assessment data for affected population?					
indicators/monitoring of progress on risk reduction/sust. hazard mitigation?					
standardized and inclusive community awareness programs?					
community education programs geared toward the development of a culture of safety?					
recovery made to benefit and improve livelihoods, quality of life and tenure concerns?					
enhance and encourage community cohesion, inter/intra-generational equity and social capital?					
creation of an insurance program based on vulnerability assessments?					
encouragement of entrepreneurship?					
creation of business continuity plans to rebuild and enhance local economy?					
Instituational Concerns					
availability and use of previously identified lessons for risk management (local/similar hazards)?					
existence of functioning public disaster relief system?					
cooperation within and across government bodies, NGOs and community?					
clarity of responsibilities, roles and relationships (pre)defined?					
efforts to ensure continuity and stability over time in government bodies? (redundancy)					
set corresponding 'acceptable levels of risk' in all relevant ministries? (e.g. housing, planning, environment, natural resources, emergency management etc.)					
empowerment of local governments to manage recovery?					
staff retention schemes to maintain capacity through various emergency events?					
inclusion of private and public sector actors?					
effective use and monitoring of DRR funding and financial capital with a focus on strengthening government (esp. local) recovery institutions, equity and sustainability?					
Biophysical Environment					
use of current hazard maps in future planning and development projects?					
understanding and documentation of function and change in bio-physical systems?					
current models predicting/forecasting probability and severity of hazard events?					
process defined/available staff to update models post-disaster?					
exitence of and evaluation of early warning system?					
preparation for multiple hazard/complex hazard or rare events?					
efforts made to use and enhance natural barriers and protective structures?					
Built Environment					
appropriate use of technology and engineering for risk reduction?					
response efforts aim to 'build back better' structurally and economically?					
reconstruction projects address need for social housing and low-income housing needs?					
redundancy in infrastructure? (e.g. evacuation routes, communication lines etc.)					
existence and enforcement of building codes for reducing risks?					
Legislation Concerns					
zoning and enforcement of high hazard areas?					
policies which foster principles of sustainable livelihoods (capacity, equity, sustainability) at local, and national levels as well as at all stages of disaster cycle?					

Table 2: Assessment of Post-disaster Effectiveness in DRR[7]

[7] Sources: (Clinton, 2006; ISDR, 2005; Benson, et. al, 2007; Comfort, et al., 1999; Cutter, et al., 2008; Davis, 2003; Manuel-Navarrete et. al 2007; UNDP, 2006; Mileti, 1999)

(Table 2) was created based on the literature and governance structures discussed herein (refer back to the summary in Table 1: Relevant International Governance Guidance Structures). The PDARRE framework is the tool used for analysis of the "biggest debris flow disaster in South America's history" which occurred in Vargas State, Venezuela in 1999.

2.6.1 *Justification of Criteria*

Sustainable development and sustainable livelihoods theory advocate for intra- as well as inter-generational equity. All people have identical rights to life and therefore deserve equal access to information about their risks. An evaluation of disaster response must, therefore, consider the adequacy of the efforts made to inform, evacuate and resettle the affected population. The criteria in the assessment tool thus address (a) the suitability of early warning and evacuation plans, (b) the quality of communication with local populations in generating awareness and a culture of safety, (c) communication effectiveness between all agencies involved in the response, (d) the clarity in identification of roles and responsibilities so as to maintain an efficient response with sufficient redundancies to ensure quality and, (e) whether adequate good information is available regarding vulnerability and capacities within the population at-risk.

Another source of failures in disaster risk reduction is a lack of monitoring and revision of policies in the years following a disaster. As mentioned, a disaster is a good opportunity to identify weaknesses and the recovery phase of disaster management allows for improvements to known areas of weakness. Other criteria in the assessment tool are included to address this need for monitoring and institutional or operational changes. First and foremost, the existence of a functioning public disaster relief system is crucial. A disaster relief system includes community members, local, state and national governments, local businesses, NGOs and financial institutions which fund disaster programs. In order for this system to be "functioning", communication, division of labour and clarity of roles and responsibilities need to be transparent. A criterion addresses the need for capable staff that will transfer knowledge and skills to other employees and future generations. Maintenance of capable and experienced staff will allow

monitoring and adjustments to be made based on lessons identified in past experiences and prevent repeating mistakes made in the past[8].

Good information is fundamental to an effective disaster risk reduction plan. Collection of data on a regular basis and diffusion of that information to all relevant actors allows decisions to be made based on the most current information. The criteria used to evaluate the availability and use of good information are as follows: (a) understanding and documentation of function and change in the biophysical system, (b) use of models for the prediction and forecasting of hazards, (c) preparation for multi-hazard/complex hazard and rare events, (d) set of corresponding "acceptable levels of risk" in all relevant ministries and, (e) standardized and inclusive community awareness programs. Together these criteria ensure that information about the specific contextual risks and vulnerabilities, both physical and socio-economic, are known and shared with those living in high risk or unsafe areas.

2.6.1 *Comments regarding the PDARRE tool*

To fully understand the assessment, there are some points which demand elaboration. The imbalance of criteria toward a more heavily *social* weighting is a result of the fact that "all disasters are essentially social occasions that primarily have to be dealt with by social more than technological means" (Quarantelli E. , 1994). This demands strong institutional policies and a staff of capable people so that many of the social vulnerabilities may be reduced in addition to addressing the need to identify physical hazards and protect against them. Focusing the criteria toward institutions and social variables makes it easier to translate the evaluation results into clear actions with identifiable outcomes.

The scale chosen for assessment (poor, adequate, good) reflects the fact that most of the criteria will have been noted by decision makers and disaster management practitioners prior to a disaster. A rating of "poor" indicates that there is some evidence of an attempt to address the criteria, although the results are insufficient. Criteria rated as "adequate" demonstrate clear efforts are being made to improve upon the given action or output, although there is still room for improvement. Finally, the best ranking of "good" means that action has satisfactorily met the

[8] Use of consultants and outside help is often an effective method to find the right, experienced person to complete a project or assessment. However, this also leads to loss of capacity within an institution long term. Poor pay and lack of training opportunities at an institution will often lead to high turnover and create a perpetual lack of capable personnel. Thus, it is important to maintain capable staff and encourage training wherever possible.

minimum requirements for that criterion. The scale was designed, however, to imply that there is always room for improvement and that monitoring of each criterion is needed so no criterion will ever be without further need of attention.

Similarly, there is no overall rating of the degree of effectiveness due to the fact that disaster risk reduction is an on-going, dynamic process which is not complete upon the conclusion of reconstruction projects. Disaster management is a cycle (recall Figure 7, p. 29) which requires that the focus move to preparedness and mitigation activities once the reconstruction and recovery phase has been completed. How well one group responds to hydrometeorological disasters compared to another is not what is important, nor is the concern for comparison of fixed time circumstances – disaster management, like socio-ecological systems, is dynamic and perpetually changing. Strategies for adaptation and improved resilience differ contextually as Wisner et al. (2004) explain, stating:

> [t]he individual, household, kinship network and larger collectivities may develop implicit or explicit strategies to manage risk, which themselves constitute an important element in well-being and provide the basis for action when vulnerability is made a reality by the disaster event itself (p. 15).

Keeping that in mind, PDARRE serves as a tool for addressing weaknesses at the local, regional and national levels. The use of post-disaster "checklists" by NGOs dealing with administrative chaos during relief activities oversimplify vulnerability by associating it with groups of people rather than comprehending "vulnerable situations" as stages which people can move in and out of over time (Wisner et al., 2004).

It is hoped that out of catastrophe all institutions and individuals will become better equipped to respond by improving upon the overall socio-ecological resilience to such hazardous events. Intrinsic to the improvement of the resilience of a community is an understanding of *why* and *how* the vulnerabilities arose in the first place. Thus, after the response and recovery phases are complete, a more reflective assessment of vulnerabilities and capacities must also be conducted as a means of updating previous data or collecting such data in preparation for any future threats.

2.7 Conceptual Framework

From this literature review I have developed a conceptual framework of the socio-ecological systems and processes, structures and institutions that mutually reinforce vulnerability or resilience in communities or settlements in LDCs. Figure 11 shows the intersection of the socio-economic, biophysical and built environment as a state where both vulnerability and resilience to

hazards are possible. To be able to use a post-disaster setting to achieve resilience, a combination of priorities must be considered: Build Back Better, Millennium Development Goals, Sustainable Hazard Mitigation, the Hyogo Framework for Action and Mainstreaming Disaster Risk Reduction. The central arrows represent not only the various motivations to consider in post-disaster response, but also the multiple actors involved. The use of these frameworks enhances resilience by taking advantage of the opportunities presented in the post-disaster setting to address deficiencies in "capital" assets and livelihoods through the recognition of vulnerabilities that were accentuated in the hazard event.

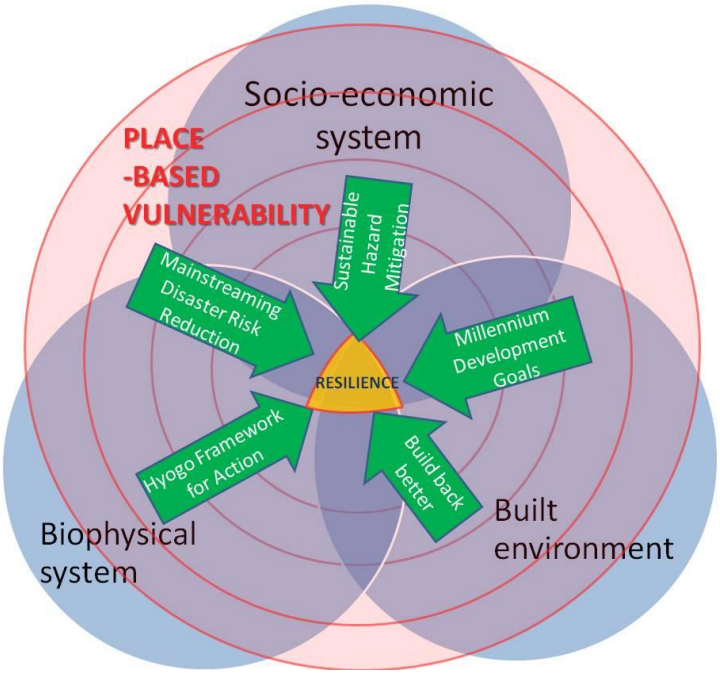


Figure 11: Conceptual Framework for Vulnerability within Socio-Ecological Systems

The concentric circles of place-based vulnerability represent the uniqueness of each community's vulnerability as compared within a single case or across case studies. Common practice suggests the use of some form of vulnerability and capacity assessment (VCA) prior to disaster, however, the post-disaster context also offers an opportunity to collect or update this data. Consequently, as response and recovery actions are taken and the goals and propositions from the frameworks in the arrows are integrated into local or national policies, vulnerability can be reduced and resilience capacities strengthened based on the current information on the socio-ecological system.

Additionally, communication and good information are important parts of strengthening resilience and reducing risks. The arrows of the frameworks point in the same direction to emphasize that collaboration and cooperation between actors and organizations will allow context-specific solutions to be derived from the diversity of actors. Inclusion and empowerment of the local population is known to be an important part of understanding the weaknesses of a place, as well as helping to ensure that the people embrace the disaster risk reduction, and broader development goals.

Chapter 3: **RESEARCH METHODS AND CASE STUDY CONTEXT**

This chapter will summarize the methods used to collect and analyze the data in this research followed by a discussion of the specific case study chosen to test the PDARRE framework.

3.1 Research Methods

This section describes and validates the methods used to address an apparent disconnection between recognized good practices in disaster risk reduction and the actions taken in preparation for and in response to emergency situations involving natural hazards. A case study was chosen to depict the disconnection because, as Yin (2003) discusses, case study analyses are effective for research directed at 'how' and 'why' questions, where the researcher has little control over events, and when the research addresses a recent issue of a practical nature. For this particular study, recall Objective 1, which seeks to identify the causal factors of the 1999 disaster in Vargas (why?). Objective 3 aims to find out 'how' vulnerability was reduced, perpetuated or created through the hazard mitigation efforts executed post-1999.

Case study research also has variable methods. Holistic and embedded analyses can be conducted as part of single or multiple case studies. "A single case can represent a significant contribution to knowledge and theory building" and may be preferred when the case is *extreme*, *unique* or *representative* (Yin, 1993, p. 40). "Lessons learned from [a representative case] are assumed to be informative about the experiences of the average (sic) person or institution" (Yin, 1993, p. 41). Commonly, in LDCs reconstruction efforts fail to generate significant vulnerability reduction (Clinton, 2006). For that reason, investigation of the reconstruction efforts after the Venezuelan debris flows demonstrates where, potentially, in the reconstruction process greater

attention must be paid in order to ensure risk reduction goals are met. The Venezuela case is 'extreme' for LAC and will therefore contribute to knowledge on debris flows and flash flood disasters. Lessons learned, however, would apply to the *majority* rather than the *average* person or institution because sustainable hazard mitigation is geared at saving as many lives as possible, not necessarily only those average persons.

Furthermore, embedded case studies examine subunits of a larger entity; in this case the subunits are the reconstruction efforts executed in Vargas State in 1999. However, in order to provide thorough analysis and draw broader conclusions, the details of these subunits must then return to the larger unit of analysis. The Vargas case will be later discussed with reference to good practices in disaster reconstruction policies for LDCs.

3.1.1 *Research Data*

Data for this analysis was collected from key informant interviews during field work in June 2008. Thirteen interviews[9] were conducted with informants using the snowball sampling method. Primary contacts were made from published document research prior to entering the field. Interviews were conducted in a combination of English and Spanish, while only two interviewees preferred no English at all. Interviews were guided by a set of interview themes (Appendix 4) with two interviewers sharing the role of asking the questions and transcribing notes. Information gathered during interviews provided contextual data and insights into the causes of the Vargas disaster as well as information on the actions taken immediately after the 1999 disaster and in the years following.

Nine professors and one researcher at local academic institutions were interviewed because of their personal and research knowledge regarding the 1999 catastrophe. Of those, one interviewee lives and a second owns a vacation home in the communities of Vargas State impacted by the 1999 disaster. The remaining interviewees are disaster specialists working in domestic or international institutions in Venezuela. One presentation made by a group of geography students in the class of an interviewed professor also served as a source of information for this study. Most interviews had duration between 30 minutes and an hour and two half-day, guided tours of affected communities were also part of the 2008 field work.

[9] Interviewees are referred to as INT #1-13, while the reviewers of the completed assessment are Reviewer #1 and 2 see Appendix 3.

The use of a case study allowed for the incorporation of multiple sources of evidence (Yin, 1993, p. 32; Schrank, 2006). Therefore, this project's data analysis involves quantitative aggregation of interview responses and confirmation of results based on the open-ended nature of interview questions used with all key informants. This data, along with secondary literature analysis informs the output evaluation framework for post-disaster risk reduction in LCDs (PDARRE in Table 2, p. 49). For accuracy, my assessment of the Vargas State post-disaster actions was sent electronically to a number of key informants for review. I received a poor response rate, although the comments and expertise of those who did respond validated and enhanced my analysis, allowing me to make more solid conclusions about the post-disaster status of vulnerability within the State. The reviewers were given the completed assessment framework and asked to comment on the ratings. This review provided the opportunity for discussion of the interpretation of the data as well as to provide an update on activities which happened over the year in which the thesis was being written.

Additionally, participant observation and secondary document analysis supplements the interview data. Observation techniques were used to identify biophysical components, location-related risks and social vulnerabilities which still exist in 2008, almost a decade after the disaster. Complementary review of secondary documents including maps, consultant reports, documentary video, news media reports, photos, published and grey literature allowed for improved understanding of the underlying causal factors which created the disaster. Numerous government reports and reports from lenders and partners were examined to identify Venezuelan policy goals relating to issues of poverty and vulnerability reduction, sustainable development and hazard planning. This part of the research provides information on broader development goals and informed discussion on mainstreaming disaster risk reduction within the Vargas case.

The supply of research and information on disaster and hazard mitigation is continually growing. Yet, disaster impacts and losses are increasing each year. This thesis questions *how* and *why* impacts are increasing given the quantity and quality of information and good practices available regarding disaster risk reduction and lessons learned from previous events. The remainder of this chapter will therefore provide a focused examination of the history of development and disasters in Venezuela. Although all of the causal factors specific to Venezuela may not extrapolate precisely to another context, the case study analysis in this chapter will identify problems which could arise in other cases.

3.2 Case Study Context

The previous chapter outlined literature on hazards which will inform the later discussion of DRR. Keeping that literature in mind, the following depiction of the Venezuelan context will provide background to the analysis of the 1999 Vargas disaster. As mentioned, contextual factors across disasters play and important role in outcomes. Therefore, using the PAR and DROP models as rough guides, the next sections will start to elucidate the circumstances of vulnerability and resilience which persist in this case study.

3.2.1 *Geography and Geology of Venezuela*

Venezuela is located on the South American continent sharing borders with Colombia, Brazil and Guyana, as well as shores on the Caribbean Sea and Atlantic Ocean. Venezuela is located in the tropics of the Northern Hemisphere but experiences a diversity of weather due to the presence of a variety of landscapes ranging from humid low-elevation plains, to glaciers and highland areas which are much cooler. The coastal region of the country experiences hot temperatures year-round. Average rainfall in the wet season, from August to October, is approximately 145 millimetres (Library of Congress, 2005).

In the northern states of the country the terrain is rugged. The mountains of the *Sierra el Avila* peak between 2,000 and 2,700 metres within 6 to10 kilometres of the Caribbean Sea coast. Streams run down the steep mountain slopes (20-40 degrees) emerging to create alluvial fan deposits in a flat transition about 1.5 kilometres wide between mountains to ocean. The *Sierra el Avila* mountain range runs parallel to the coastline and acts as a constraint to inland urban development. Communities have, as a consequence, been built on the flood plains of river valleys and on the alluvial fans along the coast.

The geology of this region consists mainly of metamorphic rock, comprised of graphitic and epidote schists extending approximately one kilometre inland from the ocean (Wieczorek et al., 2002). Additionally, different geologic conditions are noted in Vargas State: a) phyllite, hilly slopes to the east of the Naiguatá River; b) schist and gneiss slopes (Takahashi, Nakagawa, Satofuka, & Kawaike, 2001). The presence of stratified rocks within the slope-face at higher elevations demonstrates the long-standing history of landslides and debris flows to which these communities have been exposed. Some of the towns have been engineered to incorporate the debris found in some communities, although the presence of this foreign landslide debris does not seem to act as a reminder of the hazard risk (see Figure 12).

Figure 12: Stone terrace built in 1917 from boulders deposited from upstream.
This house, in Plaza de la Piedras on the Caraballeda fan, withstood debris flows, including a major event in 1951.
Source: (Wieczorek et al., 2002)

3.2.2 *Socio-economic Characteristics*

Social characteristics in a country are strongly influenced by their political and economic systems, in addition to other factors such as religion or history. Venezuela's first democratically elected president took office in 1958 and has been succeeded by other democratically elected presidents, including current president Hugo Chávez (Library of Congress, 2005).

All of the *democratic* leaders in Venezuela's history have presided over a steady income from the petroleum industry which allowed for significant investments in roads, cities, schools, and public works (Levine & Crisp, 1999). These investments transformed the country from a "poor, illiterate, fragmented, sickly, and predominantly peasant society [prior to the 1970s] into a highly urban, mobile, literate and media soaked nation" (Levine & Crisp, 1999). Starting in the 1980's, this progress was impeded by currency devaluation and extreme income inequality. The struggles facing Venezuelans during these tough times have arguably strengthened not only the democratic system but also the individual members of society. Since the 19th century the "continuous and irregular form of [political] regime change taught Venezuelans an important lesson about …capturing the moment and translating that moment into personal wealth, because tomorrow's moment would likely belong to someone else" (Ellner & Hellinger, 2003, p. 2-3).

As part of his "Socialism for the 21st Century", which aims to improve equality for all Venezuelans, the current leftist leader has made nationalization of the petroleum industry, and other successful resource extraction industries a primary focus. In 2007/2008 the petroleum

sector alone made up approximately 90 percent of export revenues and 30 percent of gross domestic product (GDP) (CIA, 2009). Despite this, the Chávez government has yet to produce significant results on their agenda of major social and economic improvements for all Venezuelans. The 2002 coup and counter coup were evidence of discontent within the population for the current government's lack of progress; nonetheless Chávez himself remains very popular (Ellner & Hellinger, 2003).

Formal, primarily resource extraction sectors – such as forestry, fisheries, petroleum, cacao, and coffee – provide employment to many Venezuelans. However, in comparison many more people are employed in the *informal* sector. Informal sector activities have grown in the Chavez years (1998 to present), accounting for roughly half of all employment from 2002 through 2004 (Library of Congress, 2005). Informal employment includes micro and small enterprises which are not formally registered or are possibly illegal (Clark & Stephans, 2002). Informal employment can often be associated with poverty and financial struggle. Supplementation of the income of those with inadequate formal earnings is a common phenomenon in LDCs. Additionally, these activities allow people in the lowest income brackets access to many necessary resources sold outside their price range in the formal market (e.g. pharmacy supplies, fast food, repair services etc.).

Some of Chávez' Socialism policies, while aiming for equality, also hinder the freedom of the population. Access to foreign currency by Venezuelans is limited because of a government policy on the sale of US dollars. The motivation for this policy is to control inflation according to the government; however, some suspect this policy is a means to keep Venezuelans from immigrating, specifically to the United States (field notes, 2008). In response to this policy individuals have made mutually beneficial exchanges with tourists and created a black market for currency. The national banks and *casas de cambio* (currency exchange houses) offer US dollar exchanges at a fixed rate. On the street, however, better rates can be negotiated with taxi drivers and shop owners who are willing to risk fines to access US dollars (field notes, 2008). In the same way, tourists want the best exchange rate possible and so, as in many LDCs, tourists provide locals with a source of foreign currency in addition to their willingness to purchase from the 'informal' market.

LDCs often use tourism to diversify their economy from traditional resource-based economic activities. Venezuela, with its wealth of petroleum resources, has not tapped into its full tourism

potential. Venezuela's natural environment boasts some impressive features including the largest lake in South America, Lake Maracaibo, and the highest waterfall in the world, Angel Falls. Nevertheless, poor quality services, crime and political instabilities have not yet been overcome in order to attract foreign tourists to sites other than the popular Margarita Island (Library of Congress, 2005). Because of this, much of the country's tourism revenues come from domestic tourists visiting family out of state. These domestic tourists are mostly wealthy employees of the international firms, academic institutions and government agencies located in the economic metropolis of Caracas.

Because of the variety of natural hazards facing different parts of the country, from earthquakes to tropical storms, the limited tourism industry may be positive in some ways. The attraction of international media after a major natural disaster hits a tourism destination is almost always negative (e.g. Hurricane Henriette in Mexico in 2007, Asian Tsunami in 2004 etc.). Not to mention, the potential for infrastructure loss during or after a disaster leads to lost revenues, which stifles the economic gains intended with a diversification into tourism.

In summary, Venezuela has a history fraught with challenges including safety concerns, political instabilities and disaster. The country has not achieved their desired level of development because of historic problems and the persistence of some of the above-mentioned threats. A good supply of natural resources offers income to this South American country but unequal distribution of wealth persists even under Chavez' Socialist regime.

3.3 Vargas State

Vargas State is located to the north of the capital city of Caracas and has a population of approximately 330,000 (CIA, 2009). The main sea and airports, linking the northern region to the rest of the country and the world, are in the town of Maiquetía (see Figure 13). These access points make Vargas State a high-traffic area for both foreign tourists and locals. The heavy flow of people and goods in this region has led to sprawling development along the coast (Genatios & Lafuente, 2003; Wieczorek et al., 2002; Rivero, 2004). It is the coastal towns and cities of Vargas that will be further examined herein because of the impacts they sustained in the 1999 debris flow disaster.

The northern coastal state of Vargas is one of the newest states in Venezuela. Vargas was separated from the nation's capital state, Distrito Federal, in 1998. The capital city is La Guaira,

where the main seaport is located, and the state runs narrowly along 170 km of the coast north of Caracas (Gobernación Bolivariana del Estado Vargas, 2009).

Historically, the convenient location of what is now Vargas State, near the airport and capital city, made for a prime settlement area. Two of the protective forts have been maintained along with the historic and narrow cobble roads (Gobernación Bolivariana del Estado Vargas, 2009). The sandy beaches of *El Litoral Central* (the central coast), make for an attractive weekend escape for the residents of Caracas. Much of the development in the coastal towns has been second home development for Caraqueños or primary homes for those who commute to Caracas for work (INT #1 & 9). Because of this, the towns are primarily residential and many of those employed locally work in the service industry, or at one of either the airport or seaport (field notes, 2008). Informal housing has been constructed on the highly hazards slopes and in the river valleys that remained after the development of the tourism industry (Takahashi, Nakagawa, Satofuka, & Kawaike, 2001).

Figure 13: Map of Vargas State, Venezuela

Lightly shaded region is Vargas State; darker region is the capital, Caracas. Inset box shows location within the South American country.

Source: Unknown

3.3.1.1 Bio-physical Characteristics

The landscape of Vargas is rugged including limited flat land between the steep mountains and shores of the Caribbean Sea. As mentioned earlier, development in the northern states has taken place on alluvial fans which formed around the river's mouth. Alluvial fans are fluvial formations generally associated with dry climates and the northern coastal region of Venezuela is classified as semi-arid with notably less precipitation than the Guyana highlands in the southeast of the country (Lyon, 2003). The wet season in Vargas generally runs from June to August when they receive 45 percent of the annual rainfall. These wet conditions progress into the dry season which occurs in the period from December to February when nine percent of annual precipitation is typical (Lyon, 2003). Vargas State experiences the same rainfall variability as the tropical Americas and this variability is related to sea surface temperatures, sea level pressure and low-level wind anomalies in both the Pacific and Atlantic basins and the Southern Oscillation [El Niño/La Niña] (Lyon, 2003).

In all, there are twenty-four watersheds along the northern part of Vargas State (INT #2). Each catchment of the *Sierra El Avila* has soils that are thin and bedrock exhibits signs of weathering. Historical records and geological evidence based on the towns in Vargas indicate that debris flow events have occurred with some regularity in this region (Wieczorek et al., 2002). Prior to 1999, the most recent debris flow event took place in 1951 and aerial photography comparisons depict the event as much smaller than the 1999 event. Terracing along stream channels 10-20m above current stream channels indicates contemporaneous tectonic uplift of the coastal range. However, slightly higher elevation toward the axis (5m) than on the flanks of the alluvial fans in Vargas indicates that the long-term rate of delivery of material from the upper watersheds is greater than the removal of material by the stream flows (Wieczorek et al., 2002) (see Figure 14).

Figure 14: Alluvial fan characteristics

Source: (Unknown)

Therefore, an increase in material in the lower reaches of the watershed during normal rainfall exposes larger boulders and debris while weakening the slope stability in the upper watershed. Together this makes for smaller, shallower channels on the alluvial fans and exposes the populations to greater disastrous flooding potential in greater-than-normal rainfall events.

Before continuing, a definition of a debris flow and the conditions required for such an event will clarify how the 1999 event differs from simple flooding or landsliding.

> Debris flows are characterized by fast movements in which the displaced mass behaves as a highly viscous fluid (Guidicini and Nieble 1984; IPT 1991). Debris flows displace a significant volume of material. They reach siginficant distances, velocities, and transport capacities, including large boulders (Gramani and Augusto Filho 2004 cited in Gomez et al., 2008, p. 198).

All mass movements have a critical "shear-failure point" where the material begins to fall, slide, flow or creep based on the size and texture of the grains of material and the amount of moisture (Christopherson, 2003, p.415-417)

The regularity with which the rivers will flood their banks or carry excess sediment into the towns is difficult to predict. Previous hydrologic events leading to severe flooding and/or landslides occurred in August 1912, January 1914, November 1938, May and November 1944, August 1948 and February 1951 (Salcedo, 2000 cited in Wieczorek et al., 2002). None of these events created much damage compared to the 1999 event due to their lower magnitude and the presence of a much smaller population. Uncertainty, along with a relative infrequency of extreme flooding, therefore permitted Vargas State's population to grow to more than 300,000 inhabitants. Much of this population growth has occurred since the last debris flow event in 1951 (Wieczorek et al., 2002). Even more, the town of Maiquetía is also known as the *San Sebastián de Maiquetía* region because it is located on the San Sebastián fault line. The Boconó-San

Sebastián-El Pilar fault system registers an annual movement of 1 cm (Audemard, 2002 cited in Altez, 2005). Despite slow, steady movement earthquakes in this region have not recently caused any events with mass casualties (USGS, 2009). The last major disaster as a result of an earthquake on the San Sebastián fault was in 1812, when 26,000 people were killed in Caracas (USGS, 2009). Nonetheless, these informal developments would easily be damaged in an earthquake of moderate strength; an additional threat facing the population of Vargas State.

3.3.1.2 Demographic and Socio-economic Characteristics

The attraction of Vargas is both financial as well as one of security and beauty. Employment in informal activities such as selling empanadas, can earn more than double that of a basic job ironing clothes in Caracas (Rivero, 2004). In addition, the large populations living in slums in Caracas have created several dangerous neighbourhoods where in a single weekend up to 20 people may be killed (INT #1). This combination of increased safety and the potential to earn a better income are logical motivators that have drawn a growing number of people to Vargas, despite the *unsafe* natural environment of much of the settlement locations.

The population is spread across the state with the largest populations concentrated in the towns of Catia la Mar, Maiquetía and Caraballeda. The pre-disaster population included a mix of demographic groups. This included 43 percent of households with female heads and the general population was composed of 51.4 percent males and 48.6 percent females (CEPAL, 2000). Major sectors of employment are warehousing, the National Guard, immigration, tourism and pig farming. Vargas has received major real estate investment and therefore growth in spas, hotels, restaurants and recreational facilities has also been on the rise (RENa, 2008).

Development of the service industry offers employment opportunities and has thus also created some informal residential development. While these communities are not planned, they do have access to infrastructure services such as water and electricity (field notes, 2008). Housing appears to be self-constructed and the location along the slopes of the river valleys makes the residents innately vulnerable to slope failures, landslides and the effects of debris flows.

With an improved knowledge of the characteristics of Venezuela and, more specifically Vargas State, this case study investigates the debris flow catastrophe that affected the Caribbean Sea coast of Venezuela in December, 1999. The flooding and debris flows from this event led to one of the largest such disasters documented worldwide (Wieczorek et al., 2002).

3.4 Events of December 1999

Beginning in early December, the interaction of a cold front with moist south-westerly flow from the Pacific Ocean towards the Caribbean Sea created unusually high precipitation over North Vargas and the northern coast of Venezuela (Wieczorek et al., 2002). Torrential rainfall starting Tuesday December 14th 1999, caused major flooding and debris flows in various states across the country including Miranda, Vargas, the Federal District, Yaracuy, Táchira, Nueva Esparta, Zulia, Trujillo and Falcón (CEPAL, 2000). The Maiquetía meteorological station, in Vargas State, recorded rainfall on December 15th and 16th (380.7 and 410.4mm respectively) which exceeded the 1000 year probability rainfall event for this location (Martinez, 2000 cited in Wieczorek et al., 2002) (see Figure 15).

Vargas State received the worst of the damages after three days of extreme rainfall totaling more than 900 mm of precipitation (Genatios & Lafuente, 2003). On December 16th several flash floods and debris flows occurred simultaneously, resulting in debris that poured through towns, burying 2-storey houses in several meters of mud and knocking the support from parts of high-rise buildings (Wieczorek et al., 2002) (see Figure 16). On Wednesday December 15th, the second day of torrential rains, the National Government issued Decree 577 declaring a "state of national emergency" as a consequence of "unusual rainfall that cause[d] material damage" across Vargas State (IDB, 2000).

Day	Precip (mm)	Acc.Precip (mm)
1	6.0	6.0
2	77.3	83.3
3	121.2	204.5
4	11.8	216.3
5	0	216.3
6	1.1	217.4
7	5.0	222.4
8	8.1	230.5
9	10.4	240.9
10	0	240.9
11	23.2	264.1
12	21.8	285.9
13	7.1	293.0
14	120.0	413.0
15	380.7	793.7
16	410.4	1202.1
17	2.9	1207.0

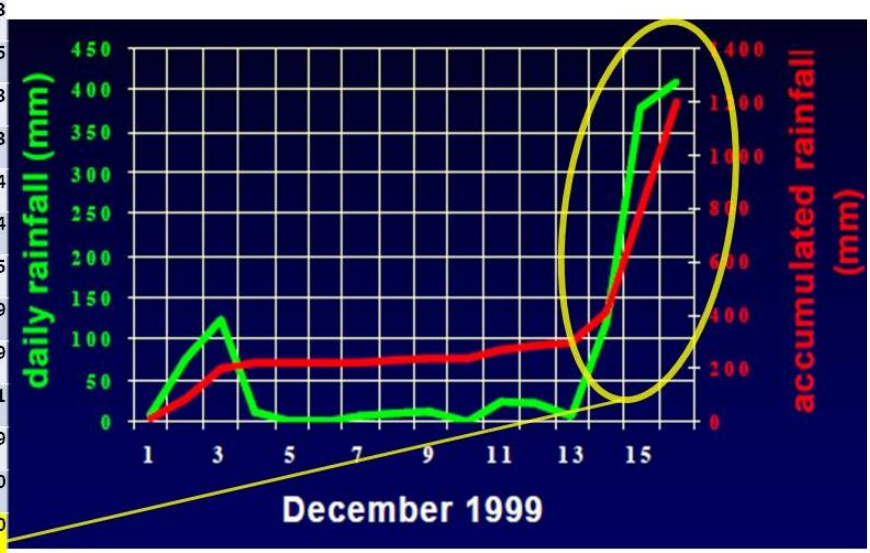


Figure 15: Rainfall Data from Maiquetía Meteorological Station
Source: Ministry of the Environment and Natural Resources, cited in (Larsen & Torres-Sierra, 2006)

Figure 16: Images of Damage to Vargas State from Debris Flow Disaster 1999
Damage to buildings in Vargas State — High water levels caused during December 1999
(Photos courtesy of Altez)

Three key causes of the disaster were mentioned repeatedly by interviewees and in secondary literature: 1) a 16 day low intensity rainfall which saturated soils across the State followed by a three day extreme rainfall event producing over 900 mm of rain in the upper catchments (Lopez et al. 2003); 2) rapid and relatively unplanned urbanization (both formal and informal) on the multiple alluvial fans found in coastal Vargas State (INT #9, 10, 11 & 13) and; 3) poorly designed and executed emergency preparedness and mitigation plans (INT #1, 2, 6, 13; Altez, 2005).

Although this data is only from one meteorological station, similar rainfall patterns were experienced across the state. NOAA (the National Oceanic and Atmospheric Administration) also reported higher than normal rainfall over the year throughout the entire Caribbean region (cited in Larsen & Torres-Sierra, 2006). The rapid urbanization in Vargas State is a result of wealth which originated in Caracas and led to the construction of second and vacation homes along the coast (INT #6 & 8). This unplanned development made the creation of a fully functioning emergency management/response plan of secondary importance after the supply of infrastructure services for the new residents (INT #6).

3.4.1 *Losses and Impacts in Vargas*

The losses from the debris flows and flooding were extraordinary. The *El Avila* Mountains drain dozens of streams northward into steep river valleys. In December 1999, twenty-four of these streams simultaneously flooded into their respective channels, while thousands of landslides carried debris at rates between 700m^3/second and 1200m^3/second at their fastest on to the towns along the coast (INT #2 & 3; Wieczorek et al., 2002; Takahashi, Nakagawa, Satofuka & Kawaike, 2001). Most of the debris flows commenced overnight on December 15th and lasted only thirty minutes (Takahashi, Nakagawa, Satofuka & Kawaike, 2001). The debris flows were followed by flash floods with comparatively thin sediments for more to ten hours in some instances.

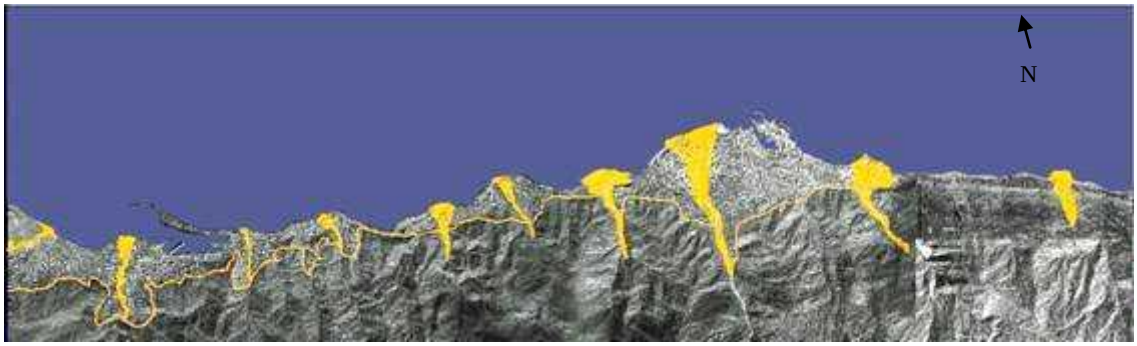


Figure 17: Alluvial Fans of Vargas State

Note: The alluvial fans are the funnel shapes along the coast, only some of the fans are shown in this diagram

Source: (Genatios & Lafuente 2003)

Although the rains had been continuous for weeks, there was very little time to warn the residents of the rushing debris which surged from the mountains in the flash floods of December 16th. The flows were so strong that boulders measuring 11.3m by 5m by 3.5m were dislodged from the slope face and carried down to sea level (see Figure 18).

Figure 18: Massive boulders transported during 1999 debris flows

Source: (Wieczorek, Larsen, Eaton, Morgan, & Blair, 2002)

Many lives were lost and livelihoods were interrupted or destroyed during the catastrophe. The death toll is estimated between 1,000 and 50,000 people who were either taken out to sea or buried in the mud (Larsen et al., 2001; CEPAL, 2000; INT #1-13). Much debate exists regarding the accuracy of the casualty figures. Some researchers contend that the method used to estimate the population of the state was flawed. It is argued that flying helicopters over the communities does not tell you whether all the homes were occupied at the time of the catastrophe and thus cannot be the only measurement tool employed and also should be verified throughout the response period (CEPAL, 2000; Altez, 2007; INT #1). Other authors point to the lack of census data as contributing to the difficulty in estimating actual numbers (Takahashi, Nakagawa,

Satofuka, & Kawaike, 2001). Nonetheless, even at the lowest estimates of 1000 killed, all of the 300,000 residents of Vargas State were affected in some way by the meteorological event in December 1999.

The diverse socio-economic composition of Vargas State led to differing levels of impacts. Children between the ages of 0 and 14 were particularly severely affected and also more female victims were found than male victims, at 52 and 46 percent respectively (CEPAL, 2000). Because of the recreational nature of the State, there were many vacation or weekend homes and public recreational facilities affected. However, the majority of fatalities occurred in low-income areas where a significant proportion of precarious and informal structures were located (CEPAL, 2000).

Impacts were seen along the entire coastline. Plumes of sediment were visible in aerial photography and shorelines extended metres further into the sea (Larsen & Torres-Sierra, 2006). The limited road infrastructure in the state made it difficult to escape the disaster. Just one highway connects the towns and it links these communities in a parallel manner along the length of the coast. Similarly, a single highway crosses over the mountains to Caracas, which meant that some communities were nearly 50km from the final evacuation route. Additionally, very little advanced warning meant very few residents were able to attempt an evacuation prior to facing congestion problems and the torrent flows which quickly blocked all passage. As a result, damages to infrastructure and housing totaled some US$3.2 billion and affected thousands of houses and many bridges (Larsen et al., 2001; Cardenas & Jiménez, 2005; Challa, 2000).

Population (pre-disaster)	Fatalities	Infrastructure Losses	Evacuees in shelters	Relocated Survivors	Reconstruction Projects
336,000	~ 50,000	$3.2 billion US • 8000 homes destroyed • 5 health care facilities damaged • 85% of roadways destroyed • 30% of education infrastructure affected	70,000+	Maracaibo, Guanare, Los Andes (Trujillo), and Ciudad Bolívar	Channels, dams, *social housing*, highway rebuilt, early warning system[10]

Table 3: Summary of 1999 Event Impacts and Projects[11]

The poorly designed and incomplete system of early warning played a major role in the number of deaths and damage caused by the debris flows. The existence of a fully functioning early warning system would have better enabled the preparatory and response capacities of residents in the most unsafe neighbourhoods. Signals such as sirens or radio announcements which direct residents to keep out of the streets are simple methods through which to communicate with the population which can improve the response as well. In the absence of good information about the vulnerabilities, residents made decisions about when to leave, where to go and how to get there based on the perceived urgency of the threats in each community. This would have made for a monumentally difficult recovery in the north coastal region as communities in each catchment derived their own response.

Cooperation and coordinated efforts across the country with national and international partners played an important role in the immediate response. Nevertheless, the disaster occurred at a time of "total political conflict nationally" (translated from Altez, 2005, p. 318) because regional elections were being held. This political instability and the relative inexperience of government workers in Vargas inhibited the post-debris flow response and also resulted in some residents remaining in their flooded homes (INT #10). Of the more than 300,000 affected, an estimated 70,000 survivors were housed in temporary shelters, such as schools, churches, sports centres and the airport (CEPAL, 2000). In addition to this, many people found accommodation with family (exact numbers are unknown).

[10] Which is still not fully operational in 2008 (INT #2, 3 & 4)
[11] (Genatios & Lafuente, 2003); (CEPAL, 2000); (INT # 1, 2, 3, 4, 6, 8, 10, 11, 12 & 13).

Decision-making within Venezuela is disproportionately focused on Caracas, especially with relation to matters of safety and vulnerability. The large number of residents in informal settlements, in combination with the levels of risk from landslides, seismic activities and flooding, have taken priority over other regions of the country. For example, Venezuela has adopted a New Housing Policy that prioritizes the identification of informal settlements for colsolidation, improvement and integration into the formal *urban* areas (CEPAL, 2000, p. 97). Additionally, in areas of high geologic risk in Caracas the priority is to invest in a) programming accessible to female-headed households and b) offering land titles to single-mothers or co-titles when both male and female are living together (CEPAL, 2000, p. 96). Other documents (e.g. Altez et al, 2002) regarding policies and governance of hazards lump Vargas State in with Caracas and although the authors do not explicitly explain why, it seems there is greater support for research relating to Caracas. Another power struggle facing Vargas relates to water supply. All of Vargas' water comes in from Caracas along the highway connecting the coastal state to the capital city (Vranes & Czuchlewski, 2003). Although Vargas now has autonomy there are still many ways in which Caracas controls decisions made in the coastal State. In some ways Vargas may be able to capitalize on the tight links it has with Caracas since the main sea and airports in Vargas State the primary access points for international trade and tourism. Nevertheless, at present many disaster management concerns and funding are geared toward the "higher risks levels" (Vranes & Czuchlewski, 2003) in Caracas.

It is obvious that the damages and disruption caused by the hydrometeorological event of 1999 indeed created a great disaster in Vargas State, regardless of the metric for damages employed. Some argue that the response and reconstruction efforts were insufficient or poorly executed. In order to measure the effectiveness of the post-disaster efforts taken by the Venezuelan government, other governments and international NGOs, an assessment tool was developed. The PDARRE tool was generated to reveal whether the post-disaster reconstruction and rehabilitation efforts effectively reduce disaster risks.

Chapter 4: **CASE STUDY FINDINGS**

The previous chapters have discussed good practices in disaster mitigation and risk reduction and highlighted the typical lack of monitoring and evaluation of such activities over a longer-term timescale. The post-disaster setting has been identified as a valuable opportunity for vulnerability identification and reduction through proactive approaches to response and reconstruction.

This chapter will analyze the results of interviews and field observations conducted in 2008 - nine years after the Vargas State debris flow disaster. These results are a summary of post-disaster activities in the region, and a measurement of the effectiveness of reconstruction efforts in reducing vulnerabilities.

The ratings for each criterion in the PDARRE tool were derived from literature published about the 1999 Vargas disaster, as well as interviews with experts familiar with post-disaster responses. The completed assessment was then sent to key informants for verification and comment. The beginning of this chapter will discuss the initial findings, followed by a review of adjustments made to the assessment post-verification, and then a discussion of other issues that arose from interviews and site observations that were not addressed in the assessment.

4.1 Findings from Assessment Tool

The following sections break down the assessment framework into tables the three realms of the conceptual framework and two subcategories as chosen for this thesis: socio-economic system, built environment, biophysical system, institutional and legislation concerns. Each criterion will be discussed with regards to the activities and perceptions that influenced the selected rating. Implications may be identified, although discussion of these and the opportunities for future work will be discussed in later chapters.

4.2 Socio-economic System

The first set of criteria evaluated post disaster activities which addressed socio-economic behaviours, changes in attitudes, awareness, capacity, vulnerability and ownership (of land and capital).

The type of data necessary for this part of the assessment includes: a) physical/material, b) social/organizational and, c) motivational/attitudinal data on vulnerabilities or capacities (Benson, Twigg, & Rossetto, 2007, p. 107).

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Socio-economic System				
current vulnerability and capacity assessment data for affected population?				N
indicators/monitoring of progress on risk reduction/sust. hazard mitigation?	-			
standardized and inclusive community awareness programs?	-			
community education programs geared toward the development of a culture of safety?		*		
recovery made to benefit and improve livelihoods, quality of life and tenure concerns?	-			
enhance and encourage community cohesion, inter/intra-generational equity and social capital?	-			
creation of an insurance program based on vulnerability assessments?				x
encouragement of entrepreneurship?	-			
creation of business continuity plans to rebuild and enhance local economy?				N

Table 4: Completed Assessment of Socio-economic Criteria[12]

One of the first results in this part of the assessment was that no data were found indicating that a vulnerability and capacity assessment (VCA) was conducted for any of the disaster-affected communities in North Vargas State, either before or after the disaster. The lack of mention of such data during interviews causes me to conclude that prior to 1999 such data were not collected or at least not frequently updated. Therefore VCA data were likely not satisfactorily considered in any disaster management or urban planning activities and remain out of date still nine years after the disaster.

Although flooding of disastrous proportion does not occur frequently in Vargas State, previous flooding events influenced the need for an improved disaster reduction/sustainable hazard mitigation plan after 1999. One interviewee (#6) indicated that the government acted without really understanding what *mitigation* meant and categorized preparedness and response activities under *mitigation* projects. The criterion for monitoring of risk reduction progress is rated as *poor*, given that interviewees commented on the deficient understanding which led to "patches of government response" and inhibited coordination within what should be an integrated system.

[12] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

Community capacity building programs executed post-1999 were mentioned when discussing mitigation efforts. The programs in Vargas were found to be effective and appropriate, however, not all communities were offered such programs and therefore the ability of these programs to reduce vulnerability and improve community capacities at the state level was limited (INT 1, 2, 6, 8, 9, 10, 11, 12). The generation of standardized programming, offered by numerous groups, whether governmental, academic or non-governmental agencies, is required to improve the rating to *good*. A 'divide and conquer' plan would allow for education and capacity training in *all* communities, thus strengthening the ability of the whole state to react in the face of the next threat.

The creation of a 'culture of safety' is mentioned throughout the literature on disaster management. A culture of safety is defined in the HFA as "[requiring] the collection, compilation and dissemination of relevant knowledge and information on hazards, vulnerabilities and capacities" and involves information management and exchange, education and training, research, and public awareness (ISDR, 2005, p. 10). The culture of Vargas prior to the disaster was considered more 'unsafe' than 'safe' by all interviewees. For example, evacuation routes identified by community members followed roadways but they had ignored the probability of the rivers flood waters also taking this route (INT #11). Community-level training and adaptation techniques also need improvement to create a safer Vargas. Interviewees recognized that current knowledge about the vulnerabilities and hazards residents face on a day-to-day basis was poor, and human created threats were not well understood by individuals living in Vargas (INT #6, 11). The 'culture' in Vargas, prior to the disaster, was conditioned by years of relatively 'safe' life. Years of urban planning and resident behaviour which did not consider debris flow hazards will indeed be difficult to reverse (INT #1, 5, 6 & 7). Some interviewees offered a positive perspective on post-disaster community education programs suggesting that these were successful in changing perspectives of both school children and their parents (INT # 10, 12). Overall, the efforts made to generate a 'culture of safety'[13], although sporadic, were successful where executed; and the recollection of the impacts/threats by the survivors, or the social memory of the event, factored into the *adequate* rating given to this criterion.

[13] 'Culture of disaster resilience' may be a more encompassing term than 'safety' implies however, safety is more quantitative than resilience and was thus chosen to increase ease of measurement.

The next criterion looks at the impacts of recovery efforts on livelihoods, tenure and quality of life. General observation of communities in Vargas indicated that restoration of the pre-disaster state was the objective. Homes had been dug out from under rubble and sediment and properties claimed for reconstruction when financial capital allowed (see Figure 19), while other homes were rebuilt in situ. Drastic changes to the organization of communities were not obvious in the present-day towns (field notes, 2008).

Figure 19: Housing still buried in 2008 after debris flows of 1999

Exterior walls have been painted by the owner to demarcate property boundary and intent to return to this home.

Photo sources: (Stager, 2008)

Tenure concerns surfaced in various interviews and were indicated to have been given limited consideration. Government housing projects built post-disaster were sold on the market rather than given to disaster survivors, which led to price speculation and eventual high prices as wealthy Venezuelans purchased and resold the homes (INT #1). The construction of limited "social housing"[14] along a stream channel that flooded in 1999 is evidence of the limited forward-thinking and vulnerability-reduction ability of the government. Not only was the social housing inadequate to accommodate all of the people left without homes, but it was built slowly, located in unsafe land, and offered on the market where speculators purchased units making them unaffordable to those most in need (INT #1, 8 & 9). Quality of life concerns appeared to be the responsibility of the individuals themselves. Government projects geared at enhancement of

[14] Technically the housing in question is not 'social housing' as it was sold on the market at high rates. Interviewees referred to these units as social housing nonetheless, so their convention is maintained for accuracy.

quality of life, such as waste management, sanitation or utility distribution, were limited to times when votes were needed rather than concern for the personal health and welfare of citizens (INT #1, 8 & 9). Together, the minimal livelihood, quality of life and tenure efforts led to a rating of *poor*. Successful reconstruction of a community with these traits was not executed despite the opportunity presented in the post-disaster timeframe.

Understanding how to enhance and encourage community cohesion, inter/intra-generational equity and social capital helps ensure the effective reduction of vulnerability. Most interviewees suggested that recovery efforts were not planned with sufficient consideration for future risks and impacts (INT 1, 2, 3, 4, 6, 8, 9, 10 & 11). The level of community cohesion actually seems to have decreased since the 1999 disaster: during a similar flooding and debris flow event in 2005, rivalry and competition between individuals was much greater than the cooperation and assistance demonstrated in 1999 (INT #10). This reduction of social capital led to a *poor* rating for this criterion.

Insurance programs are designed to spread the loss and cost of unforeseen impacts over a greater time span and over a larger pool of individuals (e.g. other insurees of the same company). Insurance is common in developed countries where incomes are generally high enough to provide disposable income for indeterminate risks (Burby, 1998). However, residents of Venezuela, like in many other LDCs, do not view insurance as a priority or it is seen as unaffordable. It is likely that there is no program of insurance available in the country to protect belongings and property from the risks found in North Vargas State (INT #6, 8). Not surprisingly, the lack of VCA data would limit the ability of an insurance program to actually reduce known vulnerabilities. Insurance may not be an effective tool for use in very low-income areas of LDCs, but Vargas has a mix of wealth and could benefit from such a program. Regardless, in order for any insurance program to be beneficial, accurate vulnerability assessments of the areas to be insured are essential. Until VCA data is available or collected by insurance providers, and insurance is made available to residents, this criterion will continue to be rated *poor*.

The BBB philosophy for disaster response posits encouragement of entrepreneurship in post-disaster settings enhances recovery (Clinton, 2006). Entrepreneurs can flourish in the post-disaster setting if new businesses can take market share and build a reputation in the newly emerging economy. Interviews conducted in Vargas State indicated very limited encouragement

of entrepreneurial endeavors. One could argue that entrepreneurship was encouraged by the government in their attempt to resettle survivors in a new community 400 kilometres away from North Vargas; putting people in a new environment challenges them to seek out new opportunities and skills. However, in reality, entrepreneurship was stifled because of the persecution and suspicion survivors experienced in the new settlement locations (INT #5, 6, 7 & 8). As well, the settlement locations were quite different from the context of Vargas, therefore, the skills and expertise of the relocated individuals did not easily match the type of skills needed for entrepreneurial activity in the new communities (INT #6, 8 & 10).

It is important to have business continuity plans in addition to the regional and national disaster management system. A business continuity plan enables the individual enterprise to maintain function, or return to normal operations quickly in the event of a disaster. Although no individual business owners were interviewed, no interviewees made mention of business-related assistance coming from the government.

4.2.1 *Institutional Concerns*

In addition to the socio-economic criteria, consideration of specific institutional practices and policies at various levels will impact the outcome of post-disaster risk reduction activities. These next criteria are geared at learning, cooperation, monitoring and capacity development within and across institutions.

Identification of lessons learned during crisis situations allows not only the personnel to gain insight into their actions, but also enhances the function of the institution as a whole. Interviewees agreed that institutional learning after the Vargas disaster was minimal. The creation of two entirely new governmental agencies, CorpoVargas and *Autoridad Unica*, to manage parts of the reconstruction process, was a primary factor which stifled learning (INT # 1, 6, 8, 9, 10 & 11). This new agency did not necessarily have access to the lessons learned during past flooding or debris flow events, nor was the knowledge and capacity of employees involved in previous responses accessible (INT # 1 & 6). Current records of lessons learned from the 1999 disaster are now available and have been transferred by the *Autoridad Única*[15] (Unique Authority) to CorpoVargas (INT #12). Thus, it is predicted that local management is now better

[15] The full name is the Unique Area Authority for Vargas State and this government body was put in charge of planning and coordination of the plans and programs of territorial organization (Corporación para la Recuperación y Desarrollo del Estado Vargas, 2006).

prepared for similar hazards. Because of these newly documented lessons, a rating of *adequate* was given to this criterion.

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Institutional Concerns				
availability and use of previously identified lessons for risk management (local/similar hazards)?		*		
existence of functioning public disaster relief system?		*		
cooperation within and across government bodies, NGOs and community?	-			
clarity of responsibilities, roles and relationships (pre)defined?		*		
efforts to ensure continuity and stability over time in government bodies? (redundancy)		*		
set corresponding 'acceptable levels of risk' in all relevant ministries? (e.g. housing, planning, environment, natural resources, emergency management etc.)	-			
empowerment of local governments to manage recovery?			+	
staff retention schemes to maintain capacity through various emergency events?	-			
inclusion of private and public sector actors?		*		
effective use and monitoring of DRR funding and financial capital with a focus on strengthening government (esp. local) recovery institutions, equity and sustainability?		*		

Table 5: Completed Assessment of Institutional Criteria[16]

More broadly, the existence of a functioning disaster relief system allows for a separation of duties and increased efficiency due to specialization. In the immediate post-disaster period, the Venezuelan *Protección Civil* was quickly deployed and temporary hospitals and shelters were erected to house the victims and survivors (INT #1, 6 &10). International aid was requested and a 'state of emergency' was declared because the extent and magnitude of the disaster was quickly recognized as beyond the national capacity (CEPAL, 2000; INT #1, 10 & 12). Although the disaster relief system did have its strengths, the absence of an early warning system had a significant impact on the number of fatalities and marooned victims (INT #1-13). In addition, the monitoring of hazards, meteorological factors and planning of the reconstruction were also viewed as ongoing shortfalls in the relief system (INT #1-13; Murria, 2005). Finally, the poor education programs have not significantly improved the general knowledge of the residents at-risk in Vargas State since the 1999 event, as was evidenced during a smaller debris flow and flooding event in 2005 (INT #1, 2, 4, 6, 8, 9, 10, 11 & 12). All of these factors indicate good attempts at making a functioning disaster relief system but more work is needed to generate a rating of *good*.

[16] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

Cooperation and information sharing are recommended for successful vulnerability reduction efforts. The number of governmental, community and non-governmental organizations seeking to assist in a disaster response requires there to be a clear division of labour and open sharing of data between all actors. In Vargas State, governmental organizations were said to have poor communication, which restrained productivity during the immediate response and also during the reconstruction and recovery phases of the disaster cycle (INT #1, 6, & 11). Again, the creation of new government bodies added to the challenge of who to get information from: these included the new entities of *Autoridad Única* (charged with the urban planning and studies after 1999 disaster) and CorpoVargas (in charge of structural responses) (INT # 6, 10, 11, 12). In consideration of these points, this criterion was rated as doing a *poor* job of reducing vulnerability.

The related issue of identifying roles and responsibilities was done somewhat more effectively. As was discussed, new agencies were created to deal with urban planning and reconstruction in addition to the roles already defined for legislation, resources management and search and rescue, to name a few. The lack of standardization within the delivery of community awareness programs was one weakness identified post-disaster (INT #10). New agencies meant some roles had to be renounced by previous agencies, this surely caused confusion, conflict and maybe greater efficiency, still continuity efforts and identification of roles and responsibilities are rated as *adequate*.

The determination of 'acceptable levels of risk' is a concept used within environmental change literature, and in practice, assists ministries to work together on management issues that overlap various bodies. In Venezuela there was no evidence of this type of cooperative management across the ministries working in disaster management (INT #1, 2, 6, 9 & 11). Collaboration across ministries was viewed by interviewees as stopping with the division of responsibilities and minimal level of communication (INT #6); therefore the rating for this criterion in post-disaster Vargas is *poor*.

Empowerment of local actors during the post-disaster phase is generally seen as a 'good practice'. The research demonstrated that empowerment of local actors was a strength of the response and reconstruction efforts within Vargas. Non-Venezuelan assistance was limited to financial contributions for both structural projects (e.g. dam and canal construction) and non-structural responses (e.g. funding of education projects) (INT # 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 &

13). CorpoVargas and the *Autoridad Unica* were staffed by Venezuelans and each institution was permitted authority over the post-disaster urban planning and reconstruction efforts respectively (INT # 6, 11 & 12). The absence of foreign agencies meant that more capacity and knowledge was kept and developed within the region, hence the rating of *good* for empowerment of local governments.

Weaknesses in institutional capacity are often highlighted during a catastrophe. Therefore, training programs, geared at building the individual employee's skills before a disaster, can improve the response to the next crisis situation. After the 1999 debris flows, the PREDERES project had the objective of "empowering the organizations directly or indirectly involved in risk management in this area, namely the Vargas Municipal Services, the Ministry of Environment, the Ministry of Education, the Maritime Caribbean University and the Central University of Venezuela, in order to improve personal (sic) capacities and favor information and experiences exchange between these organizations" (Lopez & Courtel, 2007, p. 11). Despite this training program, a *poor* rating is given because the eventual dissolution of *Autoridad Unica* inevitably led to the loss of capacity in the state apparatus as employees went on to new jobs (INT #12). The use of temporary consultants for data collection and re-development planning also contributed to the poor maintenance of capacities and knowledge (INT #1, 6, 8, 9, 10 & 11). Consultants bring expertise and experience that is very valuable in determining a good solution, however, after the contract is finished, that knowledge and experience is not available within the permanent institution.

Private and public sector cooperation, also known as public-private partnerships or PPP, can greatly affect the outcome of decision-making on projects that affect an entire socio-ecological system. In Vargas State, the inclusion of private sector experts for engineering and structural mitigation efforts, and the creation of CorpoVargas to manage the reconstruction activities, is an example of the type of cooperation attempted (INT #2, 6 & 12). The coordination and management of diverse actors, and the formation of PPPs, allowed for a stronger response than would have been possible if only public sector organizations were involved.

Global disaster risk reduction funding is usually available, as discussed in an earlier chapter, from a variety of sources. The terms of use for this funding are generally broad, and do not require monitoring of results as long as the principle is repaid to the donor agency. However, in order for real change and reduction of risk to result, monitoring of the funds is important. In the

case in question, monitoring of risk reduction progress since 1999 seems to be limited to academic reports (e.g., Altez, 2005; Cardenas & Jiménez, 2005). The Inter-American Development Bank (IDB) reported repayment of loans and grants given to the Venezuelan government for reconstruction and disaster risk reduction projects (IDB, 2009). Despite repayment, there is no indication that the projects funded by the IDB have had any further monitoring or maintenance in the literature or from interviews. In light of the use of DRR funding without adequate monitoring, a *good* rating cannot be offered. Ergo, Vargas is rated as making *adequate* efforts on this criterion.

4.3 Biophysical System

The availability of up-to-date information on the biophysical system informs a successful response and recovery from catastrophe. Hazard maps can provide an overview of areas of lowest and highest risk and can inform the prioritization of evacuation routes, zoning changes, and urban design concerns. In Vargas, hazard maps were available to decision makers prior to the 1999 disaster, although the integration of such maps into the broader planning and response system was, and continues to be insufficient to reduce vulnerability in the state (INT #1, 3, 6, 8, 9, 10 & 11). Broad, watershed-level maps were created as part of the UCV project to create a comprehensive monitoring network (INT #2), yet further use of those maps was not divulged throughout interviews. There has been much discussion about changes to urban zoning based on hazard maps since 1999, although there are "still no decisions" *nine years* after the catastrophe (INT #2).

Hazard maps can also be used to inform community members of the risks in their neighbourhood. It was discovered during a community education program directed at school age children that neither the children, nor their parents, were able to interpret such maps (INT #10). Thus, it can be concluded that although hazard maps for Vargas State were created, these were not well used for planning or education purposes and because of this, this criterion must be rated only as *adequate*.

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Biophysical Environment				
use of current hazard maps in future planning and development projects?		*		
understanding and documentation of function and change in bio-physical systems?		*		
current models predicting/forecasting probability and severity of hazard events?		*		
process defined/available staff to update models post-disaster?		*		
exitence and evaluation of early warning system?		*		
preparation for multiple hazard/complex hazard or rare events?	-			
efforts made to use and enhance natural barriers and protective structures?			+	

Table 6: Completed Assessment of Biophysical System[17]

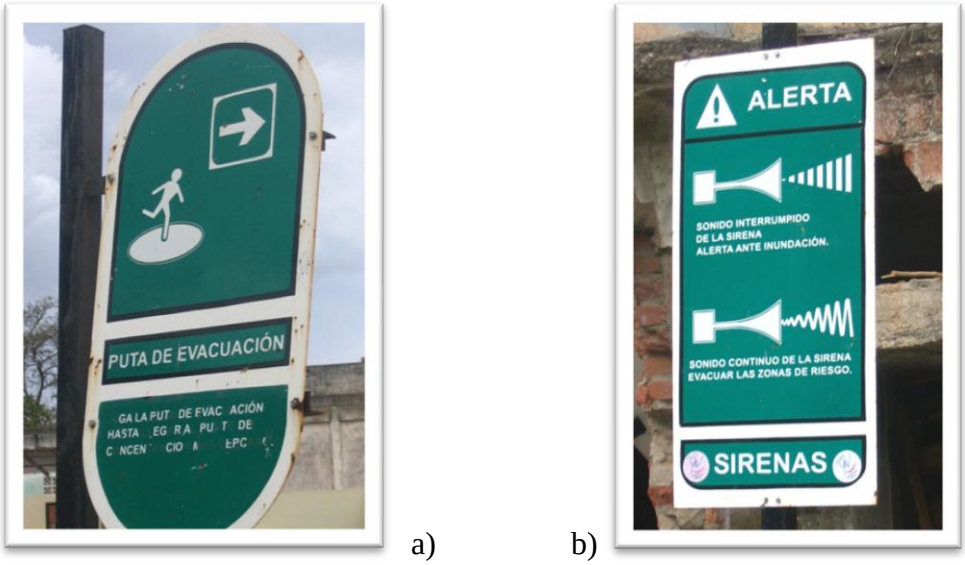
The Central Venezuelan University (UCV) has developed a system to monitor meteorological and climate data in each of the flooded stream catchments as part of the recovery after the debris flows (INT # 2, 3, 4, 8 & 12). Studies were conducted with experts from the United States Geological Survey (USGS) to determine the current and historical geomorphology and geology of the El Avila Mountain range (INT #2, 3 & 4; Wieczorek et al., 2002). Together these experiments provided *adequate* data and documentation of the changes, both real and potential, to the bio-physical system.

Additionally, the UCV has integrated the climatology and meteorology data into 11 monitoring stations to measure rainfall in real time for monitoring and measurement across the state (INT #2). Together with the hazard maps, this data was input into a FLO-2D model to simulate mud and debris flows (Lopez & Courtel, 2007). This type of mathematical model allows for the delineation of highly hazardous zones and can inform urban planning in the region. The UCV has worked closely with the local government to make this model and data available for use in the years following the tragedy (INT # 2, 3 & 4). The researchers from UCV are limited in their ability to influence policy changes; however, their willingness to cooperate with and inform policy makers will allow for maintenance of the models and a supply of current data which meets the model's requirements. Cooperation across institutions is good, however having trained staff within the government body making policy changes, whether CorpoVargas or another ministry, would improve the speed of decision-making and provide a more frequent maintenance to the model. Positive efforts for the use and updating of predictive models was

[17] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

found in this research, however, the abovementioned challenges prevented a rating higher than *adequate*.

A typical flash-flood or debris flow early warning system is comprised of hazard maps, evacuation plans, monitoring of relevant data (depending on the hazard), and is completed with a means of communicating impending danger to citizens, either through sirens or some form of message transfer (e.g. radio or telephone). The early warning system in Vargas State remains incomplete nine years after the disaster (INT #1-13). As mentioned, parts of the system are functioning, yet misleading information can be found throughout the communities (see Figure 20).



a) b)

Figure 20: Signage as part of early warning system

Text on sign a):
EVACUATION ROUTE
Follow the evacuation route to safety
(remainder illegible from vandalism)

Text on sign b):
WARNING
Discontinuous siren will sound before flood
Continuous siren, evacuate risk zones
SIRENS

Although sirens are depicted on signs posted in some communities, no sirens have been erected, nor have comprehensive programs explaining the warning system been conducted within communities (INT #2 & 12). Some communities may have attempted their own neighbourhood warning systems (INT #1 &10), but without standardization and full community coverage, this will do little to reduce vulnerabilities regionally.

A partial early warning system which currently sends data to monitoring staff at the UCV and the Caribbean Maritime University in Vargas State (INT #2) now exists, yet this system is not yet connected to community-level sirens, and without full involvement of all actors the program

will not be successful in reducing vulnerabilities. Figure 21, below, shows the system proposed by the UCV and Maritime University. Missing components and some actors who were not able to be interviewed during field work in 2008 are marked on the diagram. As is described through the diagram and the above paragraphs, the criterion related to early warning systems has been partially addressed by numerous initiatives in Vargas. Nevertheless, the system remains incomplete and therefore is rated only as *adequate*.

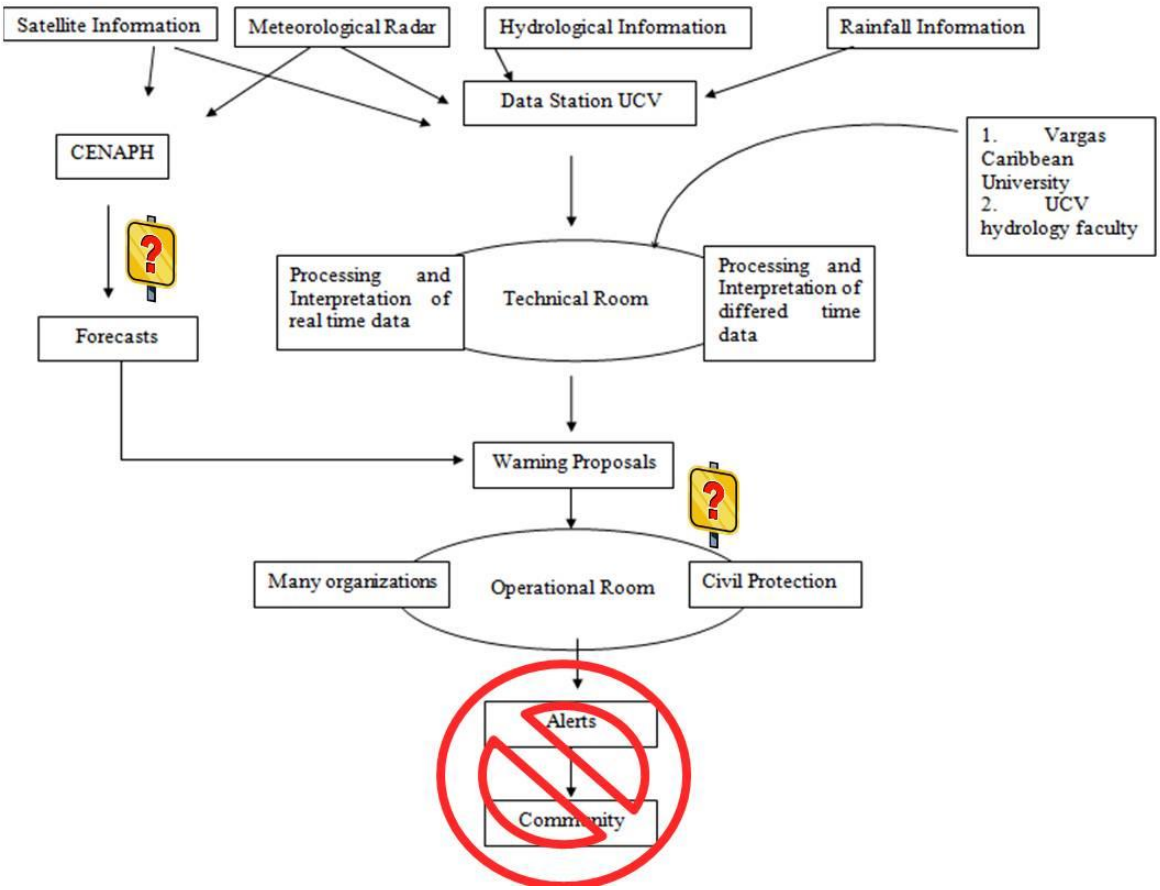


Figure 21: Proposed Early Warning System (from UCV)

Source: (INT #2, 3 & 4, 2008).

A debris flow can be classified as a complex hazard because it starts as a flood and with increasing precipitation causes mudflows and debris movement of varying sizes and consistencies. Preparation for this kind of complex hazard demands a management system which is both flexible and redundant. Redundancies in evacuation routes, shelter locations, warning systems, command agencies and response teams create a relief system which can adjust to unforeseen damages and impacts. The 1999 debris flows caught residents and government bodies

off-guard since no one had predicted that a debris flow of that size was possible in Vargas (INT #1, 5, & 7). Post-disaster, channels and dams were built on each alluvial fan in an effort to prevent damages to housing; however, their size is thought to be wholly inadequate to eliminate or control damages from debris flow events (i.e. they are not thought to have sufficient capacity to capture all sediments accompanying a flood event) (INT #2 & 3). As evidence of this, a relatively smaller debris flow event in 2005 completely filled up one of the largest dams built after 1999 (Field notes, 2008 – see Figure 22). Structural responses can successfully prevent future damage when built to accommodate significant material, however, one interviewee (#1) questioned whether the dams would help, or would actually supply *additional* material to the flows because of their insufficient size. The complexity of any disaster cannot be easily predicted, however, use of knowledge about past events, along with biophysical data, can help inform management plans.

Figure 22: Sedimentation in Dams and Channels in 2008
Dam on right is in Macuto and measures approximately 7m high and has been filled since before the 2005 flooding event. Source: (Doberstein, 2008)

Rare events, disasters which are infrequent or extreme in their magnitude of scope, also need special consideration by disaster practitioners. Swine flu, H1N1 virus, and other pandemics are the types of hazards which can quickly become unmanageable if proper contingency plans are not considered because of low statistical likelihood. Interviewees indicated that the national, state and municipal governments are inadequately prepared for both rare and complex disasters (INT #1, 6 & 12).

Several methods to enhance 'natural' protection from debris flows were found in Vargas. As mentioned, channelization of streams in each valley has been completed in an attempt to

preserve the natural flow patterns and protect homes (INT #2). The creation of the El Avila National Park, early in the 1950s, has served to protect the natural forests and limit development and forestry activities on the steep slopes of the mountain range (INT #2, 3, & 6; CEPAL, 2000). The presence of vegetation on the slopes in the upper watershed increased the absorption of precipitation and slope stability in the weeks leading up to the debris flows and, whether an intentional mitigation effort or not, has been acknowledge as important for post-disaster risk reduction (INT #6). Similarly, the use of straight channels may work to prevent damaging impacts during average rainfall events, but in extreme events, the river naturally wants to wander and the channel size is inadequate to accommodate this pattern (INT #8). Previous understanding of the physical geography on the part of urban planners needs updating to incorporate new perspectives on the river's direction and flow potential, nevertheless current efforts are deemed to be *good*.

4.4 Built Environment

A common flaw, or misconception in disaster management is that technology and engineering are always effective in reducing risks. Engineering solutions have improved safety in some cases (e.g. earthquake-proof buildings in Japan or the western USA), although engineered solutions have also created problems in other cases (e.g. the Yangtze River Three Gorges Dam and floods in China).

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Built Environment				
appropriate use of technology and engineering for risk reduction?	-			
response efforts aim to 'build back better' structurally and economically?	-			
reconstruction projects address need for social housing and low-income housing needs?	-			
redundancy in infrastructure? (e.g. evacuation routes, communication lines etc.)	-			
existence and enforcement of building codes for reducing risks?	-			

Table 7: Completed Assessment of Built Environment[18]

In Vargas, a reliance on structural responses has been the trend as demonstrated by the numerous channels and dams built, and limited use of land use zoning and building codes (INT

[18] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

#1, 2, 6 & 8). It is difficult to say that these engineering and technological solutions have only had negative impacts on risk reduction efforts; yet, the magnitude of the 1999 debris flow event was much larger than structures built post-1999 are designed to trap, hence the new structures will do little to *minimize* risks from similar future events (INT #2, 3 & 4). Therefore, the appropriateness of the design standards and use of small structural responses must be rated as *poor*. One interviewee estimated that the 35 dams in 18 channels constructed after the 1999 debris flows "cannot trap more than ten percent (10%) of the sediment produced in 1999" (INT #2). These dams have been built to protect against a one in 100 year flood, but were filled up between 2001 and 2005 by much smaller meteorological events (INT #2). Poor planning of dam sites and maintenance activities has made most dams inaccessible for the removal of this sediment, thus rendering the dams ineffective in their role of trapping sediment in a major debris flow event (INT #1, 2, 6, & 8).

The BBB propositions suggest there are numerous structural and non-structural mitigation techniques which can build resilience and reduce risks. Interviewees unanimously suggested that there had been little, if any, attempt made to 'build back better' during the reconstruction process. Community participation occurred only during education projects and inclusion of the public in planning and reconstruction efforts did not occur (INT # 1, 2, 6, 8, 9, 10, 11 & 12). The most notable failure to 'build back better' was a result of slow decision-making in the immediate post-disaster timeframe (INT #1, 2, 5, 6, 7 & 8). The delay by the local government in deciding how to proceed with recovery, resettlement and reconstruction led to the reoccupation of homes in hazardous lands and prevented successful implementation of appropriate building design and hazard zonation. The second failure to 'build back better' was the location of 'social housing' on land which flooded in both the 1999 and 2005 extreme rainfall events (INT #1 & 9). Construction of housing for those who lost their homes is an important part of reconstruction, but safe location choice is the key to rebuilding a more resilient housing stock. The size of housing projects was also thought to be inadequate to accommodate all of the low-income families who lost their homes in the disaster (INT #1, 6 & 10). Because of this, the rating for 'building back better' and addressing housing need for the lowest income segment of the population were both rated as *poor*.

Evacuation was a difficult task for many survivors of the 1999 disaster. The flood waters quickly rose to flow through the streets of communities, damaging or blocking routes which lead

to safety (CEPAL, 2000). Poor communication of pending threats and the need to evacuate, along with limited awareness of how best to react, compounded vulnerabilities in many communities across the state (INT #10). Positive features, such as redundancies in evacuation routes and means of communication during danger, could not be confirmed by any interviewee as existing prior to 1999, nor was there any indication of these redundancies emerging post-disaster. Two community education programs, one implemented by an academic NGO from UPEL[19] called *Campaña Educativa Comunidad*, and the other by CorpoVargas, have been executed since 1999 in fewer than ten communities across the state (INT #10 & 12; Barrientos Ch., 2005). These programs aim at helping the communities identify their own evacuation routes and also to interpret signs of danger (INT #10 & 12). Although these are a positive start, the limited scope of these programs led to a rating of *poor* for this criterion.

Building codes are often used to enhance the resilience and resistance of structures at-risk. It is unclear from this research whether Venezuela has newly legislated any such codes for the disaster-affected North Vargas State. The *Campaña Educativa*[20] found that some educational buildings were indeed lacking emergency preparedness codes. Bars on the windows of schools prevented exit from alternate openings and the close location of neighbouring buildings also impeded evacuation (INT #10). In addition, fallen electrical poles caused electrocution and safety equipment was only required under government regulation in private schools; therefore, public schools are poorly equipped for any type of emergency (INT #10). Although information on building codes beyond school buildings was not identified in this research, the lack of proper emergency exits and equipment in schools is enough to suggest that building codes need increased enforcement. Because of this, and due to the construction of a community centre within a marked 'limit of the flooding event from the 1999', this criterion on the use of building codes to reduce risks is also rated as *poor*.

[19] Universidad Pedagógico Experimental Libertador, program funded by FONACIT (National Fund for Research in Science and Technology)

[20] Additionally, building standards for schools in colonial towns did not exist and therefore they would not withstand an earthquake, and prior to 1999 these schools did not have emergency exits (INT #10).

Figure 23: Community centre built inside the 1999 flood zone
Text on sign reads: 'Limit of the area flooded in the 1999 event' – river is located behind the basketball court to the left, placing the community centre in a high-hazard zone.

4.4.1 *Legislation Concerns*

Legislation is a significant factor for successful implementation of any kind of program affecting a community, state or country. Previous criteria have already indicated the need for some legislation (e.g. building codes or housing policy) and to complete the assessment of post-disaster vulnerability reduction effectiveness there are two other legislation issues to consider. In Vargas State, the use of urban land use zoning to protect high hazard areas was acknowledged by interviewees as non-existent post-disaster. Interviewee #12 confirmed that permits are issued for all proposed construction within the state and posited that CorpoVargas will not issue permits for uses which are contrary to the land use zoning designation. However, the town of Macuto, for example, has been identified on hazard maps as 95 percent "high hazard", yet this town still has both commercial and residential buildings throughout (INT #2). Therefore, the integration of known hazard areas has yet to impact land use decisions. Other interviews also indicated a lack of enforcement or change to zoning after the 1999 disaster and therefore this criterion is rated as *poor*.

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Legislation Concerns				
zoning and enforcement of high hazard areas?	-			
policies which foster principles of sustainable livelihoods (capacity, equity, sustainability) at local, and national levels as well as at all stages of disaster cycle?				N

Table 8: Completed Assessment of Legislative Concerns[21]

Broader consequences that can result from legislation include a more sustainable economy and improved employment opportunities. Literature on sustainable livelihoods advocates for policies which ensure capacity, equity and sustainability within the workforce and amongst firms (Chambers & Conway, 1992). Interviews did not address sustainable livelihoods directly, thus a definitive rating on this criteria is not possible. However, further document analysis and consultation with key informants leads me to believe that the principles of sustainable livelihoods have not been incorporated into policies relating to disaster management or broader development in Venezuela (Altez, 2005; CEPAL, 2000; Lopez & Courtel, 2007; Jiménez Díaz, 1992). One interviewee did mention that community consultation is "not sustainable" because of the absence of any further consultation after the end of a project (INT #6). Another interviewee proposed that training and education would be *more sustainable* if delivered at local, small scale and if individuals were taught to incorporate risk into their everyday life due to the belief that relocating thousands of people is not feasible (INT #11). Only one program, PREDERES, was referred to as strengthening the capacity of municipalities in civil protection and other non-disaster areas (e.g. waste management, sewage treatment). Although the success of this program in achieving its goals was not indicated by the interviewee, the program sounds like an initial attempt to improve capacity and sustainability.

4.5 Adjustments to Assessment

After completing PDARRE, I consulted several key informants again and asked these individuals to review and comment on my assessment of post-disaster responses in Vargas State. This process was more difficult to accomplish than expected, and it was not possible to obtain

[21] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

the desired response rate. Nevertheless, two key informants did review my assessment, and there was general consensus from both informants on all but four criteria. These four are reviewed next.

The first criterion to be revised is under the heading *Institutional Concerns* and is "empowerment of local governments to manage recovery". The first reviewer suggested that although the Venezuelan government was in charge of much of the response and recovery process, power has not been spread broadly enough since CorpoVargas was the only institution granted the power and resources for reconstruction (Reviewer #1). The second reviewer concurred, suggesting that municipalities and regional government also should have been included in this process as they could enhance the use of resources and share in the project execution (Reviewer #2). Despite these reviewer hesitations, I feel the initial rating or *good* is still warranted. The purpose of the criterion is to rate the degree to which a local institution commands response activities, and therefore a reduction in the rating would reflect a situation where, for example, distinct efforts have been made by central government to keep power from local hands, or where there is no local involvement whatsoever. Although a rating of *good* is the highest, there is still room for improvement and as CorpoVargas gains more experience and knowledge, there is potential for continued success in this area.

Second, after reviewer's comments, I agree that three criteria under *Biophysical Systems* should be revised. The "use of hazard maps in future planning and development projects" is questioned. Although hazard maps do exist, reviewers suggested that they are not used sufficiently in planning and development (Reviewer #1, 2). For example, the presence of maps within the UCV does not necessarily mean that those maps are used by government planning authorities. The example of land use zoning provided for Macuto is but one clear example where the omission of hazard maps in zoning decisions has perpetuated vulnerabilities. Therefore this research cannot conclusively defend a rating of *adequate*, and as a result I reduced the rating to *poor*.

"Existence and evaluation of early warning system" is the next criterion which needs a revision in its rating. The rating was reduced to *poor* because the system is still yet to become fully functioning across the state (INT #2, 4, 12, Reviewer #1 & 2). One interviewee initially indicated that the siren was the only missing part of the system during 2008 field work (INT #12). However, a reviewer reinforced that education programs within communities would also

need to be conducted in order for the system to work as designed (Reviewer #2). Initially the presence of all the necessary pieces of the system was evaluated to be a good attempt, although upon reconsideration, without the education of the individuals in the community on *how to respond* to the ringing of the siren, the system will never significantly reduce vulnerability.

Finally, until I was able to read further documents and ask informants specifically about "preparation for multiple hazard/complex hazard or rare events", my evaluation of that criterion would have been speculative. I am confident now that a rating of *poor* is accurate. Consideration for climate change and El Niño are mentioned in a document discussing the effects of the 1999 debris flows and produced in part by the Venezuelan government and the Economic Commission for Latin America and the Caribbean (ECLAC in English or CEPAL in Spanish) (CEPAL, 2000, p. 89). The mention of these processes is an acknowledgement of their potential impact on future disasters, although there is no commitment to the inclusion of rare events or complex hazards in preparedness activities. Other reports refer to social complexity as a factor in disaster management (Genatios & Lafuente, 2003), yet there is no reference to steps needed in order to improve policies to account for this complexity. Actually, the extraordinary nature of the 1999 event seems to be used as evidence not to include consideration for 'rare events' because of the low likelihood of such an event to reoccur. Reviewers corroborated this evidence by suggesting that consideration of multiple or complex hazards and rare events *are not likely* currently part of policy and planning in Vargas State (Reviewer #1, 2).

Post-Disaster Assessment of Risk Reduction Effectiveness	POOR (-)	ADEQUATE (*)	GOOD (+)	NO DATA or N/A
Socio-economic System				
current vulnerability and capacity assessment data for affected population?				N
indicators/monitoring of progress on risk reduction/sust. hazard mitigation?	-			
standardized and inclusive community awareness programs?	-			
community education programs geared toward the development of a culture of safety?		*		
recovery made to benefit and improve livelihoods, quality of life and tenure concerns?	-			
enhance and encourage community cohesion, inter/intra-generational equity and social capital?	-			
creation of an insurance program based on vulnerability assessments?				x
encouragement of entrepreneurship?	-			
creation of business continuity plans to rebuild and enhance local economy?				N
Institutional Concerns				
availability and use of previously identified lessons for risk management (local/similar hazards)?		*		
existence of functioning public disaster relief system?		*		
cooperation within and across government bodies, NGOs and community?	-			
clarity of responsibilities, roles and relationships (pre)defined?		*		
efforts to ensure continuity and stability over time in government bodies? (redundancy)		*		
set corresponding 'acceptable levels of risk' in all relevant ministries? (e.g. housing, planning, environment, natural resources, emergency management etc.)	-			
empowerment of local governments to manage recovery?			+	
staff retention schemes to maintain capacity through various emergency events?	-			
inclusion of private and public sector actors?		*		
effective use and monitoring of DRR funding and financial capital with a focus on strengthening government (esp. local) recovery institutions, equity and sustainability?		*		
Biophysical Environment				
use of current hazard maps in future planning and development projects?	-			
understanding and documentation of function and change in bio-physical systems?		*		
current models predicting/forecasting probability and severity of hazard events?		*		
process defined/available staff to update models post-disaster?		*		
exitence of and evaluation of early warning system?	-			
preparation for multiple hazard/complex hazard or rare events?	-			
efforts made to use and enhance natural barriers and protective structures?			+	
Built Environment				
appropriate use of technology and engineering for risk reduction?	-			
response efforts aim to 'build back better' structurally and economically?	-			
reconstruction projects address need for social housing and low-income housing needs?	-			
redundancy in infrastructure? (e.g. evacuation routes, communication lines etc.)	-			
existence and enforcement of building codes for reducing risks?	-			
Legislation Concerns				
zoning and enforcement of high hazard areas?	-			
policies which foster principles of sustainable livelihoods (capacity, equity, sustainability) at local, and national levels as well as at all stages of disaster cycle?				N

Table 9: Revised Assessment of Post-disaster Risk Reduction Effectiveness for Vargas, Venezuela[22]

[22] Sources: (INT #1-13; Field notes, 2008; CEPAL, 2000; Challa, 2000; Wieczorek et. al, 2002; Larsen et. al, 2001; Larsen & Torres-Sierra, 2006).

4.6 Summary of Findings

The Venezuelan government dealt with the Vargas debris flows in a manner which is fairly typical of developing country governments. The Venezuelan military played a primary role in the search and rescue of both survivors, and later, bodies (Stambouli, 2000; INT 1 & 3). Foreign assistance was requested immediately after the disaster and over the subsequent years. The national government was allocated nearly US$200 million by the IDB "to restore basic services and avert additional losses in the central littoral of the country" (IDB, 2009). International aid and disaster assistance totaled 'several hundreds of millions of dollars'[23] for reconstruction and vulnerability reduction efforts in Vargas State. Despite this funding, efforts were summarized by interviewees as very slow, and 'largely rebuilding the conditions of risk and vulnerability that existed prior to the 1999 event' (INT #1, 6 & 8).

Slow governmental and aid decision-making after the disaster left many survivors 'in limbo': compensation for damaged housing was not paid out quickly and many survivors lacked the financial resources to rebuild in other less risky locations. Primary obstacles included: 1) a lack of financial capital to fund the purchase of land and building materials; 2) deteriorating social and human capital resources from the emotional distress and loss of life caused by the disaster and; 3) high competition for damaged physical and natural capital. In addition, the lack of timely decision-making about urban rezoning (e.g. identification of allowable reconstruction zones and 'no development' zones) was seen as a key component to the resettlement of residents in the damaged housing along the northern coast of Venezuela (INT #2, 6).

Additional evidence of the largely ineffective response to the 1999 disaster came in the form of a failed government relocation scheme for survivors. As time passed, the government made an attempt to get people out of shelters and into permanent homes by relocating them to other areas of the country (Doberstein & Stager, 2008). Some of the resettlement communities include Maracaibo, Guanare, Los Andes (Trujillo), and Ciudad Bolivar, none of which is less than 400 km from Vargas State (see map in Appendix 2) (INT #7 & 8). Although housing was judged to be adequate by most interviewees, relocated families soon abandoned their new homes, and many returned to the disaster-affected zone (Doberstein & Stager, 2008). Interviewees offered a

[23] Two reports which collectively confirm over $122 million USD of aid are found at: http://www.state.gov/documents/organization/46927.pdf & in (Challa, 2000).

number of reasons for the failure of the relocation scheme: the culture and way of life in the relocation areas was too different (INT #8), relocated people did not have an affinity for the new land/community or surrounding region (INT #6), relocatees could not practice customary livelihoods such as fishing, tourism and dock work (INT #7); educational and medical facilities were inadequate (INT #12), and "relocatees faced persecution and suspicion by locals in the relocation communities" (INT #5). Cardenas and Jimenez (2005) summarized the failure of the relocation scheme as follows:

> After the disaster, the government tried to offer housing solutions outside the State of Vargas, but at the end of two years most of the population returned to the site. The slowness in the response of the government to the reconstruction and recovery of housing forced people to rebuild their houses (by themselves), many of them in the same high-risk area (pg. 5).

Again, speed, or more accurately, the relative lack of speed on the part of the Venezuelan government, appears to have been a key component to the failure of this part of the recovery process (Doberstein & Stager, 2008). As is very common with relocation programmes which do not involve community consultation (see Oliver-Smith, 1991), the ties to family, customs and social cohesion were not so easily transferred to the new locations. Many people were dissatisfied with the government's offer and opted to return to their previous land and face the known risks rather than overcoming the challenges in the new community (CEPAL, 2000; INT #1, 6 & 11). By one estimate, within two years at least 80% of relocated people had returned to Vargas State (INT #6).

There is an emerging consensus in the global hazard mitigation community that actions taken during post-disaster reconstruction should aim to reduce the vulnerability of surviving residents (Wisner 1995; Clinton 2006). In the 'build back better' approach there is now an understanding that "good recovery must leave communities safer by reducing risks and building resilience" (Clinton, 2006, p.1). To do so, these reconstruction actions must be planned with the incorporation of longer-term results and executed to consider future implications and changes in variables such as demographics, economics and social structure.

The results discussed in this chapter identify several weaknesses in the response and reconstruction phases of Vargas State's disaster management system. Many of the basic tools and capacities are attainable for an improved response to the next disaster, yet the 2005 flooding event was evidence that little had changed within the system (INT #1, 2, 6, 8, 9, 10 & 11). Fortunately, the 2005 event brought significantly less precipitation and so the area affected and

damages were much less (INT #1). Nevertheless, in light of the weaknesses identified through the Assessment of Post-disaster Risk Reduction Effectiveness (PDARRE), the next chapter will identify further steps (policies, actions and solutions) which could reduce vulnerabilities in Vargas as part of broader development goals for Venezuela in order to achieve Objective 4.

Chapter 5: **DISCUSSION**

In Chapter two, vulnerability was defined as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process)" (Wisner et al., 2004, p. 11). Thus, in order to effectively reduce vulnerability, these characteristics of the socio-ecological system must be understood. Research on the Vargas State disaster of 1999 revealed several inherent characteristics which make the residents vulnerable, including: a) the rapid and unplanned development of urban settlements on alluvial fans; b) an incomplete disaster relief system and limited preventative strategies implemented prior to 1999; c) a population which is not fully informed or allowed to participate in risk reduction activities; and d) a socio-economic system which created an unequal division of wealth between Caracas and the northern coastal communities of Vargas State. In addition to these characteristics, the creation of CorpoVargas, a new government institution, in the immediate aftermath of the disaster inhibited decision-making by stifling communication and creating unnecessary uncertainty. The following chapter will discuss opportunities and concerns regarding vulnerabilities and urban settlement development. Following this, implications for a few significant groups will be discussed based on the PDARRE framework created for this research. Finally, the chapter will conclude with some recommendations.

5.1 Why Have Vulnerabilities Persisted?

To begin with, real progress was inhibited by post-disaster changes to the power structure as new institutions struggled to become effective in their new roles. This type of response to disaster has been discouraged in the build back better literature, which suggests: "the aftermath of a crisis is the wrong time to create new institutions, establish new policies and legal frameworks, and recruit new staff, as (this can create) major bottlenecks and delays, not to

mention uncertainty" (Clinton, 2006, p. 8). Regardless of the poor timing of its creation, CorpoVargas was created as a specialized institution that must be accountable for reconstruction into the future. Delays and uncertainty in decision-making were found to motivate residents to rebuild their homes in situ (see Figure 24) and can also be linked to the poor communication across institutions which arose as part of this research.

Figure 24: Individual rebuilding his home and property markers using rocks transported by the 1999 debris flows

Source: Doberstein, 2008

Secondly, the case study herein provides an example where public consultation was not effectively incorporated into response or reconstruction decisions. The failure of the survivor relocation programs should come as no surprise given the lack of public consultation which led to resettlement located some 400km away and in distinctly different socio-economic environments. Often reconstruction authorities have been said to lack sensitivity to the consequences of resettlement and may ignore the social cohesion which results from re-emergence from the rubble of a disaster (Oliver-Smith, 1991). Resettlement decisions may be able to capitalize on the strong social capital that is often revealed in the post-disaster setting, and use this to develop an advantageous and socially-acceptable relocation plan as well. In Vargas State, this opportunity was missed and resettlement locations were not accepted because the survivors were not involved in the selection of the location.

A more successful approach would have included aspects of theory from sustainable livelihoods, sustainable hazard mitigation or the PAR model since these frameworks offer

solutions to some of the challenges faced in Vargas. The sustainable livelihoods' conceptual framework is based on analyzing, understanding and managing the complexity of livelihoods while enabling trade-offs to provide potential policy interventions (Rakodi & Lloyd-Jones, 2002, p. 4). Likewise, sustainable hazard mitigation theory promotes accounting for social forces and would have enabled similar interventions. These social forces are also the 'dynamic pressures' which Wisner et al. (2004) mention in their PAR model. Incorporation of public input in the recovery, reconstruction and resettlement activities post-disaster would have identified the causal factors which perpetuate vulnerability and created policy interventions geared at the creation of a sustainable, resilient and less vulnerable community. Good practices suggest that in order for these forces to be truly be accounted for, *all* of the members of the society must have a voice that is heard.

This research revealed that some positive attempts were made to carry out hazard mapping post-disaster, but that there was an over-reliance on consultants and little long-term institutional learning. Further use of hazard maps in urban planning and design would require that more than the academic consultants from the UCV learn to use and interpret the data from the predictive 2D models created after the 1999 tragedy. An over-reliance on external consultants is common among government institutions of many LDCs. Project-oriented agencies habitually hire staff with project management skills and then outsource work to expert consultants in order to maintain an unspecialized core staff and flexibility in their operations. This method for project completion, although it provides high quality results, leaves the institution with little knowledge about the failures and possibly a list of 'lessons identified' but no real institutional *learning*.

An early warning system is a key part of the relief system, but on its own, an early warning system will create limited long-term benefits for development and vulnerability reduction goals. The creation of a solid early warning system allows people to escape disastrous natural events, yet saving lives while repeatedly losing property and infrastructure still perpetuates cycles of vulnerability and poverty. Countries such as Cuba are very good at safely evacuating vulnerable people from unsafe land whenever hurricanes are likely, often, several times each year. However, damages from hurricanes could be argued as one of the primary contributors to Cuba's continued lack of advancement. *Re*-investment by individuals and institutions into rebuilding damaged infrastructure and housing is a wasteful use of financial capital which inhibits development progress on both the local and national scale. Moreover, structural designs are

difficult to improve upon because limited financial capital can be accumulated between hurricane strikes. This research revealed that in the absence of early warning systems, evacuation of a large number of people is possible. However, Vargas also shows how a response which is not planned or well-monitored beyond the evacuation stage can leave survivors vulnerable to the same threats.

The means through which to improve future disaster response are numerous, but the following actions would generate a stronger system. CorpoVargas must prioritize the completion of the early warning system. This means the creation of community education programs associated with understanding the signals and actions for evacuation and protection. CorpoVargas may not be the proper institution to deliver community education program, but as they are closely linked to the system of early warning, CorpoVargas must find a means for presenting the completed system to ALL of the at-risk communities.

In addition to the early warning system, the creation and enforcement of building codes and building design assistance will help to protect valuable infrastructure. The failure of the survivor resettlement programs resulted in as much as 80 percent of people returning to their home to rebuild (INT #6). Financial or guidance assistance from CorpoVargas or NGOs to the returning residents would allow them to create structures that can withstand some level of flooding and debris flow. Again, community education programs can serve as the manner through which to communicate these design requirements and suggestions to those who remain at-risk to the hazards in Vargas State.

Post-disaster, the inappropriate structural responses (e.g. incomplete dam network and lack of maintenance access) and lack of partnerships or community inputs to reconstruction plans raises questions about CorpoVargas' ability to achieve their stated purpose. Had CorpoVargas properly monitored the construction of the dams, with qualified staff to evaluate the completion, then the dams would have been accessible for sediment removal. Engineers from UCV became aware of this failure following flooding in 2005, considered a typical one in 500 year event, which caused the dams to fill to their limits (INT #2-4). The relevance of the BBB propositions is epitomized in this failure of "good information" and the need for "partnerships that move beyond rivalry and unhealthy competition". All actors working on the reconstruction, whether for research or construction purposes, should be communicating, yet, like many cases globally:

> "…individuals, organizations, businesses, and governments tend not to adopt or implement on any large scale the mix of sustainable mitigation precautions that would enable them to avoid long-term losses from hazards. Thus, making mitigation a reality will require overcoming many human behaviours along with financial, political and social obstacles" (Mileti, 1999, p. 136).

Maskrey (1989) advocates the post-disaster use of community based organizations (CBOs) "at the local level to reinforce organisation, build up political consciousness and reduce long term vulnerability … [to] attack the causes and not just the symptoms … through a strategy for immediate action" (p. 46). In this way, communities are able to reduce their risk level on a day-to-day basis by demanding more capable management of vulnerabilities from their government, developing long term resilience to hazards locally, and achieving development progress. There was no evidence to suggest that CBOs played a significant role in Vargas State post-disaster reconstruction.

The lack of information sharing and strong partnerships built on trust and respect also became apparent in the structural responses to the tragedy of 1999. For example, the use of a number of different types of dams, from gabions to a Swiss technology known as 'flexible ring net barriers'[24], is an indication of a lack of research or knowledge of the best technologies and/or physical composition of the region. Lopez and Courtel (2007) suggest "interception and retention dams in the middle and lower part of the catchments (canyons) and channel works tend to limit or suppress the consequences of the [debris flows]" (2007, p. 3). However, the authors never explain why multiple types of dams were subsequently constructed in those catchments. Actually, the geology in North Vargas is cited by other researchers as fairly consistent across catchments. One example refers to the soils as being "found frequently as [clayey colluvial deposits] overlying partially-to-deeply weathered, strongly foliated bedrock" (Wieczorek et al., 2002). Therefore, the use of more than one type of dam suggests a lack of confidence in the research from either the geologists or the structural engineers.

Trust and cooperation are key characteristics for success when working on such a complex issue as vulnerability reduction in a socio-ecological system. This study found these characteristics to be lacking in the post-disaster setting. Interviewees revealed problems including: i) poor communication between government agencies (INT #11); ii) pre-disaster

[24] For further information see Geobrugg website: http://www.geobrugg.com/contento/English/Home/Debrisflowbarriers/tabid/2067/language/en-US/Default.aspx

ideological concerns including a lack of public participation and a non-comprehensive response ability (INT #1); iii) government priority for rapid rather than planned reconstruction (INT #6); iv) government fears of changing or upsetting the current socio-ecological system (INT #6 & 10); and v) the creation of CorpoVargas which resulted in two bodies having responsibility over the same land (INT #8). These issues affected the ability of decision makers to foster a trusting and cooperative environment, in turn impacting how well they were able to address and reduce the dynamic pressures which imbedded vulnerability in the region prior to 1999. Most of these pressures remain problematic, following the post-disaster response.

Overall, this case study analysis has shown the complexities which arise in managing disaster in LDCs. This next section will look more specifically at hazards in urban centres and identify further dynamic pressures which affect urban areas specifically.

5.2 Socio-economic Factors in Urban Settlements

Globally, many major disasters have occurred in large urban centres. The complexity of each disaster varies along a socio-economic spectrum, but also in relation to the size and type of hazard because "not all large urban centres have similar vulnerability profiles" (United Nations Human Settlements Programme, 2007, p. 184). In many developing country urban centres, the pressure to achieve or maintain economic development can detract attention from urban planning and create uncontrolled growth leading to further vulnerability and informal settlements. Finding a balance between managing DRR goals and economic growth is a challenge that LDCs around the globe still struggle with. Unfortunately, the infrequency of disasters often means DRR continues to take a back seat in development goals. However, this thesis has offered a prime example of the negative impacts which hazards can have on development when risk reduction is minimal, or separated from broader development efforts.

Hazard risks are not limited to Vargas State, but have also increased in Caracas because of economic pressures and urban growth. As Venezuela increased its international trade revenues, the investments from foreign companies caused urban expansion in Caracas and in the communities surrounding the main air and sea ports in North Vargas State. This expansion outpaced urban development planning, resulting in the formation of informal settlements on unsafe lands ringing Caracas Valley (e.g. ravines, steep slopes, river edges). Landslides and flash floods in the informal settlements of Caracas have caused deaths. In addition, utility

infrastructure and highways systems have also been classified as at-risk from hazards (Vranes & Czuchlewski, 2003).

Vargas faces similar challenges because of the history of post-1950s explosive urban growth on either side of the *Sierra El Avila*[25] (Jiménez Díaz, 1992). Yet the Venezuelan government has recently divided decision-making for Caracas and Vargas State, and now cooperation between levels of government has been identified as a challenge (INT #1, 6 & 11). Additionally, the location of the *Sierra El Avila* between Vargas and Caracas detracts some attention from hazard risks in Vargas. The larger population in informal settlements in Caracas have a lengthy history of landslides and were also damaged by rainfall in 1999, thus national efforts have become more focused on those citizens as time has progressed (INT #11). This disproportionate focus is not justified given the persistent threats in Vargas and the continued growth of the population on the alluvial fans there.

Not only has Vargas taken second place to Caracas in DRR, but risk reduction solutions for Caracas cannot easily be applied to Vargas' smaller urban areas mainly due to differences in livelihood assets. However, information sharing and collaborative discussion of risks would be logical in the Venezuelan context. Similarities in the physical environment mean that at least some structural responses, such as building design improvement, from Caracas could be applied in Vargas. In reality, several interviewees suggested that funding and resources have been focused on the maintenance of popular votes, rather than the reduction of risks. In both Caracas and Vargas, the delivery of utility infrastructure to *barrios* and housing in high risk zones has been endorsed by government officials to rally support for political campaigns (INT #1, 6 & 8; Jiménez Díaz, 1992). This encourages permanence in risky settlements as households invest financial resources into their homes, however unsafe their location may be.

Vargas State exemplified how hazard vulnerability can develop through urban and economic growth linked to industrial and recreational development pressures originating from its proximity to the capital of Caracas. The coastal communities have grown in recent decades because the industrial and recreation sectors provide employment opportunities. As a result, Vargas has two main types of housing: 1) permanent low-income or middle-class housing occupying marginal lands such as river beds or steep slopes and 2) vacation/second homes for middle-class

[25] This growth, by chance, also closely corresponds with the last major debris flow event in Vargas State (1951).

Caraqueños (INT #3). Housing theory suggests that social housing and/or various forms of subsidies are required in order to provide good quality/adequate housing with services for residents who cannot afford market rate housing or assist residents to improve and/or expand their homes. This was not the case in Vargas where post-disaster housing intended for the low-income survivors was sold on the market. With housing on safe lands being sold at higher prices, the lower-income segment of the population has been forced to more marginal lands where vulnerabilities are higher. Even government-built housing intended as 'social housing' has been located on flood plains, next to rivers.

In summary, many of the post-disaster actions taken by the Venezuelan government were missed opportunities which have generated and perpetuated, rather than reduced, vulnerabilities. There does not appear to be a sophisticated governmental understanding that:

> Holistic disaster recovery is really "sustainable redevelopment," … Disaster recovery provides an opportunity to correct the unsustainable mistakes of the past. Disaster recovery is not, however, the driving force behind implementation of sustainability, nor should it be. Disasters are simply catalysts for change. The post-disaster "window of opportunity" is a time when past mistakes can be assessed, and drawing upon experience, try to demonstrate the way for the future (Natural Hazards Research and Applications Information Center, 2001, p. 2.13).

Although to date Venezuela has yet to capitalize on the post-disaster "window of opportunity", analysis of this case can certainly inform future disaster management decisions both in Venezuela and elsewhere.

5.3 Implications

Objective 4 of this thesis was to identify further steps which could reduce vulnerability and risk in Vargas as part of broader development programs in Venezuela. Accordingly, the following pages will discuss possible future polices, actions and DRR solutions. The format for this discussion will direct implications toward selected actors while following the categorization of the criteria in the PDARRE framework from Chapter 4.

5.3.1 *Implications for Venezuela*

5.3.1.1 Socio-economic System

This section of criteria received mixed results, although overall the rating for risk reduction is poor. The function of the socio-economic system depends on the interactions of people at different levels. The poor execution of community capacity building programs has resulted in a

mosaic of preparedness levels across the State. Additionally, the poor communication across organizations offering programs meant that some communities never received such capacity building attention. Greater coordination, attention to livelihoods concerns and encouragement of a "culture of safety" are criteria that all need further attention from government and NGOs. The BBB propositions also encourage the use of insurance programs which demands business owners and residents understand their risks and value their safety. Through this research the realities in Vargas were depicted and many of these socio-economic criteria were not adequately addressed in post-disaster actions, although DRR could still benefit from improvement in a variety of these areas.

Interviewees were not able to answer all questions relating to the socio-economic questions, thus my efforts made to find definitive answers to all criteria were unsuccessful. I would speculate however, that VCA are not frequently updated for Vargas State. It is also likely that the responsibility for such assessments was not reallocated after the creation of CorpoVargas. With the more recent dissolution of *Autoridad Unica*, and the transfer of some responsibilities to CorpoVargas, it is probable that uncertainties have resulted in discontinuous flows of information across the State. Business continuity planning is also unlikely to rate highly on the priority list for business owners as they attempt to generate financial capital for their families and to rebuild their homes and businesses. It is not too late to institute continuity plans or VCA in Vargas. The on-going risks and vulnerabilities actually make it prudent and practical to look at incorporating these practices, along with insurance on capital assets so that losses from the next disaster are spread over a longer time period.

Successful disaster reconstruction is linked to economic development through the maintenance of foreign investments and relations. Since many LDCs depend on foreign investment for their economic well-being, disaster impacts can affect those investments through damage to infrastructure or lost productivity and the effectiveness of the disaster response also affects the impacted country's image. The case study herein demonstrates how foreign investment led to urban growth in at-risk lands as jobs were created in sectors such as tourism and import/export industries. The importance of cooperation, including honest and open communication amongst all actors post-disaster resulted in economic implications that impacted livelihoods, politics and the health of those living in Vargas. Interviewees noted that major international hotels were not rebuilt after the 1999 disaster (INT #1 & 9). The major damages to

the hotel structures could be one reason the owners withdrew their investments in Vargas. However, ineffective disaster response can have impacts on more than just infrastructure and survival rates, links to foreign investments are additional motivations for the creation of a functioning disaster relief system which protects those investments.

The complexity of the Vargas debris flow disaster is a result of a mix of socio-economic factors, including the strength of social capital and diversity of livelihoods. Vargas State is home to many non-permanent residents who own second or vacation homes which creates pockets of strong social cohesion, interspersed with communities who have limited interaction. Special consideration of how to educate this mixed group of people on the threats they face, therefore, must also be part of the broader disaster recovery plan. In addition, employment in sectors such as import/export, tourism and fisheries creates a community with different, unique interactions with the social-ecological environment of the State. These factors do add complexity to the post-disaster recovery activities, especially with the goal of creating a "culture of safety", but once acknowledged these factors can be managed. Mixed methods of communication with at-risk communities in Vargas will provide multiple opportunities for education and awareness-raising and result in a more resilient socio-ecological system.

5.3.1.2 Institutional Concerns

The post-disaster response effectiveness of the institutions in Vargas State rated slightly higher than the socio-economic criteria, although some specific institutional criteria still require attention from local governmental institutions and NGOs alike. The institutional strengths are largely a result of good identification of roles and responsibilities. Despite the poor timing of the creation of *Autoridad Unica* and CorpoVargas, these institutions had specific responsibilities that interviewees believed were well known. Access, coordination and monitoring of DRR funding allowed the response team to act quickly and plan future DRR actions. Inclusion of public and private actors during the immediate disaster response phase was another manner through which CorpoVargas followed good practice. However, greater public participation in decision-making considerations for the future was needed, and improved oversight and control of the reconstruction will create stronger decisions that are embraced by the local residents.

Poor cooperation, integration, and lack of standardization of acceptable levels of risk were also noted by interviewees as institutional weaknesses in the post-disaster response. The research revealed poor staff capacities and high turnover rates within local government organizations as

well. According to interviewees and secondary data, the Venezuelan government's standard practice when new issues relating to governance arise is to create new institutions. Therefore, challenges with the quality and supply of human capital will continue to plague all institutions and affect overall cooperation. The importance of cooperation is noted in literature on Integrated Emergency Management (see McLoughlin, 1985). Integration of activites from the local to the national level is advocated because it clarifies roles at each level of institution. Additionally, by integrating emergency management across all levels, standardization of practices and acceptable levels of risk can result. The USA's Federal Emergency Management Agency (FEMA) has a strong, integrated system and although its capacity can still be overwhelmed (e.g. during Hurricane Katrina in 2005), the benefits of coordination and cooperation can be seen in most other events. The PDARRE framework revealed that Venezuela has a well organized *immediate* response plan, which can be improved upon over the longer term through further integration and thoughtful observation of weaknesses that have emerged since 1999.

The Venezuelan institutions scored adequately on some criteria, yet overall their response needs improvement in some areas. By empowering local institutions to manage the recovery, lessons were more readily identified through the recollection of past events and their impacts on decision-making. However, since *new* institutions were responsible for managing the response, inefficiencies were evident as slow decision-making delayed important, vulnerability-reduction actions (most notably relocation of survivors and revisions to land use zoning). Maintenance of the status quo is recommended, including roles and responsibilities, because this will undoubtedly reduce inefficiencies in future emergency situations. Future additions or changes to the chain of disaster response command would only further delay decisions, and create losses of capacity across the disaster management system as personnel are moved or effective teams are interrupted.

5.3.1.3 Biophysical Environment

DRR action relating to the biophysical environment also received mixed results in PDARRE. Venezuela faces hazards in a diversity of geographic regions across the country. The 1999 disaster caused landslides and flooding in other states and yet Vargas was the worst affected. A critical reflection of which factors were different in the surrounding states is an important part of the planning and coordination as advocated in the key propositions for BBB.

The improvement of the biophysical environment's ability to absorb and adapt to major hydo-meteorological events would involve post-disaster actions such as reforestation and upper watershed protection. The existence of the *El Avila* National Park provides a solid means through which to protect and ensure upper watershed stability, but poor enforcement of the regulations within the park boundaries has limited their effectiveness.

Further recovery of the biophysical environment could include river monitoring, sediment traps and channelization of streams. These activities have been incorporated into the post-disaster activities in Vargas but with minimal results. The sediment trapping abilities of the dams constructed after 1999 are inadequate for the on-going sediment deposition that occurs in these streams during regular rainfall. The channels were also not built wide enough or in the proper locations to provide real protection from debris flows (Lopez & Courtel, 2007). Consideration of the location and direction of roadways could enhance channel function by allowing flood waters to use roads as secondary channels. The natural barriers, forested slopes and stream channels, serve a very important purpose in preventing land-slides and debris flows, but can protection can be enhanced using well-devised structural responses. CorpoVargas, in conjunction with experts from engineering and ecology, must seek to better understand the processes in the natural environment to improve the use of these inherently protective and stabilizing features.

General knowledge of processes which occur in the biophysical environment in Vargas is visible from the 1999 response activities. Researchers have recognized that systems such as the cold front that stalled over the Southern US in December 1999 could recur and cause extreme rainfall if extratropical circulation features reach the deep tropics during the dry season (Lyon, 2003). An El Niño event occurred in 1997-98 followed by a La Niña event in 1999-2000, these events cause changes in sea-surface temperatures which also affect climate (Vitelli, 2000). In addition, socio-ecological systems are known as dynamic systems which require not only knowledge of the environment, but also on-going monitoring and modeling. Competent, trained staff with an awareness of the connections between processes will allow decision-making institutions to derive solutions based on current data and then subsequently reduce vulnerability with minimal interruption of the normal function of the socio-ecological system. Staff training programs will improve risk reduction efforts because the staff will have the proper knowledge to make decisions, but also because of the added loyalty and value a person feels when they are offered additional educational opportunities.

5.3.1.4 Built Environment

A basic concern in the immediate post-disaster setting is the return of basic infrastructure, safety and sanitation. Physical infrastructure, including roadways, utilities and public buildings, can significantly affect vulnerability and livelihoods. Through careful evaluation, reconstruction of these structures can allow for effective improvements to the resilience of the structures, which will have ripple effects on, for example, evacuation during the next disaster. The PDARRE indicates that Vargas institutions need to make changes to their current practices post-disaster to make better use of built structures.

Furthermore, land-use planning determines what type of construction is allowed, or not allowed, in a given location. The long decision-making delays with regards to changes in land-use have resulted in the reconstruction of risks in many parts of Vargas State. Even in 2008, nine years after the disaster, there are structures which have been rebuilt on high-risk lands because no new zoning plan has been developed. To create a reduction of risk, land-use zoning must be implemented and enforced so that high-hazard areas are demarcated and development of fragile buildings does not continue. CorpoVargas, as the institution in charge of reconstruction, must work to create these new land-use plans and make certain that they are followed as the reconstruction continues.

Post-disaster reconstruction in Vargas had several weaknesses. The delay in land-use and community design decision-making allowed survivors to return to their homes and rebuild the structures in the same risky locations with the resources available to them (see Figure 24, p.97) CorpoVargas failed to offer building design assistance which would have created stronger, more resilient homes for the survivors. Individual houses that need to be rebuilt can benefit from design changes such as building homes to direct the flow around the structure – for example, build the widest side of the house parallel to the flow direction so that there is as little resistance as possible on for the debris flow (Doberstein & Stager, 2008). In Vargas, the use of retention walls around homes (see Figure 19, p. 75) can also create problems. This type of property marker is common in many Latin American countries, however these walls can also block people inside or cause sudden and intense flows. Building codes in Vargas must therefore change to consider this architectural feature and the safety implications it raises.

The construction of dams provided evidence that CorpoVargas was indeed working to rebuild the State; what is questionable is how well that reconstruction has reduced risks in the

communities. The ability to remove sediment from debris flow dams is essential to the dam's ability to withhold material in a future debris flow. Literature on dams and their maintenance advises that 'sand pockets' and sediment removal is necessary (Takahashi et al., 2001). Since CorpoVargas has yet to make provisions for sediment removal, and the 2005 event demonstrated the limited holding capacities of the dams, it is questionable whether the agency comprehends fully the function the dams should serve, or the scale needed to adequately protect downstream communities.

5.3.1.5 Legislation Concerns

This research did not reveal any post-1999 changes to disaster risk reduction legislation in Vargas State, nor in Venezuela. Changes to land-use zoning were not identified to be part of the response by the local government, *Autoridad Unica* or CorpoVargas. In the absence of such legislation the northern coast has continued development on all but one alluvial fan. The Venezuelan armed forces have taken possession of Carmen de Uria and thus residential development has been stopped there (INT #9). The military was able to claim possession of this area because of the severe debris coverage, although a change in land-use designation was not indicated by interviewees.

Legislation issues surround and are inextricably linked to many of the above-mentioned weaknesses in the post-disaster actions. Strong legislation must be accompanied by clear communication of the laws and regulations as they are created and deliberate enforcement of the legislation is also needed. CorpoVargas is in charge of the *reconstruction* but has the authority to approve construction permits as well (INT #12). Decisions about construction are made on the basis of out-of-date information on threats since no changes were made after 1999. Additionally, cooperation with municipal governments, local law enforcement and other ministries including, housing and the environment is needed for effective maintenance of safe and resilient structures. The decisions made by these other institutions must be based on current information, and their operations could also inform future changes to land-use zoning changes to be made by CorpoVargas.

All of the criteria of PDARRE are important, but in this case a few key criteria could lead to significant improvements in preparation for the next disaster and hopefully even result in a reduction of impacts in these inherently unsafe communities. The importance of cooperation, communication, trust and good information has repeatedly been identified within the categories

of the post-disaster assessment. Competent, knowledgeable staff to foster these qualities is also needed to improve the DDR effectiveness in Vargas, as in other cases. The discussion will now progress to implications for other actors and academia and will be followed by a short list of recommendations for specific criteria that will have important effects on future success in Vargas.

5.3.2 *Implications for Humanitarian Aid and Relief Agencies*

The assessment tool created in this study provides useful information not only to governments but to aid agencies as well. International humanitarian organizations offer great support to local governments after a disaster. The BBB propositions identify that these organizations must act to assist and empower local governments, and in Vargas after the debris flows, this did occur. The 1999 debris flows offer a good example of the local government maintaining control of the immediate response and recovery. But the overall failure to significantly reduce vulnerabilities indicates that NGOs and donors did not meet their responsibility, as defined in the BBB approach, of strengthening local government recovery institutions and ensuring quality responses. The take away message for humanitarian relief and aid agencies is to seek out methods through which their expertise from previous disasters can be used to further improve vulnerability reduction in the context in which they are currently working.

Another implication of this research is that the impacts from disaster *response activities* must also be measured and considered, in addition to those impacts from the actual, physical event. This lesson has been learned in other global disasters, including the 2004 Indian Ocean Tsunami where it was recognized that "the ecological costs of cleanup and reconstruction following the Indian Ocean Tsunami will compete with or even exceed environmental losses caused by the wave" (IFRC, 2003 cited in United Nations Human Settlements Programme, 2007, p. 178). As part of the disaster management cycle, all sources of impact need to be factored in so that activities at one stage of the cycle do not impede efforts in another, or likewise that the actions of one institution do not create work for another. This was particularly evident in the failed Vargas State resettlement plan which saw people forced to relocate twice – once away from the disaster zone and later on back to the disaster zone. Use of a complex systems approach to understanding the interconnections between processes within the socio-ecological system can assist long-term planning and risk reduction programs. This also brings about the need to make deliberate

decisions based on good information which very likely will require the development of partnerships between NGOs and local governments.

This research has generated a new tool for monitoring and evaluating post-disaster reconstruction activities. Relief and aid agencies may be able to enhance and test this framework and use it to complement current practices and tools. The BBB propositions and the PDARRE evaluation resulted from specific cultural settings but when applied in other settings still have relevance. Testing PDARRE in other contexts would improve the robustness of the tool and identify whether criteria need adjustment for different settings.

Theoretical knowledge about disaster management is important, but practical application of that theory is the only way to validate research. Currently, the use of checklists and tools such as rapid needs assessment are commonly used for management of immediate response activities. After the immediate response is complete, the NGOs commonly move to another disaster and the communities are left to complete reconstruction and prepare for the next disaster on their own. It is hoped that this evaluation framework will encourage NGOs, governments and communities to think about vulnerability reduction as a part of disaster response, longer-term planning, and sustainable development decision-making.

5.3.3 *Implications for Disaster Stricken Communities*

The communities in Vargas illustrate how people who are poorly-informed about their vulnerabilities and who have few resources can overcome severe disastrous events where lives are interrupted and whole cities are buried in sediment. Although the Vargas communities are not the first to endure this kind of disaster, their ability to carry on despite some serious weaknesses in the post-disaster response is remarkable. The weaknesses in the post-disaster response activities have allowed identifiable vulnerabilities to persist and will thus need to be addressed if the Vargas communities do not wish to relive such tragedy again.

Educating local residents and building social capital through knowledge and empowerment is suggested in the literature on public/stakeholder participation as necessary for success. Simple *participation* would fall on rung three of Arnstein's Ladder, which is an improvement upon the 1999 situation, where no participation existed. However, as the public and local organizations become better informed, efforts to achieve more than *tokenism* would result in better vulnerability reduction (Arnstein, 1969). Empowerment of communities through education is also known to promote CBOs that take action to improve livelihoods and security.

Unfortunately, one interviewee (INT #10) indicated a decline in social cohesion because neighbours did not help each other as much after the 2005 debris flows. Over time, this cohesion may return as residents realize that they too may require assistance in emergency situations, but active fostering of community cooperation by local government representatives and NGOs can also assist the maintenance of social cohesion. If cohesion cannot be encouraged, at least individuals will have the knowledge to act, or react to the threats and hazards through the continuation of capacity building programs.

Housing implications for the disaster-stricken communities were also exposed from this research. Social housing responses by government were almost absent, and what housing was available at lower rates was located in unsafe lands which interviewees identified as having flooded in both 1999 and 2005. The inadequate housing for the poorest segment of the population led to a housing supply which was built long after residents had made alternate arrangements to rebuild on previous sites, or new housing was purchased by the wealthy. The supervision of the housing market and construction locations was the responsibility of CorpoVargas, which was evidently unable to ensure housing to those who needed the most assistance. Proposition #2 of the BBB framework posits equity as one of its main facets. In Vargas the housing reconstruction remains inequitable.

Figure 25: Flooding and 'Social Housing' constructed in Camuri Chico
Source: Altez, 2005; Doberstein, 2008

The final implication to be discussed in this section relates to vulnerability assessments and monitoring of changes. The towns of Vargas State are built on alluvial fans. Geologists and scientists assert that flooding and debris flows recur periodically on alluvial fans. Although the recurrence cannot be predicted, careful monitoring of changes can ensure some level of safety for those living on these formations. Up-to-date and publically disseminated information about the socio-economic and biophysical systems was lacking in Vargas, but this information is essential to an effective response and recovery from disastrous events on alluvial fans. In the literature, VCAs are used to assist in land-use planning and for disaster response planning. Technological advancements are also improving the ability of planners to integrate indicators of both social vulnerability and biophysical risk (Cutter, 2003). Technologies may be expensive and beyond the budget of LDC governments normally, however, the post-disaster context offers the opportunity for investment in longer-term management through the use of post-disaster funding.

5.3.4 *Implications for Academia*

Literature on disaster management and post-disaster reconstruction is not lacking, although there is still much that can be learned. Case study investigations of post-disaster responses can reveal some of the problems that require further study, or identify successful methods used for DRR. The Vargas case does offer some positive actions that others can learn from, but mostly the weaknesses in their post-disaster response identify challenges faced by LDCs that may be improved by academic studies.

First, institutional learning was not achieved in the Venezuelan institutions. Although interviewees offered some insights into the reasons for this, further research would be needed to identify the internal pressures which affected institutional learning in Vargas. This is not a phenomenon limited to Venezuela: "There is a marked inability by the scientific community to adequately convey the results of their research to communities, governments, and the private sector, which consequently remain poorly equipped to interact with decision makers to address vulnerability" (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007, p. 212). From interviews with engineers and scientists at UCV in Caracas, there did not seem to be any lack of evidence regarding the biophysical characteristics and thresholds of the watersheds in Vargas State. Yet based on the decisions taken by CorpoVargas, relating to the construction of dams for example, a problem in understanding the scientific knowledge available to them is obvious. Investigation into the relationship between engineers and scientists at UCV and decision makers would

indicate the source of the communication challenge and potentially also offer solutions to the problem of poor institutional learning.

Next, the research for this study indicates that vulnerability has not been significantly reduced in the nine years that have passed since the 1999 debris flows along the northern coast of Venezuela. What is also relevant is understanding how the vulnerabilities are perceived by the communities at present. Future research, including focus groups with community leaders and interviews with new and long-term residents of the State would provide useful additional information regarding vulnerability. Additional interviews with key informants could better address uncertainties regarding insurance plans, business continuity planning and the integration of sustainable livelihoods into policies. Social memory length is known to vary across contexts and based on numerous variables. In North Vargas it would be relevant to know if the 2005 floods, where people lost further property and family members, served to reinforce the unsafe nature of this location in the social memory. Studies of community cooperation and cohesion would also indicate how social memory and vulnerability are impacted in communities with high quality capital assets as compared to those with poor quality capital assets. Finally, investigations which seek to determine whether community or household level activities to reduce vulnerability have been more or less successful than the government actions could uncover alternatives to policy solutions.

The 'build back better' approach is relatively new but has received credibility and popularity since the 2004 Asian Tsunami. The ten propositions (see Appendix 1) offer good practices that are applicable to diverse contextual circumstances. From this research, timing of decision-making has been a notable challenge. The need for an estimated timeline or deadline for actions may improve the BBB approach. How best to derive such a timing estimate is beyond the scope of this research, but possible research areas include: the amount of time NGOs are willing to dedicate to any one recovery, how long survivors are content in shelters, or how long aid agencies should remain before community dependency sets in. These and other, long-term studies can assist in improving the BBB approach.

PDARRE, the evaluation framework herein, was derived from good practices in disaster management, sustainable livelihoods and vulnerability reduction. Complementary case study evaluations using this assessment tool would also enable improvements to the list of criteria and allow other vulnerable communities to improve upon their reconstruction efforts. Repeat

assessments in Vargas in ten or twenty years are also recommended. Future data showing changes in policies, practices and the socio-ecological system will serve to monitor disaster management activities at different stages of the cycle. Future assessments will help indicate whether disaster management remains a priority in the absence of disastrous events, or the future assessments may be performed more promptly after the next disaster where it may be used to guide CorpoVargas and its partners to a more successful reduction of risk.

5.3.4.1 Limitations of this Research

Some of the limitations of this research have implications for future researchers interested in Venezuela. My original plan was to use the June 2008 field work as a scoping exercise to be followed up with a return visit to Vargas State sometime after September 2008. Safety concerns were not considered to be particularly significant in the initial planning of research in Venezuela. However, I was warned numerous times, by several people not to return without a field assistant, preferably male. Additionally, as much of the literature on communities suggests, finding someone from the local area would have been even more appropriate for building trust with the communities and would have assisted me in revealing the necessary information. My personal financial restrictions and a lack of additional funding limited my ability to cover my own flight and accommodations, not to mention the additional time needed in the field and the costs associated with finding an appropriate assistant. Therefore, the research was completed with reference to secondary documents and reports (approximately 30) and the idea of consulting key informants to review the assessment was derived. Making contact with more key informants prior to arrival in Venezuela would have been useful and could have saved the limited time I had in the country for the collection of data. All of the people interviewed were incredibly helpful and generous with their time, thus to make better use of that assistance through more detailed contact prior to field work is recommended for the next study.

5.4 Summary of Implications

This section has highlighted the many implications revealed through this study. Local level governmental agencies have many actions that can be taken now and into the future that will improve their ability to reduce vulnerabilities. NGOs and communities can also learn from the events of 1999 and the response since then.

Academia has offered valuable tools and knowledge to assist with post-disaster risk reduction, but the outcome of the response and reconstruction efforts after the Vargas State debris flows re-emphasizes many problems facing the developing world. For instance, recall the thirteen interrelated and recurrent factors used to explain vulnerability to hydrometeorological disasters in Latin America and the Caribbean:

> (a) poverty and socio-economic marginalization,
> (b) institutional and democratic weakness,
> (c) rapid, unregulated, and unplanned urbanization,
> (d) formation of slums and occupation of hazardous areas,
> (e) population growth,
> (f) migration from rural to urban areas,
> (g) increasing population affected by disasters,
> (h) ecosystem conversion,
> (i) erosion,
> (j) increasing intensity of hydrometeorological events causing disasters,
> (k) increasing economic damage due to disasters,
> (l) failure to communicate scientific knowledge effectively, and
> (m) expansion of agriculture
>
> (Manuel-Navarrete, Javier-Gómez, & Gallopín, 2007, p. 210)

Many of these factors were evident in this analysis of the 1999 disaster and still persist in Venezuela today. The discussion herein offers insight into solutions and adjustments to the disaster management system in Venezuela that can initiate actions aimed at reducing vulnerability. Such actions will create change over time and will require on-going re-assessment. It is only from critical reflection and proactive adjustments based on identified weaknesses/obstacles that learning can happen and resilience can be embodied by institutions and communities alike.

5.5 Recommendations

The following list prioritizes some recommended actions which address the weaknesses and obstacles identified in Vargas State through this research:

1. **Complete the early warning system**

The severity of the risks in Vargas is great and the speed at which the 1999 debris flows inundated the community makes it essential that CorpoVargas complete a functioning system of early warning with the help of the local scientists and engineers. CorpoVargas must identify a team to maintain the system and ensure communities are aware of the signals and procedures in this system. Community training programs regarding the early warning system will also serve to reinforce that there are on-going threats to the socio-ecological system in Vargas.

2. **Increase public participation in decision-making**

Inclusion of citizens in planning will result in acceptance of disaster management decisions and protocols. Active participation will also lead to successful preparedness, mitigation, response and recovery in future disasters as all actors are aware of their individual roles and can act promptly and effectively to ensure safety and reduce risks.

3. **Immediately enforce land-use zoning and building codes for all development**

Land-use planning is an important tool for identification of high-hazard zones and allowable uses of land, whereas building codes are used for the construction and maintenance of safe and resilient structures. Vargas State currently lacks both of these safety mechanisms and its residents thus face undue risk. Through proper implementation and enforcement of land-use zoning and building codes, vulnerability will be reduced.

4. **Regularly monitor and evaluate project goals and progress**

CorpoVargas and the municipal government unnecessarily failed to oversee reconstruction projects and ensure their full and proper completion. Through the use of monitoring and evaluation of projects with vulnerability reduction in mind, both during execution and post-completion, objectives and goals will be successfully achieved.

5. **Maintain institutional organization and encourage capacity building and staff training programs within government institutions**

The institutional organization in Venezuela has traditionally been added to when new governance issues arise. I recommend that Venezuela maintain the current status quo in order to keep clarity of roles and responsibilities and prevent undue confusion within the system. In addition, staff at all institutions should be offered training related to their job responsibilities (e.g. community capacity building techniques, biophysical modeling and reading of hazard maps etc.) to maintain a core staff of competent and dedicated workers.

Chapter 6: **CONCLUSION**

The primary purpose of this thesis was the development and field testing of a tool to address the need for improved monitoring and evaluation of post-disaster recovery and reconstruction activities. The Venezuelan debris flow disaster of 1999 was used in this study because it was the largest disaster in Venezuela's history and also because, as one of the largest debris flow disasters in Latin American history, the case findings can be used to elucidate some common failures in LDCs. To be able to assess reconstruction efforts sufficient time must have passed to allow recovery and risk reduction projects to be executed. This evaluation of the major Vargas State debris flows was conducted nine years following the disaster; in a smaller disaster the PDARRE evaluation could have been conducted sooner.

Consistent with the perspective of prominent international NGOs, this research is based on the prevailing belief that disaster management can be more successful if mainstreamed into broader sustainable development goals and activities. The discussion in Chapter 5 served to summarize the implications of this study and now these final pages will recall the objectives and make concluding remarks about the links between disaster management and development in LDCs.

6.1 Revisiting the Research Objectives

Objective 1: To identify the causes of the 1999 debris flow disaster

Several root causes were identified, including the distinct socio-economic division within Venezuelan society, where wealth is concentrated in a small portion of the population, mainly located in the capital city. However, the most significant contributor to the occurrence of debris flows in the northern coastal State of Vargas comes from the region's biophysical characteristics. The steep slopes of the *Sierra El Avila*, which peak a short distance from the Caribbean Sea, and the intensity of rainfall in December 1999 resulted in extensive flooding of cities built on alluvial fans. Massive sediment loads were carried by numerous rivers through the steep river valleys, causing channels to overflow and two-storey houses to become buried. Neither of these root causes, the socio-economic division nor the biophysical characteristics, could have independently caused a disaster. The dynamic pressures which generated unsafe conditions are more appropriately attributed this credit. Relatively uncontrolled and poorly-planned urban development in recent decades exposed a large population to the volatile debris flows. The long

time period since the last disaster (1951) also resulted in a population of people unable to imagine the extent of the hazard threatening their homes and livelihoods. Pre-disaster institutional weaknesses, revealed in the research, further contributed to the tragedy of December 1999.

As with many disasters, the Vargas debris flow disaster was a convergence of unfortunate and dangerous circumstances. Prominent minds studying hazards and vulnerability have argued for decades that governments need to have solid understanding of their socio-economic and biophysical systems as well as well-planned disaster recovery actions. As disasters continue to grow in magnitude and increase in frequency, the importance of strong disaster management plans will be reinforced the world over. LDCs face a complex array of pressures. By integrating disaster risk reduction into broader development goals and objectives, and strengthening disaster preparedness and response, catastrophes will no longer impede advancement to the same extent.

Objective 2: To review 'good practices' in DRR and develop an evaluation framework for post-disaster risk reduction effectiveness

The literature on hazard mitigation has a long history, marked by changes encouraged and influenced by authors such as Gilbert White, Piers Blaikie and Dennis Mileti. Structural and non-structural response techniques have been tested and validated, along with the definition of the disaster management cycle: preparedness, mitigation, response and recovery. Long-term monitoring of post-disaster recovery and reconstruction has typically been left to local governments that often get distracted by economic pressures and changes. Recent work by the ProVention Consortium and other authors advocate for the 'Mainstreaming Disaster Risk Reduction' which would aid disaster practitioners with their on-going efforts to mitigate and prevent serious disaster impacts. As part of these efforts, the Post-disaster Assessment of Risk Reduction Effectiveness (PDARRE) was created to monitor and evaluate post-disaster actions.

The criteria for this assessment were derived from many sources and were organized into categories according to the three realms of a socio-ecological system: socio-economic, built environment and biophysical systems. These categorized criteria will assist local governments to see which areas of their disaster response system are weakest, and enable effective adjustments to their activities, consequently improving the entire disaster management system.

Other checklists and tools for post-disaster response activities do exist, however, I argue that these over-emphasize the immediate response activities and time-frame. Although, the first few

days after a disaster offer significant DRR opportunities, longer-term planning and monitoring is needed for governments and NGOs to ensure their DRR efforts are maintained and weaknesses in the disaster management cycle are promptly addressed. PDARRE can serve this purpose by providing a list of criteria which can be evaluated at any time, whether immediately following a disaster, several years later, and even over a generation. This extended application, if properly integrated in an adaptive management approach, can also act as a reminder of past events and ensure continuous institutional and community learning.

Objective 3: Evaluate the extent to which vulnerabilities and risks were reduced, perpetuated or created through the post-disaster reconstruction efforts in Vargas State

The PDARRE assessment allowed for the evaluation of data collected from interviews and field observations in June 2008. In order to determine whether vulnerabilities and risks were reduced, perpetuated or created, this data was evaluated according to the PDARRE criteria.

In the case of Vargas, many vulnerabilities and risks were perpetuated or created, with very few post-disaster actions leading to a reduction in risk or vulnerability. Despite empowerment of local agencies, assistance from international NGOs and compliance with some of the guidelines offered for disaster management (BBB/HFA etc.), vulnerability reduction was not expressly integrated into response and recovery in Vargas after the debris flows in 1999. Slow government decision-making and reconstruction efforts aimed at visible action rather than effective response are among the causes for limited reduction of risk or vulnerability. The continued vulnerability was exposed in 2005 when excessive rainfall and flash flooding/debris flows again inundated the coastal cities causing further damage. Although early actions taken to reduce vulnerabilities are ideal, it is not too late to address the shortcoming in Venezuela's disaster management system. The perpetual nature of flooding and debris flows in Vargas indicates and requires that DRR actions are taken otherwise continued losses are a certainty.

Objective 4: Identify further steps (policies, actions and solutions) which could reduce vulnerabilities in Vargas according to the PDARRE results.

The discussion and recommendations from Chapter 5 offer possible actions that CorpoVargas, NGOs, local communities and other government agencies could take. Many of these actions would serve to improve the local disaster *relief* system for the next disaster. However, because of the cyclical nature of disaster management, recommended actions also serve to better prepare the

residents and government bodies, with the intention of mitigating the impacts and losses of subsequent disasters.

This research revealed that much work is still needed to achieve real vulnerability reduction in the communities of the northern coast of Venezuela, and through on-going monitoring of risks and collection of biophysical and socio-economic data the underlying causes of this disaster can be addressed. Documentation of lessons identified and communication between actors are some of the important factors to *learning* from the events of December 1999.

6.2 Mainstreaming Disaster Risk Reduction

Given that disastrous events are often the first indication a community gets of their vulnerability, it is important not only to have an effective disaster management system in place, but also to have a well-informed population. "While extensive risk would appear to not contribute significantly to either global disaster mortality or economic loss, [risk] is increasing rapidly and poses a considerable threat to the livelihoods of poor rural and marginal urban communities. Current progress in local-level disaster preparedness can potentially reduce the mortality associated with extensive risk" (ISDR, 2007b). But local-level post-disaster response and recovery activities still represent an obstacle to the achievement of sustainable livelihoods and the MDGs in less-developed and developing countries. Therefore, as this thesis has demonstrated, the best method for protecting survivors in disaster-affected communities is to reduce disaster risks through well-planned post-disaster reconstruction and recovery efforts. In that way, more sustained development progress will also result so that losses and mortality associated with disasters will also decline.

Over time, disaster management has drawn from complementary fields because of the noted successes of a more participatory management style. Historic practice used top-down, expert-driven decision-making for disaster mitigation (Maskrey, 1989). In recent decades an appreciation for local ecological/traditional knowledge and public input have been integrated into the decision-making process for disaster management. Public participation allows for the development of mitigation strategies which generate lasting resiliency and, also result in reduced vulnerability. Local residents have been given a voice on matters which affect their lives and livelihoods because of a recognition that a community is more likely to embrace strategies which they helped develop.

Major recent disasters have highlighted the vulnerability of urban settlements in the developed and developing world alike. The post-disaster context provides an opportunity to harness funding that can be directed at-risk and vulnerability reduction efforts. The post-disaster context presents an opportunity for local governments to mainstream DRR into development activities because of access to funding which is not available in normal circumstances. With a synthesis of poverty and vulnerability reduction strategies, disaster-affected communities can use the post-disaster context as an opportunity to achieve more sustainable livelihoods, increased equity and improved safety. In so doing, at-risk communities will be ready to face the increasing number of hazard events that have been predicted and hopefully this resilience will lead to a reduction in losses and impacts from disaster as well as a continued decline in the number of fatalities.

Appendices

Appendix 1: Key Propositions for Building Back Better

Proposition 1. Governments, donors, and aid agencies must recognize that families and communities drive their own recovery.
Proposition 2. Recovery must promote fairness and equity.
Proposition 3. Governments must enhance preparedness for future disasters.
Proposition 4. Local governments must be empowered to manage recovery efforts, and donors must devote greater resources to strengthening government recovery institutions, especially at the local level.
Proposition 5. Good recovery planning and effective coordination depend on good information.
Proposition 6. The UN, World Bank, and other multilateral agencies must clarify their roles and relationships, especially in addressing the early stage of a recovery process.
Proposition 7. The expanding role of NGOs and the Red Cross/Red Crescent Movement carries greater responsibilities for quality in recovery efforts.
Proposition 8. From the start of recovery operations, government and aid agencies must create the conditions for entrepreneurs to flourish.
Proposition 9. Beneficiaries deserve the kind of agency partnerships that move beyond rivalry and unhealthy competition.
Proposition 10. Good recovery must leave communities safer by reducing risks and building resilience.

(Clinton, 2006, p. 3)

Appendix 2: Resettlement Locations for Survivors from Vargas State

Source: adapted from Google Maps

Appendix 3: Interviewees from 2008 Field Work

Interviewee #1: June 9, 2008. Professor of Anthropology, *Universidad Central de Venezuela* (UCV)

Interviewee #2: June 10, 2008. Professor from the Institute of Fluid Mechanics, UCV

Interviewee #3: June 10, 2008. Professor from Institute of Fluid Mechanics, UCV

Interviewee #4: June 10, 2008. Professor from Institute of Fluid Mechanics, UCV

Interviewee #5: June 12, 2008. Researcher from Geography department, *Universidad Pedagogica Experimental Libertador* (UPEL)

Interviewee #6: June 12, 2008. Professor in Geography, UCV

Interviewee #7: June 13, 2008. Disaster Specialist, UNDP, Caracas

Interviewee #8: June 13, 2008. Professor of Geography, UCV.

Interviewee #9: June 13, 2008. Professor and Researcher of Geography, UPEL

Interviewee #10: June 16, 2008. Professor and Researcher of Science, UPEL

Interviewee #11: June 17, 2008. Professor at Andean University in Merida and Policy Consultant

Interviewee #12: June 18, 2008. Specialist in Environmental and Risk Management, CorpoVargas.

Interviewee #13: June 13, 2008. Presentation from Geography students, UCV

Reviewer #1: June 26, 2009. Professor in Geography, UCV

Reviewer #2: July 22, 2009. Professor of Anthropology, UCV

Appendix 4: Interview Themes

Disaster Cause(s)

- Could you explain in your own words what you understand to be the cause(s) of the December 1999 flash flood (debris flow) disaster?
- What do you think is the most important cause of the disaster?
    - What role did human management of natural resources (e.g. forests, water resources) play in this disaster?
    - How much of the original forest remains in the area near the disaster zone, and how adequate is forest management?
    - What role did human settlement location play in this disaster?
    - What role did poverty play in this disaster?
    - What role did corruption play in this disaster?
- Do you feel this was a 'natural' or human-created disaster? Why?

Resource Management: institutions and programs in the disaster zone (pre-disaster)

- What government agencies were active in the area where the disaster happened?
- What NGOs and aid agencies were active in the disaster zone?
- Were there any resource protection or management programs carried out in the last 10 years? (e.g. reforestation, watershed management)

Post-disaster learning and adaptive hazard mitigation

- Could you describe how government agencies, NGOs and/or aid agencies have responded to the disaster?
- Can you identify some of the hazard mitigation (or 'risk reduction') activities that have gone on since 1999?
- How have communities and individuals in the area responded? [Probe for changes …housing design, forest use, changes in human settlement location, etc]
- Have there been any changes to resource protection or management following the disaster? [Probe for details: Policies, development programs, resource management practices, community-level programmes, etc]
- Can you summarize what has been the impact of the disaster on land use in the affected areas?
- What learning has occurred as a result of the disaster? [Probe for specifics]
- Do you feel this disaster could happen again in the same area? [Probe for why/why not]

Bibliography

Abramovitz, J. (2001). *Unnatural Disasters.* Washington, DC: Worldwatch Institute.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change , 16*, pp. 268-281.

Adger, W., & Brooks, N. (2003). Does global environmental change cause vulnerability to disaster? In M. Pelling (Ed.), *Natural Disasters and Develoment in a Globalizing World* (pp. 19-42). London: Routledge.

Agrawal, A., & Gibson, C. (1999). Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation. *World Development , 27* (4), 629-649.

Ahmed Obaid, T. (2007). *State of the World Population 2007: Unleashing the Potential of Urban Growth.* New York: UNFPA - United Nations Population Fund.

Aide, T., & Grau, H. R. (2004). Globalization, Migration and Latin American Ecosystems. *Science , 305*, 1915-1916.

Alexander, D. (1993). *Natural Disasters.* New York: Chapman & Hall Inc.

Alexander, D. (2005). Vulnerability to Landslides. In T. Glade, M. Anderson, & M. Crozier (Eds.), *Landslide Hazard and Risk.* Sussex: John Wiley & Sons Ltd.

Altez, R. (2005). Historia sin memoria: la cotidiana recurrencia de eventos desastrosos en el estado Vargas-Venezuela. *Revista Geográfica Venezolano , Número Especial*, 313-342.

Altez, R. (2007, Octubre). Muertes bajo sospecha: Investigación sobre el número de fallecidos en el desastre del estado Vargas, Venezuela en 1999. *Cuaderno de Medicina Forense , 13* (50).

Altez, R., Rodriguez, J., Urbani, F., Delgado, J., & Chmitz, M. (2002). Riesgos ambientales urbanos y vulnerabilidad en Caracas y el Estado Vargas - Aludes como fuente de riesgo - presente y pasado. *III Jornadas Venezolanas de Sismología Histórica* (p. 22). Caracas: Congreso Geologico Venezolano.

Arnstein, S. (1969). A Ladder for Citizen Participation. *Journal of the American Institute of Planners , 35* (4), 216-224.

Barrientos Ch., Y. (2005). Avances del Proyecto de Investigación: Campaña Educativa Comunidad- Escuela para la Mitigación de los Riesgos Socionaturales Asociados a las Cuencas de los Ríos Osorio y Piedra Azul, Estado Vargas, Venezuela. *Aula y Ambiente: Revista Ambiental , 5* (9-10), 197-203.

Batterbury, S., Foresyth, T., & Thomson, K. (1997). Environmental Transformations in Developing Countries: hybrid research and democratic policy. *The Geographical Journal , 163* (2), 126-132.

Benson, C., Twigg, J., & Rossetto, T. (2007). *Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organizations.* Geneva: International Federation of Red Cross and Red Crescent Socities/ ProVention Consortium.

Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards , 41*, 283-295.

Bezada, M. (. (Director). (2006). *Vargas: Una Tragedia Anunciada* [Documentary video].

Birkmann, J. (2005). Danger Need Not Spell Disaster - But How Vulnerable Are We? (U. N. University, Ed.) *Research Brief , 1*.

Boyden, S., Millar, S., Newcombe, K., & O'Neill, B. (1981). *The ecology of a city and its people: the case of Hong Kong.* Miami: Australian National University Press.

Britannica, E. (2008). *Venezuela*. Retrieved 02 26, 2008, from Encyclopaedia Britannica Online: http://www.search.eb.com.proxy.lib.uwaterloo.ca/eb/article-9108771

Brookfield, H. (1999). Environmental damage: distinguishing human from geophysical causes. *Environmental Hazards , 1*, 3-11.

Burby, R. (Ed.). (1998). *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities.* Washington, D.C.: Joseph Henry Press.

Burton, I., Kates, R., & White, G. (1978). *The Environment as Hazard.* New York: Oxford University Press.

Cannon, T. (2003, August). Vulnerability Analysis, Livelihoods and Disasters Components and variables of vulnerability: modelling and analysis for disaster risk management. *IADB/ IDEA Program on Indicators for Disaster Risk Management Execution of Component II* , http://idea.unalmzl.edu.co. Manizales: Universidad de Colombia.

Cardenas, C., & Jiménez, V. (2005). *Lessons Learned in Post-Disaster Recovery and Development Processes in Latin America and the Caribbean - Case Study: Venezuela.* Bogotá: UNDP - Disaster Prevention and Recovery Directorate of the Disaster Reduction Unit.

CDERA (2008). *CDERA: Managing Disasters with Preparedness*. Retrieved April 8, 2008, from http://www.cdera.org/about_history.php

CEPAL (2000, February 14). *LOS EFECTOS SOCIOECONÓMICOS DE LAS INUNDACIONES Y DESLIZAMIENTOS EN VENEZUELA EN 1999.* Retrieved October 17, 2007, from Centro Regional de Informacion sobre Desastres: http://www.crid.or.cr/digitalizacion/pdf/spa/doc12959.pdf

Challa, K. (2000). *Venezuela Emergency Assistance (+) Report No. PID9123.* Washington D.C: World Bank.

Chambers, R., & Conway, G. (1992). *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*. Brighton: Institute for Development Studies.

Chang, T.-C. (2007). Risk Degree of Debris Flow Applying Neural Networks. *Natural Hazards* , 209-224.

Christopherson, R. (2003). *Geosystems: An Introduction to Physical Geography (5th Ed)*. Upper Saddle River, New Jersey: Pearson Education Inc.

CIA. (2009, April 23). *CIA World Fact Book: Venezuela*. Retrieved May 15, 2009, from Central Intelligence Agency World Fact Book: https://www.cia.gov/library/publications/the-world-factbook/geos/ve.html

Clark, H., & Stephans, B. (2002, September). *Glossary*. Retrieved May 25, 2009, from United Nations Capital Development Fund: http://www.uncdf.org/mfdl/workbook/pages/glossary.htm

Clinton, W. (2006). *Lessons Learned from Tsunami Recovery: Key Propositions for Building Back Better*. Special Envoy for Tsunami Recovery. New York: United Nations.

Comfort, L., Wisner, B., S, C., Pulwarty, R., Hewitt, K., Oliver-Smith, A., et al. (1999). Reframing Disaster Policy: the global evolution of vulnerable communities. *Environmental Hazards , 1*, 39-44.

Corporación para la Recuperación y Desarrollo del Estado Vargas. (2006). *CorpoVargas*. Retrieved July 29, 2009, from Gobierno Bolivariano de Venezuela: Ministerio del Poder Popular para la Planificación y Desarrollo: http://www.corpovargas.gob.ve/mision.html

CRED, Centre for Research and Epidemiology of Disasters. (2008). *EM DAT: Emergency Events Database*. Retrieved May 28, 2009, from EM DAT: http://www.emdat.be/Database/Trends/trends.html

Cutter, S. (2003). GI Science, Disasters and Emergency Management. *Transactions in GIS , 7* (4), 439-445.

Cutter, S. (1995). Race, Class and Environmental Justice. *Progress in Human Geography , 19* (1), 111-122.

Cutter, S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., et al. (2008). A place-based model for understanding resilience to natural disasters. *Global Environmental Change* , 598-606.

Davis, I. (2003). The Effectiveness of Current Tools for the Identification, Measurement, Analysis and Synthesis of Vulnerability and Disaster Risk. *IADB/ IDEA Program on Indicators for Disaster Risk Management*, http://idea.unalmzl.edu.co. Manizales: Universidad Nacional de Colombia.

Davis, M. (2006b). *Planet of Slums.* New York: Verso.

Davis, M. (2006a, March/April). *Slum Ecology: Inequity intensifies Earth's natural forces.* Retrieved November 25, 2007, from Orion Magazine: http://www.orionmagazine.org/index.php/articles/article/167/

DFID, Department for International Development (1999). *Sustainable Livelihoods Guidance Sheets.* London: DFID.

Dilley, M. (2006). Disaster Risk Hotspots. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards: Towards disaster resilient socities* (pp. 182-188). New York: United Nations University.

Doberstein, B., & Stager, H. (2008). Urban Poverty and Environment (UPE) Conference presentation: "Post-disaster vulnerability reduction in informal settlements through improved tenure and housing design: Lessons from Dominican Republic and Venezuela". *(unpublished).* Jinja: International Development Research Centre (IDRC - Canada).

Ellner, S., & Hellinger, D. (Eds.). (2003). *Venezuelan Politics in the Chávez Era: Class, Polarization & Conflict.* Boulder: Lynne Rienner Publishers Inc.

El-Masri, S. (1997). Urbanisation, povety and natural disasters: Vulnerability of Settlements in Developing Countries. In A. Awotona (Ed.), *Reconstruction after Disaster: Issues and Practices* (pp. 1-12). Vermont: Ashgate Publishing Co.

Emergency Capacity Building Project. (2007, October). *Emergency Capacity Building Pilot Projects: Promising Practices for Risk Reduction.*

Encyclopaedia, B. (2008). *Venezuela, Year in Review 2005*. Retrieved 02 26, 2008, from Britannica Book of the Year, 2006: http://www.search.eb.com.proxy.lib.uwaterloo.ca/eb/article-9403434

Few, R. (2007). Health and climatic hazards: framing social research on vulnerability, response and adaptation. *Global Environmental Change , 17*, 281-295.

Gallopín, G. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change , 16*, pp. 293-303.

Genatios, C., & Lafuente, M. (2003). *lluvias torrenciales en vargas, venezuela, en diciembre de 1999. Protección ambiental y recuperación urbana.* Retrieved October 17, 2007, from Instituto de Materiales y Modelos Estructurales Universidad Central de Venezuela [41(2-3)]: http://www.scielo.org.ve/scielo.php?script=sci_arttext&pid=S0376-723X2003000200004&lng=es&nrm=iso

Gobernación Bolivariana del Estado Vargas. (2009). *Historía*. Retrieved June 2, 2009, from Gobernación Bolivariana del Estado Vargas: http://estadovargas.gob.ve/

Godschalk, D. R., Beatley, T., Berke, P., Brower, D. J., & Kaiser, E. J. (1999). *Natural Hazard Mitigation: Recasting Disaster Policy and Planning.* Washington, D.C.: Island Press.

Gomez, R., Guimarães, R., Carvalho Jr, O., Fernandes, N., Vargas Jr, E., & Martins, E. (2008). Identification of the affected areas by mass movements through a physically based model of landslide hazard combined with an empirical model of debris flow. *Natural Hazards* , 197-209.

Gryc, W. (2005, May 1). *The Importance of Secure Tenure in Slum Communities*. (F. M. Midnight, Producer) Retrieved November 25, 2007, from Five Minutes to Midnight: http://i2r.org/fmm/issues/may2005/article5.html

Hanna, K., & Slocombe, S. (Eds.). (2007). *Integrated Resource and Environmental Management.* Don Mills: Oxford University Press.

Haque, C. E. (Ed.). (2005). *Mitigation of Natural Hazards and Disasters: International Perspectives.* Dordrecht, The Netherlands: Springer.

Hardoy, J., Mitlin, D., & Satterthwaite, D. (2001). *Environmental Problems in an Urbanizing World.* Sterling, VA: Earthscan Publications Ltd.

Heming, L., Waley, P., & Rees, P. (2001). Resevoir Resettlement in China: past experience and the Three Gorges Dam. *The Geographical Journal , 167* (3), 195-212.

Hidalgo, S., & López-Claros, A. (2007). *The Humanitarian Response Index 2007: Measuring Commitment to Best Practice.* Madrid: Palgrave Macmillan.

Holloway, S., Price, S., & Valentine, G. (Eds.). (2007). *Key Concepts in Geography.* Thousand Oaks, California: Sage Publishing.

IDB. (2000). *Emergency Program for Torrential Rains, Flooding and Landslides (VE-0122).* Washington D.C.: Inter-American Development Bank.

IDB. (2009). *Venezuela and the IDB*. Retrieved May 16, 2009, from Inter-American Development Bank: http://www.iadb.org/countries/home.cfm?id_country=VE&language=English

Independent Evaluation Group (IEG). (2006). *Hazards of Nature, Risks to Development: An IEG Evaluation of World Bank Assistance for Natural Disasters.* Washington, D.C.: IEG.

ISDR. (2007b). *Disaster Risk Reduction Global Review 2007*. Geneva: United Nations International Strategy for Disaster Reduction (ISDR).

ISDR. (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disaster.* Kobe, Japan: International Strategy for Disaster Reduction.

ISDR. (2009). *International Strategy for Disaster Reduction*. Retrieved June 1, 2009, from ISDR: http://www.unisdr.org/#

ISDR. (2007a). *International Strategy for Disaster Reduction/International Decade for Natural Disaster Reduction.* Retrieved November 20, 2007, from ISDR, International Strategy for Disaster Reduction: http://www.fire.uni-freiburg.de/programmes/un/idndr/idndr.html

ISDR, International Strategy for Disaster Reduction. (2004, March 31). *Library on disaster risk reduction*. Retrieved Aug. 20, 2009, from ISDR: http://www.unisdr.org/eng/library/lib-terminology-eng-2004.htm

Jiménez Díaz, V. (1992). Landslides in the squatter settlements of Caracas; towards a better understanding of causative factors. *Environment and Urbanization , 4* (2), 80-89.

Kasperson, R., & Pijawka, K. (1985, January). Societal Response to Hazards and Major Hazard Events: Comparing Natural and Technological Disasters. *Public Administration Review , 45* (Special Issue: Emergency Management: A Special Challenge for Public Administration), pp. 7-18.

Kates, R. (1971). Natural Hazards in human ecological perspective: hypotheses and models. *Economic Geography , 47* (3), pp. 438-51.

Kay, J., & Waltner-Toews, D. (2002, March 20). *About...the diamond diagram and its siblings*. Retrieved April 13, 2008, from James Kay: An ecosystem approach: http://www.nesh.ca/jameskay/www.jameskay.ca/about/diamond.html

King, D., & MacGregor, C. (2000). Using social indicators to measure community vulnerability to natural hazards. *Australian Journal of Emergency Management , 15*, pp. 52-57.

Kulikowski, M. (2007, May 22). *North Carolina State University*. Retrieved March 29, 2008, from News Release: http://news.ncsu.edu/releases/2007/may/104.html

Larsen, M. (2000, January 19). *USGS: Water Resources of the Caribbean*. Retrieved April 8, 2008, from http://pr.water.usgs.gov/public/venezuela

Larsen, M., & Torres-Sierra, H. (2006, December 27). *USGS: Caribbean Water Science Center*. Retrieved April 1, 2008, from http://pr.water.usgs.gov/public/venezuela/image_2.html

Larsen, M., Wieczorek, G., Eaton, S., Morgan, B., & Torres-Sierra, H. (2001). *Natural Hazards on Alluvial Fans: The Venezuela Debris Flow and Flash Flood Disaster*. Retrieved September 30, 2007, from USGS: Science for a changing world: http://pubs.usgs.gov/fs/fs-0103-01/fs-0103-01.pdf

Levine, D., & Crisp, B. (1999, Winter). Venezuela: The Character, Crisis and Possible Future Democracy. *World Affairs , 161 (3)* , 123-165. Washington, DC.

Library of Congress - Federal Research Division. (2005). *Country Profile: Venezuela.* Washington DC: Library of Congress.

Lopez, J. L., & Courtel, F. (2007). An Integrated Approach for Debris Flow Risk Mitigation in the North Coastal Range of Venezuela. *XIII World Water Congress* . Montpellier, France.

Lyon, B. (2003). Notes and Correspondence: Enhanced Seasonal Rainfall in Northern Venzuela and the Extreme Events of 1999. *Journal of Climate , 16*, 2302-2306.

Manuel-Navarrete, D., Javier-Gómez, J., & Gallopín, G. (2007). Syndromes of sustainability of development for assessing the vulnerability of coupled human-environmental systems. The case of hydrometeorological disasters in Central America and the Caribbean. *Global Environmental Change , 17*, 207-217.

Maskrey, A. (1989). *Disaster Mitigation: A Community Based Approach.* Oxford: Oxfam.

Maslow, A. (1948). "Higher" and "lower" needs. *Journal of Psychology* , 433-436.

McCarthy, G. (2004, June 29). *The Price of Living in Urbanized Areas.* Retrieved December 7, 2007, from San Bernadino Sun Special Report "Unnatural Disasters": http://lang.sbsun.com/projects/fireflood/P3/bn29caracas.asp

McEntire, D. A. (2004). Development, disasters and vulnerability: a discussion of divergent theories and the need for their integration. *Disaster Prevention and Management , 13* (3), 193-198.

McEntire, D. A. (2005). Why vulnerability matters: Exploring the merit of an inclusive disaster reduction concept. *Disaster Prevention and Management , 14* (2), 206-222.

McLoughlin, D. (1985). A Framework for Integrated Emergency Management. *Public Administration Review , 45* (Special Issue), 165-172.

Menoni, S., & Pesaro, G. (2008). Is relocation a good answer to prevent risk? Criteria to help decision makers choose candidates for relocation in areas exposed to high hydrogeological hazards. *Disaster Prevention and Management , 17* (1), 33-53.

Michael-Leiba, M., Baynes, F., Scott, G., & Granger, K. (2003). Regional Landslide Risks in the Cairns Community. *Natural Hazards , 30*, 233-249.

Mileti, D. (1999). *Disasters By Design: A reassessment of Natural Hazards in the United States.* Washington D.C: Josheph Henry Press.

Mitchell, B. (2002). *Resource and Environmental Management.* Toronto: Pearson Prentice Hall.

Mitchell, J. (1990). Human dimension of Enviromental Hazards: Complexity, Disparity and the Search for Guidance. In *Nothing to Fear: Risks and hazards in American Society* (pp. 131-178). Tucson: University of Arizona.

Monday, J. (2002, February). *Building Back Better: Creating a Sustainable Community After Disaster*. (Natural Hazards Centre, University of Colorado at Boulder) Retrieved May 5, 2009, from Public Information for Earthquake Hazards: http://www.colorado.edu/hazards/publications/informer/infrmr3/index.htm#toc

Murria, J. (2005). *Five years after the tragedy in Vargas (1999-2004): social, political, cultural and economic considerations.* ISDR.

Myers, C., Slack, T., & Singelmann, J. (2008). Social vulnerability and migration in the wake of disaster: the case of Hurricanes Katrina and Rita. *Population and Environment , 29*, 271-291.

Natural Hazards Research and Applications Information Center. (2001). *Holistic Disaster Recovery: Ideas for Building Local Sustainability After a Natural Disaster.* Boulder: Pulic Entity Risk Institute (PERI).

O'Keefe, P., Westgate, K., & Wisner, B. (1976). Taking the naturalness out of natural disasters. *Nature , 260*, 566-567.

Okunishi, K., & Suwa, H. (2001). Assessment of Debris Flow Hazards on Alluvial Fans. *Natural Hazards , 23*, 259-269.

Oliver-Smith, A. (1991). Successes and Failures in Post-Disaster Resettlement. *Disasters , 15* (1), 12-23.

Pelling, M. (1999). Political Ecology of flood hazard in urban Guyana. *Geoforum , 30*, 249-261.

Pelling, M. (2003). *The Vulnerability of Cities: natural disasters and social resilience.* London: Earthscan Publications Ltd.

Peterson, G. (2006, March 16). *Resilience Science.* Retrieved April 4, 2008, from Planet of Slums: http://rs.resalliance.org/2006/03/16/planet-of-slums/

ProVention Consortium Secretariat. (2009). *About Us: Purpose*. Retrieved May 31, 2009, from ProVention Consortium: http://www.proventionconsortium.org/?pageid=7

Quarantelli, E. (1994). *Future Disaster Trends and Policy Implications for Developing Countries.* Retrieved May 5, 2009, from University of Delaware Library Institutional Repository: http://dspace.udel.edu:8080/dspace/handle/19716/585

Quarantelli, E. (1995). Patterns of sheltering and housing in US disasters. *Disaster Prevention and Management , 4* (3), 43-53.

Rakodi, C., & Lloyd-Jones, T. (Eds.). (2002). *Urban Livelihoods: a people-centred approach to reducing poverty.* Sterling, VA: Earthscan.

Rashid, H., Hunt, L., & W, H. (2007). Urban Flood Problems in Dhaka, Bangladesh: Slum Residents' Choices for Relocation to Flood Free Areas. *Environmental Management , 40*, 95-104.

RENa, Red Escolar Nacional. (2008). *Estado Vargas*. Retrieved June 15, 2009, from Ministerio de Poder Popular para Ciencia, Tecnología e Industrias Intermedias: http://www.rena.edu.ve/venezuela/vargas.html

República Bolivariana de Venezuela - Gabinete Social. (2004). *Cumpliendo las Metas del Milenio.* Retrieved May 19, 2009, from Gobierno en Linea: http://www.gobiernoenlinea.ve/misc-view/sharedfiles/Metas_Milenio.pdf

Rivero, Y. (2004, January 5). *Venezuela's Vargas Disaster Hard to Forget*. Retrieved February 23, 2008, from Tierramerica: http://www.tierramerica.net/2004/0105/iacentos.shtml

Robbins, P. (2004). *Political Ecology: a critical introduction.* Carleton, Australia: Blackwell Publishing.

Schrank, A. (2006). Case-Based Research. In E. Perecman, & S. Curran (Eds.), *A Handbook for Social Science Field Research: Essays & Bibliographic Sources on Research Design and Methods* (pp. 21-45). Thousand Oaks: Sage Publications.

Sen, A. (1981). *Poverty and Famines.* Oxford: Oxford University Press.

Smit, B., & Wandel, J. (2006). Adaptation, Adaptive Capacity and Vulnerability. *Global Environmental Change , 16*, 282-292.

Smith, K. (2004). *Environmental Hazards: Assessing risk and reducing disaster* (Fourth Edition ed.). New York: Routledge.

Stambouli, A. (2000, January). Natural Disaster in Venezuela - Vargas (presentation). Geneva, Switzerland: Ministry of Planning and Development.

Stevens, L., Coupe, S., & Mitlin, D. (Eds.). (2006). *Confronting the Crisis in Urban Poverty.* Rugby, UK: Intermediate Technology Publications Ltd.

Takahashi, T., Nakagawa, H., Satofuka, Y., & Kawaike, K. (2001). Flood and Sediment Disasters Triggered by 1999 Rainfall in Venezuela; A River Restoration Plan for an Alluvial Fan. *Journal of Natural Disaster Science , 23* (2), 65-82.

UNDP. (2006). *About Millennium Development Goals*. Retrieved March 12, 2009, from United Nations Development Programme: http://www.undp.org/mdg/basics.shtml

UNDP. (2005, April). *BCPR- Crisis Prevention and Recovery - Disaster Reduction Unit*. Retrieved May 31, 2009, from United Nations Development Programme: http://www.undp.org/cpr/disred/english/publications/publications.htm

UNDP. (2008). *Fast Facts: Bureau of Crisis Prevention and Recovery - Latin America and the Caribbean.* Retrieved June 2, 2009, from United Nations Development Program: http://www.undp.org/cpr/documents/FastFact_LAC_May08.pdf

UNEP. (2007). *Environment and Vulnerability: Emerging Perspectives.* UN International Strategy for Disaster Reduction- Environment and Disaster Working Group. Geneva: United Nations Environment Programme.

United Nations Human Settlements Programme. (2007). *Global Report on Human Settlemetns 2007:Enhancing Urban Safety and Security*. London: Earthscan.

United Nations. (2008). *United Nations Millennium Development Goals*. Retrieved March 12, 2009, from End Poverty 2015: Make it happen!: http://www.un.org/millenniumgoals/index.shtml

USGS. (2009, June 2). *Earthquake Hazards Program*. Retrieved June 17, 2009, from United States Geological Survey (USGS): http://neic.usgs.gov/neis/last_event/world_venezuela.html

Vitelli, S. (2000, Jan 13). *IRI Climate Information Digest - December 1999*. Retrieved Sept 20, 2009, from IRI Climate Data Library: http://iri.columbia.edu/climate/cid/Dec1999/

Vranes, K., & Czuchlewski, K. (2003). Integrating Complexity of Social Systems in Natural Hazards Planning: An example from Caracas Venezuela. *EOS , 84* (6), 55-56.

Walker, B., & Salt, D. (2006). *Resilience Thinking: Sustaining Ecosystems and People in a Changing World.* Washington, DC: Island Press.

Waltner-Toews, D., Kay, J., Murray, T., & Neudoerffer, C. (2004). Adaptive Methodology for Ecosystem Sustainability and Health (AMESH): An Introduction. In G. Midgley, & A. Ochoa-Arias (Eds.), *Community Operational Research* (pp. 317-349). New York: Kluwer Academic/Plenum Publishers.

Wieczorek, G., Larsen, M., Eaton, L., Morgan, B., & Blair, J. (2002, December 2). *Debris-flow and flooding hazards associated with the December 1999 storm in coastal Venezuela and strategies for mitigation.* Retrieved November 25, 2007, from USGS: Science for Changing World: http://pubs.usgs.gov/of/2001/ofr-01-0144/

Wilpert, G. (2006, July 11). *The Meaning of 21st Century Socialism for Venezuela*. Retrieved May 19, 2009, from Venezuelanalysis.com: http://www.venezuelanalysis.com/analysis/1834

Wisner, B. (2000). *Disaster: What the United Nations and Its World can do.* Retrieved Jan 31, 2009, from United Nations Chronicle (online edition): http://www.un.org/Pubs/chronicle/2000/issue4/0400p6p.htm

Wisner, B. (2003). Turning Knowledge into Timely and Appropriate Action: Reflections on IADB/IDEA Program on Disaster Risk Indicators. *IADB/IDEA Program on Indicators for Disaster Risk Management Execution of Component II* , http://idea.unalmzl.edu.co. Manizales: Universidad Nacional de Colombia.

Wisner, B., & Walker, P. (2005). The World Conference on Disaster viewed through the lens of Political Ecology: A Dozen Big Questions for Kobe and Beyond. *Capitalism, Nature, Socialism , 16* (2), 89-95.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At Risk - Natural Hazards, people's vulnerability and disasters (second edition).* New York: Routledge.

Yin, R. (1993). *Applications of Case Study Research* (Vol. 34). Newbury Park: Sage.

Zapata Martí, R. (2006). *Los efectos de los deastres en 2004 y 2005: la necesidad de adapción de largo plazo.* México D.F.: CEPAL - Punto Focal de Evaluación de Desastres.