COMPREHENSIVE DISASTER MANAGEMENT AND DEVELOPMENT: THE ROLE OF GEOINFORMATICS AND GEO-COLLABORATION IN LINKING MITIGATION AND DISASTER RECOVERY IN THE EASTERN CARIBBEAN

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DEDICATION

With my deepest sincerity and warmest love, I dedicate this dissertation to my caring parents, Clarestine Lucinda Huggins and the late James Godwyn Huggins; to my wonderful daughters, Lenique Kori La-Fleur and Anya Khloe Constance Huggins; to my supportive parents-in-law, Samuel Conrad and Mary Magdelene Constance, and to my loving, faithful wife Monique Adonis Constance-Huggins.

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ABSTRACT

The recurring failure of communities at risk to build mitigation into disaster recovery activities to reduce risks against future disaster events remains unresolved. In fact, some communities seem to learn so little from the disastrous experience of other communities; they either commit the same calamitous mistakes or do nothing to improve their circumstances before disaster actually strikes them. Policies exist, yet resilience building systems are lacking from the pragmatic stages of disaster recovery. Beyond sustained preparedness and relief operations, communities must also concentrate on effective rehabilitation and efficient disaster recovery if they are to become resilient against future hazards. The Eastern Caribbean islands, like many other developing countries, typify this failure of integrating mitigation into disaster recovery despite numerous incidents of hurricanes and tropical storms over the past decades. It is a socio-technical issue that needs to engage reliable information exchange mechanisms and efficient social networks to initiate and create solutions.

The overall objective of this study is to explore how countries can improve mitigation through disaster recovery activities. It documents the results of an analysis of experiences in disaster recovery and mitigation in the Eastern Caribbean following Hurricane Lenny in November 1999 and Hurricane Ivan in September 2004. Through nested case design, the study

constructs a framework for integrating mitigation into disaster recovery and comprehensive disaster management. It highlights relationships and interactions among households, builders, building designers, post-disaster rehabilitation agencies and disaster management organizations that can facilitate mitigation. It identifies factors that facilitate geospatial support in disaster management in the Eastern Caribbean and how geocollaboration enhances performance and effectiveness in comprehensive disaster management. Finally, the study modifies existing mechanisms for disaster mitigation and develops a scalable DHaRMS synchronization tool for mitigation implementation at multiple levels of society.

This study is deemed important from an empirical perspective because it could yield valuable insights into the strengths and weaknesses of mitigation implementation as well as provide policy recommendations for improving the efficiency and effectiveness of mitigation and comprehensive disaster management. From a theoretical perspective, this research is oriented toward contributing to the theories of comprehensive disaster management and complexity.

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PREFACE

My academic pursuits and achievements in life would not have been attainable without the grace of Almighty God. I graciously cherish the blessings and opportunities that He granted me in reaching this milestone. Though words could never express my full sentiments, I would like to acknowledge the persons who have supported me throughout this challenging academic experience; from those in academia to funding agencies to survey participants to family and friends. I am foremost grateful to the late Steve Manners of the University Center for Social and Urban Research (UCSUR) and Dr. David Y. Miller (Associate Dean of the Graduate School of Public and International Affairs) for encouraging me to enter the doctoral program at GSPIA. To Dr. Miller, for his continued insight and guidance throughout my doctoral program. This journey would not have been possible without your support in securing a research assistantship at GSPIA for the duration of my coursework. Also, to Dr. Stephen Farber for guiding me through my coursework.

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1.0 INTRODUCTION

This dissertation addresses the recurring failure of communities at risk to build mitigation into disaster recovery activities to reduce risks against future disaster events. Like so many, I have grown increasingly bewildered by the fact that despite increasing disaster preparedness and repeated incidents, many communities have failed to make adjustments to systematically improve building construction and siting to effectively mitigate against future disaster events. Similar hurricanes, be it category 1, 2, 3, 4 or 5 have wrecked the same or greater havoc on communities than the ones before. Why? Why?

In fact, some communities seem to learn so little from the disastrous experience of other communities; they either commit the same calamitous mistakes or do nothing to improve their circumstances before disaster actually strikes them. Despite the disastrous experience in Jamaica from Hurricane Gilbert in 1988 and the Leeward Islands from Hurricane Hugo one year later, Grenada and other islands in the Windward Islands, simply watched and awaited their demise 15 years later in the name of Hurricane Ivan. Is this a problem of policy-making or policy-implementation? Policies exist, yet the failure of the disaster recovery and resilience building systems are so conspicuous. This dissertation explores the mechanisms that spur implementation of mitigation activities particularly during the disaster recovery phase. It also examines how geoinformatics shape the analysis as well as the solution to the recurring failure to mitigate.

Disaster recovery is not the most-desired opportunity for mitigation, yet it creates a window of opportunity to build more resilient structures and systems. The task of getting affected households, individuals and agencies to incorporate mitigation activities into recovery initiatives is a complex and often uncoordinated one. Yet, effective mitigation in disaster recovery requires coordinated action as well as efficient information flow among multiple actors and across several jurisdictions to reduce future risks. The problem is socio-technical and depends on the development of effective rehabilitation mechanisms. Such mechanisms rely on the structure and performance of information systems that provide rapid transmission of reconstruction requirements that support decision making among human managers. They also rely on knowledge of the social network that fosters coherence, accessibility and efficiency in information flow.

1.1 PROBLEM OVERVIEW AND CONTEXT: INTEGRATING MITIGATION INTO DISASTER RECOVERY

On September, 2005, Hurricane Katrina wrecked havoc in the Gulf States of Louisiana and Mississippi, exposing not only fragile critical infrastructure, but also a brittle, non-responsive system of disaster management. After one year of restorative efforts in the City of New Orleans, only 20% of the residents have returned to rehabilitate the City. Nine months prior to Hurricane Katrina, on December 26, 2004 a bludgeoning tsunami destroyed coastal communities in the Southern Indian Ocean killing over 250,000 people. Not more than five months earlier, Hurricane Ivan ransacked the islands of Grenada, Haiti and Jamaica with storm surge, wind damage and flooding. All of these places are still in a state of recovery and rehabilitation to date. In Grenada, 90% of the housing stock was destroyed, but two years later the country has established several policies and procedures to ensure that mitigation is incorporated into the development process and that recovery occurs in a sustainable way. These events highlight the significance of extreme natural events and their impact on the economic and socio-political systems of countries throughout the globe. They especially reflect the vulnerabilities that developing countries and small island states possess and the risk to which they are exposed. Over the past decade, there has been a reduction in the number of deaths and injuries from hurricanes due to better preparedness and warnings, but in contrast, there has also been an increase in property damage due to unsuitable building and siting practices. Beyond sustained preparedness, communities must also concentrate on effective rehabilitation and efficient disaster recovery if they are to become resilient to hazards.

Communities have repeatedly failed to build mitigation strategies for future events into disaster recovery activities (Lavell 1994; Comfort 1999). Many communities have witnessed increasing economic losses, which have led to increased vulnerability and slowed economic resilience[1]. This dilemma stems from inefficient information-sharing, poor communication, inadequate coordination and decision-making in the uncertain environment of the disaster. Time and time again, disaster managers did not have valid information to act on; they often have to filter large amounts of irrelevant and/ or complex data (Rose, 2004).

[1] Resilience refers to the “nonlinear adaptive response of organizations” in efforts to absorb, cushion and recover from severe shock, which “emphasizes ingenuity and resourcefulness during and after the disaster “(Comfort 1999, Rose 2004).

Integrating mitigation into recovery depends heavily on information generation and exchange. Without appropriate information, decisions are ill-informed. When a disaster strikes, the response and recovery activities require information on pre-existing conditions as well the current disaster in order to mitigate against future damages and losses. However, there can be bottlenecks in information generation and exchange, which could result in conflict and poor decision-making (Comfort, 1998). Without a systematic approach to incorporate mitigation information into the active recovery environment, resiliency programs fail and the gap widens. In such socio-technical situations, scholars believe that the appropriate use of information technology could help to bridge this gap by creating a transition between mitigation and recovery (Comfort 1999; Lavell 1994; Rosenthal, Boin and Comfort, 2001). There is therefore a need to "integrate incoming information with existing knowledge and information to create a timely, informed basis for action at each level of the disaster management system" (Comfort, 1999: 31) to aid decision making.

Additionally, the efficacy of coordination, organizational performance and physical implementation of mitigation policies tend to decrease during the actual disaster environment (Comfort, 1999) because of inadequate, invalid, irrelevant, and untimely information flow. Unless there are integrated disaster recovery and mitigation plans, post-disaster coordination and communication tend to be disjointed and focus almost entirely on relief operations. Often governments make plans for disaster response in terms of search and rescue and material or relief assistance, but fail to provide guidance to structure activities that can enhance mitigation in the transition and reconstruction phases of recovery (Lavell, 1994). In most instances today, the role of emergency managers has been expanded beyond response to also include recovery and mitigation efforts. Yet they do not have the resources or training to fully accommodate public safety as well as disaster risk management and mitigation. Not only do they have to coordinate with public safety agencies such as police, fire, hospitals, they also have to coordinate with city planners, building board officials, public works and other public agencies to integrate mitigation measures into recovery phases of the disaster cycle. It is this expansion of responsibilities without the necessary resources and institutional-building capacities that make it difficult for emergency managers to coordinate effectively and efficiently with the appropriate agencies and recovering communities (Berke and Beatley, 1997). The established as well as self-organizing mechanisms are therefore critical to the flow of information and the performance of the organization in disaster mitigation.

The recurring problem of lack of mitigation in the disaster recovery process also stems from an unclear understanding of the organization and shared risk in the sustainable disaster management environment. According to Comfort (1999), "since all residents are vulnerable, they all share the responsibility to reduce the risk." Although the actors are numerous and different in mitigation and recovery, they are bound together by the same set of environmental constraints and opportunities. The system of recovery has been disjointed between the different levels of society in the disaster area and has resulted in the failure to channel energies and resources into mitigating against future losses. For example, household recovery may progress without enforcement of existing (mitigative) building codes and siting strategies because there is inadequate information exchange between the organizations in the disaster environment. Many scholars argue that in the context where small numbers of organizations with long-standing relationships share information, expertise and resources, communication will be enhanced and shared goals will be better achieved (Comfort 1999; Rosenthal et al 2001)

The recurring problem of the failure of communities to mitigate can not be more astounding than in the case area studied in this research, the Eastern Caribbean. The islands of this region are very similar in geophysical and socio-economic characteristics, but more importantly share the same (public) risks[2]. They and all residents are exposed to the same tropical storms and hurricanes each year. Yet, these islands have varying vulnerabilities and as a result are impacted differently by hurricanes and have different degrees and extent of recovery and rehabilitation. Overall, the islands have risks that are interdependent and dynamic (Comfort 1999), which make the problem of integrating mitigation into current recovery more difficult to resolve.

Finally, the failure to mitigate against future disasters can slow poverty alleviation efforts. The absence of mechanisms to integrate mitigation into recovery may expose the poor and vulnerable to repeated and future disaster events. The Eastern Caribbean region, for example, lacks a framework for incorporating poverty reduction strategies into disaster recovery (Herbold, 2000). This research explores the mechanisms for integrating mitigation into disaster recovery activities in the Eastern Caribbean to present findings that can stem the failure in the Eastern Caribbean region and similar localities. To address the effectiveness of the existing mitigation mechanisms, I will re-examine how geoinformatics as a tool enhances information generation and exchange for mitigation during the disaster recovery process in the Eastern Caribbean.

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[2] This concept is based on Comfort's (1999) concept of shared risks.

1.2 COMPREHENSIVE DISASTER MANAGEMENT IN THE EASTERN CARIBBEAN

The push towards comprehensive disaster management in the entire Eastern Caribbean islands has significantly intensified since the beginning of the 21st century. This trend was most evident in the Leeward Islands after Hurricane Georges in 1998 and in the Windward Islands just before and after Hurricane Ivan in 2004. Up to this point, disaster preparedness and disaster relief remained the two phases that were best developed and implemented. In fact, many islands had disaster management offices, but had not formally adopted disaster management plans and legislation to fully empower the disaster management executive and committees. On some islands, emergency housing and disaster recovery plans are still not complete or formally adopted and critical infrastructure restoration and recovery plans are non-existent. Though the existing disaster management legislation and plans prioritize the restoration of water and electrical services, they often do not require a critical infrastructure restoration or recovery plan. In the last few years since Hurricane Lenny, most of the islands have been successful in formalizing hazard mitigation plans and shelter management plans.

At the regional level, the Caribbean Disaster Emergency Response Agency (CDERA) coordinates comprehensive disaster management and response. Since 2001, CDERA has aggressively promoted and facilitated mitigation policy-making and planning at the national level through its CHAMP program. Prior to Hurricane Georges in 1998, the islands of the Eastern Caribbean did not systematically engage in mitigation on a consistent, regulated basis. Several policy changes such as emergency preparedness plans, functional disaster management offices were triggered after Hurricane Hugo in

1989, but the progress towards comprehensive disaster management was somewhat ‘tortoisal’ over the next decade. Following Hurricane Georges, USAID funded a Post-Georges Mitigation Project in St. Kitts, Nevis and Antigua, which along with the CDERA CHAMP program, catalyzed the mitigation, institutionalization, and comprehensive disaster management processes. CDERA has a vibrant regional structure that supports comprehensive disaster management at the national level and ably engages the international and regional community for funding, technical support, and relief.

Despite the recent influx of funding, policy adoption and technical support since the turn of the century, the islands of the Eastern Caribbean do not have truly comprehensive disaster management. Physical planning activities remain somewhat divorced from disaster management activities at least on a day-to-day basis. Disaster managers are treated as end-users of hazard maps and development projects, rather than planners. Digital mapping remains underutilized, though it has become more common since Hurricane Ivan in 2004. As such geoinformation remains fairly static in a complex environment where dynamic information is so critical to effective decision making. This study explores how comprehensive disaster management in the Eastern Caribbean can be pushed to a more auto-adaptive approach through geocollaboration.

1.3 SUMMARY OF THEORETICAL FRAMEWORK

Disaster risk reduction and risk management depends not only on preparedness, but also on effective mitigation. Effective mitigation in the disaster recovery process can reduce risk against future disasters, minimize losses and save property. Though disasters are complex and unpredictable, structure can be incorporated into the disaster recovery process to integrate mitigation into disaster recovery activities. It relies on communication, knowledge generation and information exchange, good governing mechanisms as well as effective utilization of advanced technologies. This study builds its conceptual model on integrating mitigation into disaster recovery on the concept of comprehensive disaster management, complex adaptive systems and the above concepts. Previous studies have shown that advanced technologies within an efficient communication infrastructure can increase performance and effectiveness in the disaster environment. This study builds on this research and emphasizes the need to incorporate these aspects into the mitigation and recovery process. The study proposes a synchronization tool and a scalable approach for technology integration within the auto-adaptation framework so that it improves the effectiveness of building more resilient communities following disaster events.

1.4 SCOPE OF RESEARCH

Efficient disaster recovery is expected to include (1) the integration of mitigation strategies that build resistance into the society and economies of the affected communities. It also requires (2) mutual understanding at various levels of jurisdiction between governing bodies, resource agencies, coordinating and rehabilitation agencies and affected households and communities. This requirement is needed through all phases of the disaster management cycle, and even more importantly in the post-disaster environment (disaster recovery stage) in order for improvement to be realized and to prevent already limited resources from being wasted. Effective integration is therefore the critical element in this study. It is limited by information, coordination, spatial distance, governance, resources, tools and technologies. Therefore, this study is somewhat broad-based in an attempt to capture the key functions and computations that are necessary for effective integration of mitigation strategies into disaster recovery activities.

The use of technology and geoinformatics facilitates efficient and effective decision-making as well as communication among agencies, disaster managers and the affected. This study explores the structures and limitations for geoinformatics and GIS application that are currently in practice in the disaster recovery process. As multiple agencies are working to rehabilitate the affected communities, they have a shared responsibility to build more resilient communities. Rehabilitation agencies including builders, planners, and funders as well as households need to understand their needs and capability in building resilience and avoiding damages or disruption to lives in future events.

1.4.1 Definition of Terms

In this subsection, I define the terms, geoinformatics and geocollaboration, with reference to the context of this research. According to Wikipedia.org, "Geoinformatics is a science which develops and uses information science infrastructure to address the problems of geosciences and related branches of engineering. Geoinformatics combines geospatial analysis and modeling, development of geospatial databases, information systems design, human-computer interaction and both wired and wireless networking technologies. Geoinformatic technologies include geographic information systems, spatial decision support systems, global positioning systems (GPS), and remote sensing. Geoinformatics uses geocomputation for analyzing geoinformation."

I define Geocollaboration as the sharing and exchange of geospatial information in a timely, efficient and interoperable manner to enhance communication and decision making.

1.4.2 Research Questions

To explore the integration of mitigation strategies into disaster recovery activities and the aforementioned comprehensive disaster management issues, this study addresses the following three primary research questions:

1. **To what extent do regional agencies, national governments, local builders, planners and households in the islands plan to integrate mitigation into recovery from hurricane-related disasters?**

   To address this question, I will determine to what extent the islands experience similar or different disaster recovery and mitigation issues as well as what forms of mitigation they use to enhance of recovery. I will also assess the degree to which factors such as building construction practices, availability of resources and others identified through survey, affect the recovery and planning for recovery in the case of the islands.

2. **To what extent is an understanding of social networks and key actors in disaster recovery and mitigation important to, and utilized in, comprehensive disaster management?**

   To address this question, I will determine how communication among the different organizations and actors involved in the disaster management process take place and use this information to identify the networks that are critical to disaster recovery and mitigation. I will also identify how the networks impact coordination, mitigation and adaptability of the disaster recovery system. I also analyze the existing frameworks for the level of mitigation integration that they incorporate and how they could be enhanced, updated or modified for a more efficient integration process.

3. **To what extent does the use of geoinformation shape the solution to the recurring failure of communities to mitigate following hurricane-related disasters?**

   To address this question, I will determine the structure and infrastructure for geospatial support in comprehensive disaster management through survey of disaster management organizations and planning agencies. I will also assess the capacity for geospatial support and analysis in disaster management on the islands. I will also obtain existing geospatial data from the islands and collect some GPS points from affected households. Finally, I will inventory geospatial tools that have been used in the Eastern Caribbean region to improve mitigation integration and briefly assess their effectiveness.

1.5 SIGNIFICANCE OF STUDY

Several researchers have identified the issues of information sharing and collaboration as key to managing crises and effective disaster management (Comfort, 2003; Bardach 1998). Effective use of relevant and valid information in the disaster recovery process has received significant attention particularly since the December 26 (2004) Tsunami and (2005) Hurricane Katrina. Communities, not only need to develop careful preparedness strategies and rapid, well-coordinated emergency response capabilities, but they also need to develop efficient integration mechanisms in disaster recovery to build resilience against future disasters. While many researchers agree on building resilience, there remains no consensus on the appropriate mechanisms for doing so. This study contributes to the understanding of the appropriate mechanism to integrate mitigation measures into disaster recovery activities at the local, national and regional levels.

This research examines comprehensive disaster management in the Eastern Caribbean and explores the role of geoinformatics and social networks through scalable levels of governance and management across the OECS sub-region. Focusing primarily on the process of self-organization, the study tackles the concepts of (1) integration of geoinformatics and information technology, (2) interagency coordination and collaboration as well as (3) community networks, to ascertain a mechanism for building resilience, reducing risks and increasing efficiency in comprehensive disaster management. By incorporating information from these three concepts into the decision-making system, I am able to provide a better understanding of the dynamic disaster recovery environment. This study therefore contributes to the understanding of shared systems and self-organization.

This study is also important because it utilizes information within the existing social context to develop a mechanism that will ensure those who should know, are cognizant of the resilience that needs to be built into structures and infrastructure. Several scholars, USAID and regional documents have shown there is a tendency to adopt an "if it's not broke, don't fix it" attitude towards improving the structural safety of houses and property (Lavell 1994; USAID 2000). There is a need therefore to use the opportunity when the structure is broken to have it strengthened or retrofitted to meet safe building guidelines.

Finally, this study provides a baseline (before) for assessing approaches to disaster recovery at the micro, meso and macro levels if future disasters (after) occur in the Caribbean region.

1.6 SUMMARY OF METHODOLOGY

This research is designed as an exploratory case study investigation of the integration of mitigation into disaster recovery after two hurricane events: (1) Hurricane Lenny (November 1999) and (2) Hurricane Ivan (September 2004). I used the case of seven islands in the Eastern Caribbean that were affected by either of these storms. Both quantitative and qualitative methods were utilized to derive the best answers to the research questions in these cases (see page 11). Case study research not only requires contextual description of the case (s) involved in a bounded system, but also examination of the actors, their responsibility, their actions as well as their relationships over time and place (Robert Stake 2000; Lincoln and Guba 1985). In this particular study, I focused on the national and regional organizations instrumental in the recovery from hurricanes Ivan and Lenny.

Households are central to implementing mitigation activities into reconstruction and rehabilitation actions, but they rely on designers and builders to provide sound advice and workmanship, as well as national rehabilitation agencies such as the Red Cross, Planning and the national emergency management agency (NEMA) to provide guidance and support. While NEMA represents the core agency in disaster management on most of the islands, development planning, public works and non-governmental agencies such as the Red Cross play key support, and in some cases, core roles. Understanding the roles and interactions among these agencies will inform the scalable mechanism for efficient integration of mitigation into disaster recovery. This study therefore analyzes the relationships and interactions between these players through individual as well as a nested case analysis. The nested-set case study approach enables the researcher to better understand information flow.

Finally, I used a synchronization framework (discussed in Chapter 2.6, page 53) based on the mitigation strategies and network to tie information with key actors in the mitigation process. This relies on the sharing of geoinformation, hence the term geocollaboration.

1.7 FULL OUTLINE OF DISSERTATION

The remainder of this dissertation is divided into six additional chapters. **Chapter 2** provides a review of the theoretical elements, methods and empirical findings in the existing literature that explains sustainable disaster management, risk reduction, disaster resilience and the integration of mitigation strategies into disaster recovery activities. It provides the research framework on which to determine an appropriate mechanism to integrate mitigation strategies into disaster recovery activities using the case hurricane disasters in the Eastern Caribbean. **Chapter 3** provides the methodology for this research and analysis.

Chapter 4 discusses the state of disaster management in the Caribbean in reference to comprehensive disaster management, development and geoinformatics. I also examine the context for each of the case studies and some of the initial response to the mitigation within the cases.

Chapter 5 discusses mostly the quantitative findings and results related to how households and house designers and builders participate in the disaster recovery process. It examines practices for disaster mitigation and comprehensive disaster management in general. **Chapter 6**, on the other hand, focuses on the qualitative analysis of the study. It discusses the relationship among the various organizations and how this relationship impacts disaster mitigation and recovery.

Chapter 7 discusses the role of geoinformatics and geospatial relations between hazard mitigation planning and disaster impact in the two case studies. It identifies relationships that are essential in building an efficient geospatial mechanism for mitigation and efficient disaster recovery. Chapter 7 also outlines the development and functions of the DHaRMS synchronization tool and its contribution to the field of disaster management.

[Chapter 8](#) ties the results in chapters 5 to 7 together and discusses the concepts that drive the effective and efficient integration of mitigation into disaster recovery and comprehensive disaster management. It summarizes the socio-geotechnical framework that facilitates mitigation in an auto-adaptive disaster management system. Finally, it discusses implications for future research.

1.8 SUMMARY

This study seeks to determine the appropriate mechanisms to integrate mitigation into disaster recovery in a timely manner at the local, national and regional level of implementation in the Eastern Caribbean. It also reexamines the role that geoinformatics should play in effective coordination, communication, analysis, and implementation among the various agencies and affected communities. Finally, it addresses the need for pre-disaster planning and efficient data collection and reporting to reduce the chaos and mal-functions now associated with disaster recovery. Seven islands are explored for their experiences with hurricane disasters in two cases; Hurricane Lenny in 1999 and Hurricane Ivan in 2004. In addition, four islands are examined more closely for the linkages between rehabilitation agencies and the affected communities. The findings are expected to help local rehabilitation agencies enhance their performance in ensuring that rebuilt structures become more resilient against future disasters.

2.0 A CONCEPTUAL MODEL FOR INTEGRATING MITIGATION INTO DISASTER RECOVERY IN THE COMPREHENSIVE DISASTER MANAGEMENT ENVIRONMENT

Many researchers have characterized mitigation as a pre-event process for reducing loss, even in the case where it is a post-event process for a given event to reduce loss against future disaster events. Mitigation generally refers to the structural and nonstructural "preventative actions taken before a disaster to reduce loss" (Mileti, 1999). However, the inherent and adaptive responses taken during and after a disaster that result in reduced losses in future disaster events are also considered to be mitigation activities – a post-event characterization of mitigation. According to Haddow and Bullock (2004), the implementation of mitigation strategies after a disaster occurs can also be considered part of the recovery process. Resilience on the other hand (as defined by Bruneau et al, 2003, p 3) relates to "the ability of social units (e.g. organizations, communities) to (1) mitigate hazards, (2) contain the effects of disasters when they occur, and (3) carry out recovery activities in ways that minimize social disruption and mitigate the effectors of further disasters." Mitigation and resilience are not equivalent terms, yet they are interdependent and inherently linked. This study focuses primarily on the third aspect of resilience as defined by Bruneau et al (2003) and the mitigation that occurs during and after current disasters to effect future disasters.

This study addresses the recurring failure of communities at risk to build mitigation into disaster recovery activities to reduce risks against future disaster events. How geoinformatics shape this problem is also analyzed and mitigated. Disaster recovery is not the most-desired opportunity for mitigation, yet it creates a window of opportunity to build more resilient structures and systems. The task of getting affected households, individuals and agencies to incorporate mitigation activities into recovery initiatives is a complex and often uncoordinated one. Yet, effective mitigation in disaster recovery requires coordinated action as well as efficient information flow among multiple actors and across several jurisdictions to reduce future risks. The problem is socio-technical and depends on the development of effective rehabilitation mechanisms. Such mechanisms rely on the structure and performance of information systems that provide rapid transmission of reconstruction requirements that support decision making among human managers. They also rely on knowledge of the social network that fosters coherence, accessibility and efficiency in information flow.

This chapter is subdivided into seven sections. Section 1 discusses the role of risk management in comprehensive disaster management, the relationship between resilience and mitigation and the opportunity presented to build mitigation into disaster recovery within the comprehensive disaster management environment. Sections 2, 3, 4 and 5 then outline the quadrangular theoretical framework within which this study is bounded and explored. These sections discuss and utilize the concepts of complex adaptive systems; small world networks and self organizing systems within social networks; governance and interagency coordination; as well as geoinformatics, information and knowledge management, and collaboration to explore the ability of organizations to incorporate mitigation into disaster recovery activities. These theoretical elements are then synthesized into the conceptual model in section 5, which will be used to examine the cases identified in this study. This model is designed to facilitate the integration of mitigation into disaster recovery activities through efficient mechanisms determined by the study.

The aforementioned four theoretical concepts will be used to examine the comprehensive disaster management in the Eastern Caribbean. The disaster recovery process is examined in the context of island systems among seven islands in the Eastern Caribbean following the impact of Hurricane Ivan in 2004 and Hurricane Lenny in 1999. Surveys, structured interviews, and analysis of local newspapers and documents are used to determine the interactions and processes involved in disaster recovery. Also, GIS and geospatial analysis are employed to not only support decision-making among public managers and policy makers, but also to facilitate effective communication between citizens, managers and rehabilitation agencies.

2.1 RISK MANAGEMENT, MITIGATION AND RESILIENCE IN COMPREHENSIVE DISASTER MANAGEMENT

In order to address the research questions posed in chapter one, this section will explain the key terms and continue to frame the context for this study. According to Aaron Wildavsky (1988) in his book *Searching for Safety*, risk is ever present in the complex world and society chooses which risks to minimize as well as which ones to accept. Risk represents the possible occurrence of a harmful event to society, and the occurrence of the disaster represents a failure of existing policy (Comfort, 2005). Therefore, the ability to anticipate a disastrous event and take proactive steps to reduce the impact of the disaster even if the disaster occurs constitutes management of risks. Risks can be dynamic and exaggerated in the complex disaster environment. Wildavsky (1998) suggests that risk varies under different conditions and the efficient management of these risks is guided by valid information, often through governmental instruments and policies. Incidentally, it is inadequate planning and the ill-informed actions of individuals and organizations that exacerbate a disaster and restricts the minimization of these risks. The process of minimizing risks is facilitated by mitigation and resilience. Yet, the task of reducing these risks is a shared responsibility between government agencies, private businesses, non-governmental organizations households and communities (Comfort 1999). This study explores this shared responsibility in the comprehensive disaster management environment and focuses on how this shared responsibility influences the mitigation of risks.

Comprehensive disaster management and risk management

Comprehensive disaster management focuses on two distinct, yet overlapping management approaches: risk management and emergency management. Risk management centers primarily on preserving and protecting property and avoiding financial losses while emergency management concentrates more on the safety of the people affected by the disaster. Both of these approaches are critical to disaster recovery and mitigation. Emergency managers now have an expanded role beyond response to also include recovery efforts in their preparation, planning and management of disasters. With this role, emergency managers not only have to coordinate with public safety departments such as police, fire, hospitals, but they also have to coordinate with city planners, building officials, public works and other public agencies to implement the mitigation and recovery phases of the disaster cycle. Comprehensive disaster management draws upon this integration of roles and attempts to capitalize on the opportunities presented in the various stages of the disaster cycle to build resilience and reduce vulnerabilities to disasters (Table 2.1). It consumes both formal and informal interactions among institutions, financial mechanisms, regulations, and policies to be effective (Inter-American Development Bank, 2002). Ultimately, comprehensive disaster management relies on pragmatism in economic development, poverty reduction, environmental protection and disaster management to become pragmatic itself. Recurring natural phenomena such as hurricanes, for example, will continue to impact communities negatively if communities do not make adequate adjustment to prepare and withstand these exogenous shocks in development and cultural practices.

Risk management involves three major components: (1) risk identification and analysis; (2) risk reduction and (3) risk sharing or transfer, which are critical in effective disaster recovery. Risk identification focuses on the nature and extent of risk on a particular area or for a particular hazard or circumstance. Not only is the risk identified, but it is analyzed and assessed to determine the potential and actual benefits for risk reduction. Risk analysis examines the frequency, magnitude and severity of past hazards, the degree of exposure as well as the resilience built into local communities to withstand exogenous events. Table 2.1 illustrates the risk management elements for comprehensive disaster management and highlights the avenues for mitigation through risk reduction. In the pre-disaster phases, there are significant attempts to build instruments for risk transfer and disaster preparedness. While the post-disaster phase often reinforces policies geared towards mitigation and risk transfer, it also promotes risk reduction through mitigation in rehabilitation and reconstruction (Table 2.1).

Table 2.1 Risk management elements for disaster management
(Source: Inter-American Development Bank 2000)

Pre-disaster phase				Post-disaster phase	
Risk identification	**Mitigation**	**Risk transfer**	**Prepared-ness**	**Emergency response**	**Rehabilitation and reconstruction**
Hazard (H) assessment	Physical or structural mitigation works	Insurance and re-insurance of public infrastructure and private assets	Early warning systems and communication systems	Humanitarian assistance	Rehabilitation and reconstruction of damaged critical infrastructure **Structural mitigation**
Vulnerability (V) assessment	Land-use planning and building codes	Financial market instruments (such as catastrophe bonds and weather indexed hedge funds	Contingency planning	Clean-up, temporary repairs, and restoration of services	Macroeconomic and budget management (stabilization and protection of social expenditures) **Nonstructural mitigation**
Risk assessment [f(H) + f(V)]	Economic incentives for pro-mitigation behavior	Privatization or competitive management of public services with safety regulation (energy, water & transportation)	Networks of emergency responders	Damage assessment	Revitalization for affected sectors (tourism, agriculture, etc.) **Structural and non-structural mitigation**
Hazard monitoring and forecasting (GIS, mapping, modeling)	Education, training and awareness about risks and prevention	Calamity Funds (national, local and regional)	Shelter facilities and evacuation plans	Mobilization of recovery resources (public, multilateral, and insurance	Incorporation of disaster mitigation components in reconstruction activities **Structural and non-structural mitigation**

Note: This table is adopted from the Inter-American Development Bank 2000 Report on Facing the challenge of Natural Disasters in Latin America and the Caribbean. Mitigation approaches are noted **(in bold)** *in the rehabilitation and reconstruction phase.*

Risk reduction involves three distinct, yet overlapping measures: (1) to avoid or prevent the risk; (2) to limit or mitigate the risk and (3) to lessen the potential impact of the hazard through preparedness, that is taking precautionary actions against a potentially harmful hazard. This research concentrates primarily on the second measure as a vulnerability reduction strategy. Disaster risk reduction employs both structural (physical) and non-structural mitigation over extensive periods to enable comprehensive disaster protection or reduced vulnerabilities. Structural mitigation uses technological or physical solutions such as flood defenses, groynes, dikes, levees and safe building construction to address vulnerabilities and reduce the impact of hazards on people on structures. Non-structural mitigation, on the other hand, depend on less tangible measures such as early warning systems, land use planning, insurance, zoning, public sensitization and legislation in effecting change in behavior and practices that result in reduced risk. Non-structural mitigation is more geared to reducing the intensity of the hazards or vulnerability to the hazards. Once mitigation is successfully employed, it has three key resulting attributes: (1) reduced failure probability; (2) reduced consequences from failure; and (3) reduced time to recovery (Bruneau et al, 2003; Rose 2004).

Thirdly, risk management involves risk sharing and transfer – a mechanism through which the financial and economic aspects of the disasters can be reduced. Comfort (1999) asserts that while risks may never be eliminated, they are shared because of similarities in exposure, extent, location etc among the affected or global communities. Instruments such as insurance not only help to transfer risks from individuals to communities and companies to the global market where there is greater economic means to withstand shocks. As would be elaborated later in this section, risk reduction has marginal returns on investment after a certain stage and time, and thus some element of risk sharing or transfer is necessary to further manage risk. Additional tools such as informal community pools, micro-insurance and social protection funds are a means to transfer risk to a larger collective with greater economic means to manage the financial risks of a disaster.

Resilience

Resilience as defined by the United Nations International Strategy for Disaster Reduction (UN-ISDR, Geneva 2004) is the "capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure." The concept of resiliency focuses primarily on the preexisting conditions in a society that are necessary to prevent or reduce the severity of disasters as well as foster a speedy and efficient recovery from the impact. Over the past decades, there has been increasing incidence of disaster and increasing costs to society. In fact, over the last decade alone, 2.4 billion people were impacted by disasters with the majority being from developing countries. Not only have communities suffered greater losses, but they have also experienced more difficulties in bouncing back from disasters (through resilience). These communities such as New Orleans (after Hurricane Katrina) and Grenada (after Hurricane Ivan) have failed to effectively balance risk against losses and absorb losses (Comfort, 2005; Wildavsky 1988). This problem is tied to the failure of the community systems to capitalize on collective capacities when dealing with risks and addressing the concerns in the disaster environment. They have also failed to reduce vulnerabilities to future hazards because of losses in developmental gains, which have also limited the scope of mitigation (CDERA, 2006). Building resilience in the complex, dynamic, multidimensional and interactive disaster environment requires communication among agencies through both official and small world networks to increase communication efficiency and reduce the risk of disasters. Preparedness helps to enhance resilience before the event, but it is the capability of society to organize itself in such a way to learn from past disasters to improve risk reduction that ensures future protection and society-wide resilience.

Mitigation

Resilience also embraces mitigation. Mitigation is the process of preventing hazards from developing into disasters by reducing the effect of disasters. Many disaster management systems represent mitigation as one of the four stages of the disaster management cycle (Figure 2.1). However, any action that reduces or eliminates risk against a future disaster event over time is considered to be a mitigation activity, whether this action occurs before or immediately after a disaster event. In essence therefore, the precursor to any mitigation is the identification of risks.

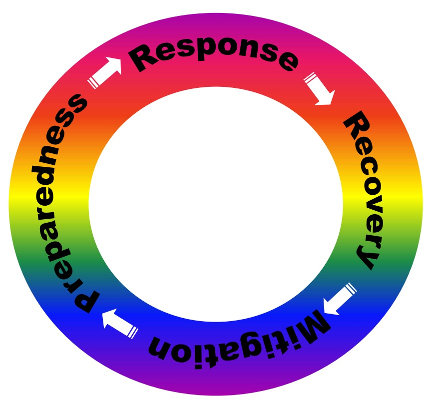

Figure 2.1 Four phases in the disaster management cycle

Mitigation is a cost-effective way to reduce vulnerabilities against future hazards. As figure 2.2 illustrates, the initial investments in physical mitigation can significantly reduce the vulnerability of the structure against a hazard. However, as more mitigation is done and the risk is reduced, the marginal cost of mitigation increases. At some point, further reduction in risk is best achieved by insurance. As the level of disaster or hurricane activity has increased, safety from natural disasters has increasingly being treated as a public good. Insurance companies have moved away from financing risks in highly vulnerable areas, making it more difficult to cover the remaining marginal risks. The more such risks are treated as public good, the more there is likely to be underinvestment in reducing these risks because of the lack of competitive market conditions.

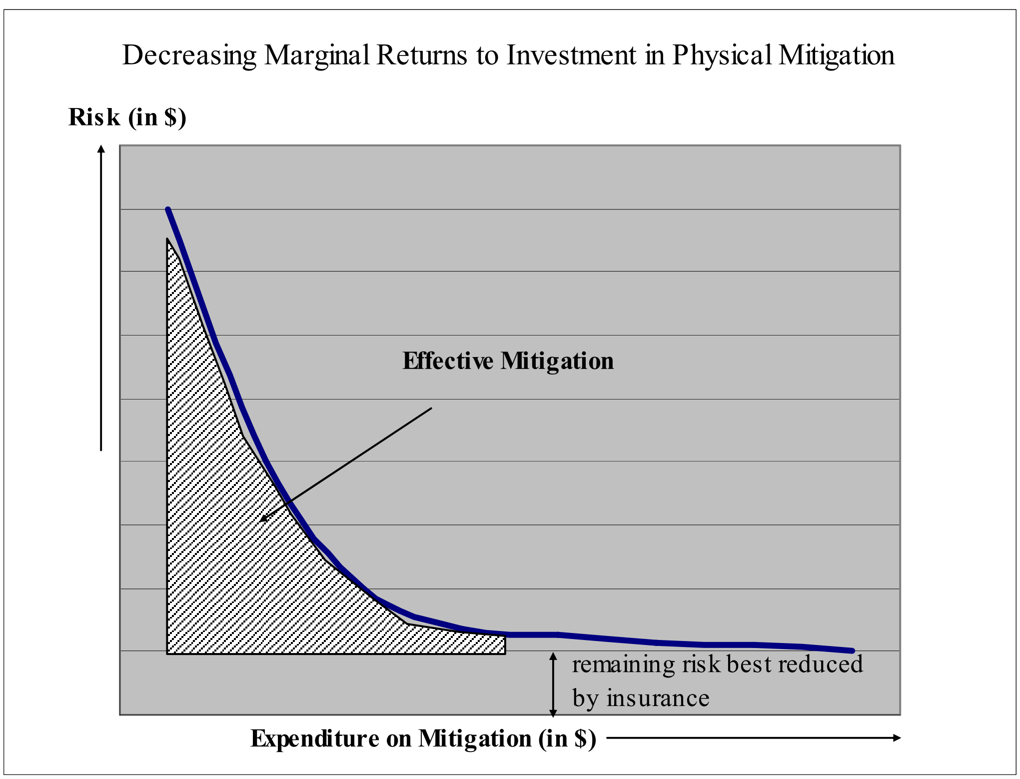

Figure 2.2 Marginal returns to investment in physical mitigation against risk

Window of opportunity for mitigation in disaster recovery

The disaster recovery phase is primarily concerned with the restoration of the affected area to its previous state. It involves rebuilding and repair of destroyed property and infrastructure as well as re-employment. However during a disaster, destroyed or damaged structures present an opportunity to incorporate mitigation activities without significant cost compared to the overall restoration or rehabilitation process, which would also minimize the loss of development gains from future hazards. Schumpeter's theory of development emphasizes technical and institutional change[3]. According to him, development only occurs when an entrepreneur makes an innovation. An expanding economy is not a developing economy unless the coefficients are changed. The disaster recovery period represents an excellent opportunity for change in the political, technical and economic process. Previous research on behavior and public policy initiatives following disaster have shown that policy experts are most likely to effect change immediately after a storm or disaster (Kingdon, 1984). The disaster recovery stage is therefore a critical "policy window" stage, not only to make policy changes, but more importantly to implement planned, physical changes to human settlement and the environmental resources that would build resilience and address the needs of the poor.

Also, the literature on social tolerance of inequality suggests that as long as everyone gains in absolute terms, changes in relative inequality are more tolerable. It further suggests that social tolerance increases in times of crises (when the crisis is perceived to be because of exogenous events), when there are opportunities for exit

[3] Handbook of Development Economics. CH 6. Long-Run Income Distribution and Growth, by Lance Taylor and Persio Arida.

(mobile society), if inequality is seen as necessary for future improvements for all, and if inequality is less visible[4]. Hence, change becomes easier to accept. As the disaster fades and long-term recovery sets in, however, people tend to provide less support for policies and change. Disaster mitigation is essential for planning for disaster recovery in a way that breaks the "disaster-rebuild-disaster-rebuild" cycle. Using Kingdon's (1984) notion of a "policy window" and Schumpeter's theory of change to effect development, this study will examine the importance of geoinformation and the level of support for integration of mitigation at varying levels after the disaster. Many plans (such as the USAID-led Housing Recovery Plans) have been developed in response to particular hurricane disasters to take advantage of such opportunities, but without the institutional mechanism to ensure sustainability, such policy changes sometimes become ineffective.

Effective mitigation and poverty reduction

The poor differ from others in their exposure, vulnerability and aversion from natural disasters (Sinhua et al, 2002). In most cases, natural disasters such as hurricanes lead to more poverty triggering also deterioration in terms of trade, reduction in income-earning work (Lavell, 1994). Such exacerbation of the factors that contribute to poverty coupled with the frequency of hurricanes in the region can therefore lead the poor into a chronic state of poverty. Mitigation, especially in the disaster recovery phase, would affect mostly the poor since they are the ones to more likely sustain significant structural damage. A disaster provides an opportunity due to increased flow of resources to build resilience into poor communities. Micro-based mitigation interventions would foster

[4] Handbook of Development Economics. CH 19. Income Distribution and Development, by Irma Adelman and Sherman Robinson.

redistribution with rehabilitation and reconstruction that would lead to increased value of assets owned by the poor. This research examines the geospatial aspects of poverty in relation to hazard mapping and provides a geo-technical approach to integrate mitigation into disaster recovery that also promotes poverty reduction.

2.2 COMPLEX ADAPTIVE SYSTEMS AND SELF-ORGANIZATION

Complex-adaptive systems (CAS) and self-organizing systems are two systems that are commonly observed in the active disaster recovery environment. Complex-adaptive systems function where individual and organizations (agents) evaluate their own behavior in the disaster context, and then modify their actions to improve functionality and performance when the evaluation indicates failures in the intent of current tasks. This approach suggests a top-down method where the global behavior depends on the experience of the managers and the existing system, and adjustments are made at this level and sent to its local parts. Self-organizing systems, on the other hand, are bottom-up. They are composed of large, heterogeneous components that interact locally according to simple rules. This network allows the global behavior of the system to emerge from the local interactions. Hence, studying only some of the local parts will not present the true global picture, as the network efficiency is based on the interconnectedness and communication among all the parts. Self-organizing systems are more closely related with the recovery process while complex adaptive systems are more closely related with an efficient mitigation process. This study marries these two systems and attempts to find an efficient mechanism to integrate mitigation into disaster recovery.

This study examines the problem of integrating mitigation into disaster recovery in the complex, dynamic, interactive disaster environment. The marrying of the processes of mitigation and recovery involves different actors with different responsibilities across different levels of administration, different levels of solution and at various states of resilience. The problem is therefore multi-dimensional and requires a high degree of interoperability. Comfort (1999) suggests that it requires non-linear adaptive responses by the agents to foster different levels of solution to the problem. Several scholars also stress that rapidly-evolving changes in the complex disaster environment also call for continuous adaptation and creative response[5].

Complexity and CAS

The disaster recovery environment is a complex environment where the interactions continuously occur among the actors which impact not only the outcome of activities, but also influence the probabilities of later events. Axelrod and Cohen (1999) suggest that rather than ignoring or eliminating complexity, agents should harness this complexity by taking advantage of variation, interaction and selection processes that can foster change and bring success. They argue that agents can manipulate the interactions in an organization and the overall system as well as support those functions and components that are most viable to the success of the system. In so doing, Axel and Cohen contend that the agents of the system will generate new questions and possibilities for action that would make the design of organizations, strategies and mechanisms more efficient and effective in the complex settings. This framework is essential in studying mitigation and

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[5] Axelrod, Robert and Michael D. Cohen. 1999. Harnessing Complexity: organizational implications of a scientific frontier. New York, NY: The Free Press.

comprehensive disaster management systems as the interactions also influence information exchange and knowledge management. Axelrod and Cohen's complex adaptive framework also emphasizes a key role for information validation and communication in complex adaptive systems. They argue that information is critical to promote adaptation.

Biologist Stuart Kauffman (1993) further captures the essence of information in dealing with complexity in his theory of "edge of chaos." Kauffman describes systems as operating on a continuum that ranges from order to chaos. He suggests that systems can move either way along this continuum, but more commonly that systems operating at either end of the continuum can mover toward the opposite end. Thus a system operating at the chaotic end can move towards order. Kauffman identifies a narrow band at the center of the continuum as the "the edge of chaos." He argues that there is sufficient structure at this point to entertain both structural and non-structural approaches to the system. Kauffman stresses that there is enough structure to support structured information exchange, and enough flexibility to allow the system to adapt to the dynamics of the environment and the system itself. The information exchange in the edge of chaos allows managers and agents to be more innovative about decisions and actions and foster adaptation to the changes in context. Better decisions could therefore be made considering the multiple constraints: scarce resources, multiple actors, urgent time frames and multiple levels of urgency and needs. Kauffman deduces that the main factors in enhancing the capability of agents to deal with uncertainty in the complex systems are information infrastructure and organizational flexibility.

Comfort (1999), in her book "*Shared Risks,*" extends Kauffman's combinations of the two crucial components for managing uncertainty in the complex environment: information or technical infrastructure and organizational flexibility, to also include cultural openness. While Comfort supports Kauffman's basic tenet for information infrastructure, she also emphasizes that there must be a sufficient level of technical interoperability for information and communication exchange to be efficient and effective among the disaster management agents. Some scholars contend that minimizing complexity by including more technology may alleviate some problems, but it can lead to less flexibility in the system (Mileti, 1999). Comfort further agrees that organizational flexibility is essential to reduce complexity where agents are able to differentiate functions between different agencies and still integrate tasks and functions for the successful performance of the entire system. She strongly affirms however that the willingness of the agents to accept changes, resolve conflicts, remediate differences, learn from mistakes as well as experience and improve performance, that is, *cultural openness* is essential to developing an adaptive organization. The level of integration of these three elements: technical infrastructure, organizational flexibility and cultural openness, determines the type of recovery system that evolves in the complex environment. This study acknowledges the value of information exchange and efficient networks in finding an efficient mechanism for integrating mitigation into disaster recovery as well as the need for organizational flexibility and cultural openness.

Complex adaptive systems and self-organization

Comfort identifies four distinct complex response systems which are synonymous with recovery systems: non-adaptive, emergent adaptive, operative adaptive and auto-adaptive systems. These four systems illustrate a process of transition towards self-organization, where non-adaptive systems are the most rigid and auto-adaptive ones are the most flexible in promoting change. Non-adaptive systems have low organizational flexibility, non-adaptive or non-existent technical structure and low cultural openness, while auto-adaptive systems have high organizational flexibility, sound and adaptive technical structure and high cultural openness. Emergent and operative adaptive systems fall on the continuum between non-adaptive and auto-adaptive systems. This model will be used to analyze the roles of rehabilitation and recovery agencies during a hurricane disaster recovery event on individual islands. The level of pragmatic mitigation of disaster risk through appropriate technical structure, flexibility, commitment, organizational learning with effective feedback and coordination will determine which system best characterizes the recovery structure on each island.

Comfort contends that auto-adaptive systems with their self-organizing elements are the most efficient for managing complex disasters. Self-organization is a process in which various components in a certain context interact independently of their physical nature but yet exhibit a spontaneous emergence of order and system structure that is not pressured or guided by exogenous forces outside the system (Kaufmann, 1995). Such systems are usually open and are characterized by both positive and negative feedback mechanisms; balance of exploitation and exploration and multiple interactions. There is the potential for change and continuous learning to promote efficiency among the self-organizing systems (Comfort, 2000). Though the system is mostly emergent, that is it becomes increasing more complex and unpredictable, it can also be non-emergent and stable. Kaufmann also shows how complex systems such as the disaster recovery process can exhibit order through self-organization. Rehabilitation agencies need to adapt to cope with demands to reduce risks against future disasters within the often short time frame to impact the affected communities. Such a situation requires structure and infrastructure, yet it also requires flexibility and openness.

2.3 SOCIAL NETWORKS AND COMPREHENSIVE DISASTER MANAGEMENT

One way to view the disaster management environment is as a system of dynamic networks that is characterized by its structure and dynamic interactions. The effectiveness of such networks in dealing with disasters and promoting resilience and risk reduction depends on the ability of the participants to generate valid information, make good and informed decisions and execute timely action or, at a minimum, commit to such actions (Argyris, 1982). According to Comfort (2005), network strategies provide a viable alternative to hierarchical systems in conditions that are uncertain and complex. Therefore, network capital is essential in promoting linkage between various levels of government and the community as well as mustering integrated agency performance (which is often overwhelmed by the disaster). From a network perspective therefore, members of the disaster management environment are interdependent with connections between them that allow for such activities as information exchanges and sharing of resources. Local citizens and community groups are engaged and influenced by the relationships with builders, planning regulators, civic groups, disaster management agencies and institutions. On the other hand, local knowledge by citizens is crucial to the viability of the network and efficient knowledge transfer (Putnam, 1993). It is this interdependent network that this research attempts to disconnect, reconnect, understand and evaluate so as to identify or develop an appropriate information sharing mechanism.

2.3.1 The social network perspective

The social network perspective provides a framework for studying the structure of interaction among rehabilitation agencies and the communities. This approach examines how the individual unit is embedded in a structure and how the structure emerges from the relations between its individual parts (Hanneman, 2001). Network analysis examines how this structure emerges into larger structural relations and identifies the dependencies and pivots that drive the interactions between the parts. Network analysis allows for manipulation of matrices to determine social patterns at varying layers of analysis. It also allows analysts to determine information flows as well as detect structural constraints within the network. In this study, governance in the disaster recovery environment is perceived as a set of interacting networks co-existing with the traditional hierarchical structure and approach (*discussed further in the section 2.4*). These interacting networks produce the scope and order that defines the system as well as the spontaneity that emerges as the system operates.

One aspect of networks that is significant in the examination of the disaster recovery environment is the strength of network ties. Granovetter transitivity theory states that strong ties create transitivity and are often embedded in tight homophilous clusters. Yet, it is the weak ties in this structure that connect to diversity and add value or novel information to the network. This research attempts to identify "Granovetter ties" which can be pivotal in information sharing and knowledge building in the dynamic disaster recovery environment. Social network analysis will be used to identify actors that are central to the networks and those that are hubs between networks. Such actors are keys to sustainable disaster management since they can facilitate or hinder the flow of information and the timeliness and quality of the recovery efforts (Wasserman and Faust, 1994). The higher the degree of connectivity between actors, the more they communicate, interact, share resources and learn (Carley, 2004).

Another feature of networks that is significant to this research is the concept of network density. Evolving networks (Watts 2003, Barabasi 2002) are characterized by nodes of dense interaction with ties connecting the nodes. The denser the network, the greater is the tendency for self-organization. This is possible because it is easier and faster to reach a large number of actors through a small number of densely connected nodes. However, though these systems may be efficient, scale–free networks in the dynamic, stress-laden disaster recovery environment, they can also be vulnerable to significant breaks in information flow and operations if one node is severed (Borgatti, 2004). The transactions that occur between individual units in a network not only influence the strength and density of networks, but also help to identify asymmetry in information transfer through structural holes or gaps. These gaps demonstrate disparities in access to information and weaknesses in the disaster mitigation-recovery mechanism. The integration of mitigation into disaster recovery requires an understanding of the network for recovery and the communication and coordination processes that occur.

Many researchers, however, challenge the network analysis approach on the grounds that sometimes it is nor methodically feasible to conduct studies or analyze them objectively. Recent studies have demonstrated that appropriate bounding of cases and application of more rigorous survey, statistical and mathematical techniques make network studies a viable field. Watts (1999) supports the emerging recognition of social networks and network analysis as a viable field in his book, *Small Worlds*. He stresses the emergence of global computational capability from locally connected systems where cooperative behavior and actions affect information processing and communication.

2.3.2 Network analysis and comprehensive disaster management

This study inquires into how different rehabilitation agencies operate and interact during the recovery and rehabilitation stages of a disaster at the island (national) and sub-regional levels. Carley and Hill (2001) argue that the position of agents (individual or organizations) within the network is critical to their ability to enable or constrain knowledge and information flow. They refer to these agents as intelligent adaptive agents because their social characteristics and networks influence their knowledge network, which in turn influences the behavior of the organization and the meta-network. In the recovery network, builders and reconstruction agents are critical pivots in ensuring that mitigation activities are incorporated into new and damaged structures. They interact directly with households, yet interpret policies and procedures regulated through planning and rehabilitation agencies. Information and resources that flow through these networks and sub-networks therefore affect the performance of the larger island system for disaster management. Understanding these networks as well as the linkage and functions that the agents perform will further identify how to integrate operations and promote efficient coordination.

While networks, be they nested or irregular, indicate linkage and some level of cooperation at various levels throughout an island or nation, they may not necessarily demonstrate the same level of effectiveness (Provan and Milward, 2001). Provan and Milward (2001) discussed the evaluation of networks of community based welfare organizations and contend that they should be evaluated at the community, network and organization levels. This research relies on triangulation from these three levels to generate a truer picture of how the recovery system operates.

2.4 GOVERNANCE AND INTERAGENCY COORDINATION

Comprehensive disaster management involves formal and informal interaction between institutions, financial mechanisms, regulations and policies (IADB, 2002). In this perspective, organizations are viewed as distributed knowledge systems (Weick and Roberts, 1993; Boland and Tenkasi, 1995) as well as socio-technical systems (Scott, 1998), in which knowledge is constructed and distributed across space and time using a system of technology and "emotional" or cognitive alignment. Therefore, the structure of relations, be it hierarchical, horizontal or some hybrid, affects the organizational capacity and ability to share information, generate knowledge and learn (Coakes et al, 2002). The literature provides two key approaches to disaster risk management: (1) focusing disaster recovery through existing government and governmental institutions, and (2) decentralizing recovery programs through local initiatives, non-governmental organizations and community-driven agencies. Albala-Bertran (1993) in examining the political economy of large disasters stressed that government-led disaster management tends to be overwhelmed by power structures rather than the local concerns. But yet, other scholars see a central role for government as it provides a better mechanism for comprehensiveness. Neither of these two approaches completely accomplishes effective disaster recovery that accounts for mitigation. This research will utilize various aspects of these two schools of thought to determine the most viable combination for effective disaster recovery.

2.4.1 Governance

Complex systems are often dynamic systems, subject to different rates of change in their different components. Simple variations on old themes and traditional rational models are not sufficient to bring about the efficiency of the disaster management system. Rather, the systems and their constituent elements need to be open in an environment where there is continuous interaction as well as the opportunity to collectively learn and channel energies and resources where they are most needed (Scott 2003). Traditional bureaucratic systems are not fit to deal with the dynamic and complex systems, typical in disaster management. They rely heavily on top-down and command-and-control management styles rather than cooperation and participation. In fact, hierarchical systems tend to hinder cross-functional and horizontal communication. They are not very open to the interchanges that influence the viability of the system (Kiel 1994; Rolfe & Britton 1995; Maurer 1971). Flat organizational structures, on the other hand, tend to better assist the coordination and control of knowledge creating a social context that favors effective knowledge management

Governance within the disaster environment can be complex, yet the goal is to ensure that informed decisions are made by the persons at risk. Decentralization of some disaster management activities can promote greater community involvement and possibly a more effective way of reaching the persons at risk. Administrative decentralization seeks to redistribute or share authority, responsibility, and financial resources for providing public services among different levels of government as well as non-governmental organizations. It is the transfer of responsibility for planning, financing, and managing certain public functions from the central government and its agencies to field units of government agencies, subordinate units or levels of government, semi-autonomous public authorities or corporations, nongovernmental organizations or area wide, regional, or functional authorities. Administrative decentralization is complex and can by done to different degrees, whether by - *deconcentration*, *delegation* or *devolution*. The successful implementation of decentralization depends on the commitment from central governments, updated knowledge of small world networks, the capability of the national bureaucracy to facilitate and support decentralized recovery activities and the capacity of field agencies to coordinate their activities at the local level (Rondinelli and Cheema, 1983).

2.4.2 Interagency Coordination

Coordinated action facilitates effective strategies to solving problems in complex environments where there are multiple interactions, responsibilities and actors. To effectively manage uncertainty in the disaster operations environment, Csete and Doyle (2004) suggest that a systematic approach for collaboration and coordination needs to be established. This approach fosters learning among actors, agents and organizations, with feedback mechanisms for adaptive learning and updated actions that adapt more to changes in the environment. The responsibilities of organizations often overlap at different levels in the comprehensive disaster management system and there is a need for integration of knowledge and function among different agencies for service delivery (Provan and Milward, 2001). Agencies need to work together, but always getting them to do so is a significant challenge in disaster recovery.

Interagency coordination depends on both complex adaptive systems (by design) and self-organization to maintain the organizational adaptive capacity necessary for effective management of uncertainty in the complex, dynamic disaster recovery environment. For a disaster management system to be adaptable, its members must have the ability to communicate, exchange information and resources, learn and coordinate their efforts. Therefore, the system's efficiency is directly related to the efficacy of communication and coordination between its members. Complex, adaptive systems absorb information from their environment and interact with it through its members (Comfort 1999; Kauffman 1993). This way information can be worked into a model (learning by experience) for managing the actual situation on an ongoing basis. This is essential because we do not know how the system might react (uncertainty). By integrating mitigation into recovery, we obtain more knowledge about the past and thus reduce the uncertainty within the system (Dovers and Handmer 1992).

As the complexity increases, the difficulty of integration, coordination and decision-making also increases. The interaction of multiple actors with varied interest and resources not only increases the complexity of managing cataclysmic disasters, but also how the same actors communicate and influence each other (Weiss and Collins 1996). McCarthy and Gillies (2003) state that complexity, as a system's attribute, "increases as the number and variety of elements and relationships within the system becomes greater, and increases as the level of predictability and understanding of the system as a whole decreases."[6] Despite this, the nature of communication, collaboration and coordination is systematic, which suggests that this complexity could be harnessed into building an efficient system (Axelrod & Cohen 1999). Organizations can learn; households can become better informed and practices can become more institutionalized. Without information and learning, it is difficult for the system to adapt and for change to occur. As Comfort puts it, change is "… a process of societal learning in complex systems, using information technology as a means to facilitate the review, reflection, and redesign of action at multiple points in a continuously evolving system."[7]

A key approach that captures the flexibility of self-organization as well as the structure of complex adaptive systems in guiding coordinated action in the complex, dynamic disaster recovery environment is a socio-technical model, the "bowtie" model (Comfort 2005, Crete & Doyle 2004). In the recovery environment, consistency is difficult to achieve without clear guidelines for decision making. The bow-tie model presents a decision-making information flow model to promote consistency among organizations (Figure 2.3). The bowtie model "facilitates coordinated action in the complex disaster environment" (Comfort 2005). The center would not only serve to

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[6] McCarthy and Gillies 2003. "Organizational Diversity, Configurations and Evolution." Complex Systems and Evolutionary Perspectives on Organizations: Application of Complexity Theory to Organizations. Ed. Eve Milton-Kelly. Oxford: Elsevier Science Ltd, 2003. 71-98.

[7] Comfort, Louise. (1994) "Initiating Change: A Dialogue between Theory and Practice." Journal of Public Administration Research and Theory. 4.3: 325.

integrate, analyze, process and disseminate information, but will be a central point for collection of primary data for disaster assessment. Its program, collaborative efficiency and effectiveness are influenced by the nature of the social networks in the disaster management environment. The model allows information to flow through an agency that provides support to all disaster management and development departments or agencies with substantial feedback mechanisms to keep information current and available. This structure promotes consistency.

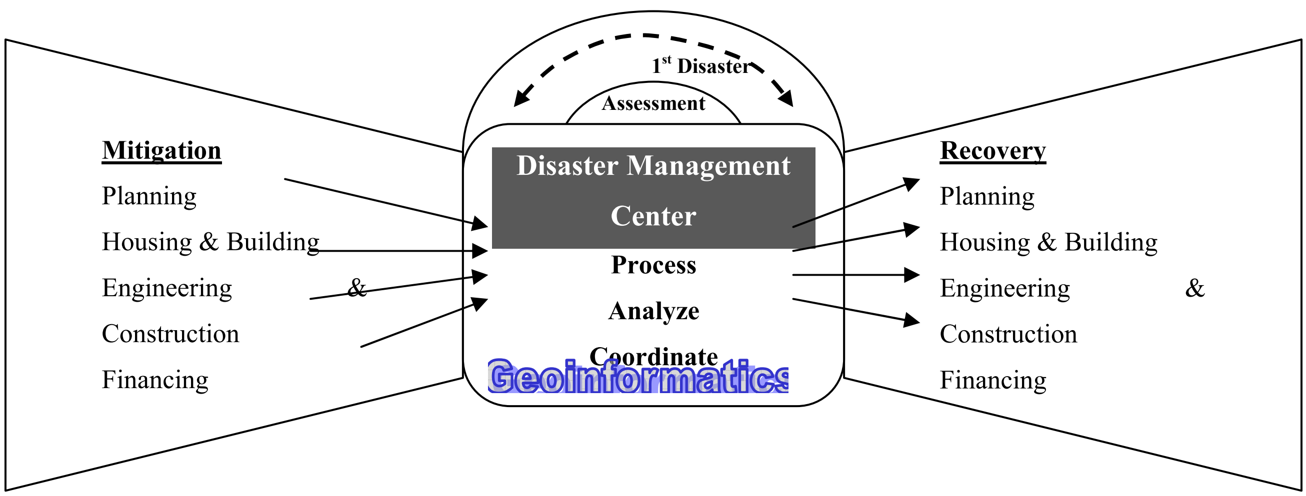

Figure 2.3 Modified bow-tie information sharing model[8] for linking mitigation and recovery (Comfort 2005)

[8] This model is based on the bowtie model developed by the IISIS Project at the University of Pittsburgh, and illustrated in Comfort, 2005.

2.5 GEOINFORMATICS, INFORMATION MANAGEMENT AND COLLABORATION

This section discusses the socio-technical perspective relating to the relationships between the social and the technical parts of the system, particularly the utilization of geoinformation and its related management and collaboration. Similar to efficient market, timely information is critical for effective decision-making and performance of individuals and organizations in the dynamic, stress-laden disaster environment (Comfort, 2005; Flin 1997; Weick & Roberts 1993). Often practitioners, rehabilitation agencies, and households rely on previous or acquired knowledge and models rather than searching through documented standard operating procedures to determine the most appropriate means to ensure mitigation is incorporated into disaster recovery. According to Klein (1993), they rely more on "recognition-primed decision-making." Since organizations become more familiar with the disaster context over time, they tend to rely on their mental models to quickly detect anomalies, make assessments and guide recovery rather than other models to determine action and performance. If rational principles of decision-making are built into their individual mental models through experiential and organizational learning, then recovery tend to be more closely correlated with effective mitigation and the effective performance of the organization. Therefore, information organization, dissemination and training prior to a disaster are critical in building the capacity of organizations to mitigate against future disasters during and after a current disaster event.

Though information is the foremost requirement in the disaster recovery process, the technical (and organizational) systems are essential in enabling the organization to adapt to the context and maintain effective performance. The geoinformatics approach allows geospatial information to be generated, shared and managed for disaster recovery. Geoinformatics provides data quality, immediacy and accessibility within a scalable technical infrastructure to support informed action in the complex disaster environment. If valid information is readily available and updated in real time, organization can use this information to adapt their response to the situation and make more informed decisions (that is, increase their adaptive performance).

The interaction of multiple actors with varied interest and resources not only increases the complexity of managing cataclysmic disasters, but also how the same actors communicate and influence each other (Weiss and Collins 1996). McCarthy and Gillies (2003) state that complexity as a system's attribute, "increases as the number and variety of elements and relationships within the system becomes greater, and increases as the level of predictability and understanding of the system as a whole decreases."[9] Despite this, the nature of communication, collaboration and coordination is systematic, which suggests that this complexity could be harnessed into building an efficient system (Axelrod & Cohen 1999). Organizations can learn; households can become better informed and practices can become more institutionalized. Without information and learning, it is difficult for the system to adapt and for change to occur.

Several scholars stress that communication is key in the complex disaster management environment (Comfort 1988, 1999; Mileti 1999). However, effective communication in such a dynamic environment depends on heavily timely and accurate

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[9] McCarthy and Gillies 2003. "Organizational Diversity, Configurations and Evolution." Complex Systems and Evolutionary Perspectives on Organizations: Application of Complexity Theory to Organizations. Ed. Eve Milton-Kelly. Oxford: Elsevier Science Ltd, 2003. 71-98.

information gathering, exchange, analysis and dissemination to where it is needed to inform decisions (Comfort 1999).

2.5.1 The socio-technical perspective

The socio-technical perspective provides a holistic view of the role of technology in the organization in harnessing knowledge, particularly the rich tacit, dynamic knowledge of people in the disaster recovery environment. In this perspective, organizations are viewed as distributed knowledge systems (Weick and Roberts, 1993; Boland and Tenkasi, 1995) as well as socio-technical systems (Scott, 2003), in which knowledge is constructed and distributed across space and time using a system of technology and "emotional" or cognitive alignment. Both the social and technical forms of the systems must coexist, with the content and interwoven connections within and between each subsystem driving the efficiency of the organization in knowledge management. Coupling and optimizing the management of this knowledge with technology also allows the organization or agent to adapt to the environment. According to Liebenau and Backhouse (1990), the information system has to be centered on the organizational culture and interpersonal communication to be efficient.

Knowledge sharing and integration

The socio-technical perspective attempts to systematically transform data to information and knowledge via technology and social collaboration among different organizations, functions and agents. Lembke and Wilson (1998) refer to this social collaboration as "emotional alignment" (perspective-taking) which depends on the negotiations and interactions of the participating agents. Information has no particular value until it is transformed into knowledge. This knowledge is created through the dynamic processes of exchange and combination among agents and functions and is embedded within the social context in which the knowledge was created. In the disaster recovery environment, significant information is generated, but this information is not necessarily transformed into efficient knowledge if it does not result in learning or integration of mitigation. Therefore, efficient knowledge integration not only depends on technological advancement but also the achievement of emotional alignment of agents in the disaster recovery environment (Coakes et al 2002). Lawrence and Lorsch (1967) contend that organizational efficiency in knowledge management rests in the efficient integration of technology and social collaboration. This study recognizes that there must not only be interoperability of the technology parts of the system, but also a similar degree of interoperability and alignment on the social parts of the system for information sharing to be effective in the disaster recovery environment[10].

2.5.2 GIS and the spatial perspective

Geoinformatics involves the utilization of special techniques, technologies and tools to acquire, process, manage, analyze and visualize geospatial data (Karimi, 2000). Geoinformatics is being used in the various stages of the disaster cycle including hazard monitoring (NOAA/NWS 2002); vulnerability assessments (USAID); Cutter et al, 2000); loss estimation (FEMA, 2005); rehabilitation and reconstruction. Large volumes of

[10] This is supported by the social construction perspective that requires both intellectual and emotional elements to work together in efficient knowledge management

accurate, relevant, on-time geo-information is necessary to effectively manage the situation during and after disasters as well as plan effectively for them. Geo-information technologies such as GIS and global positioning systems (GPS) coupled with telecommunication networks provide the means for the integration and mobility of these context-aware technologies to the actual context. Thus, they can provide access to needed information in a timely manner and enhance the interoperability of the disaster management services. These technologies are however dependent on fault tolerant redundancies that render them fail-safe, especially during high-peak use (Karimi, 2000). Theoretically, these computerized systems can process information much faster than humans and they can retain more information which can be retrieved quickly to inform decisions. Analytically, geoinformation provides for spatial overlay of several layers of information with conditions to determine the best guidance in decisions such as rebuilding, relocating, or even the incorporation of poverty reduction strategies into post-disaster recovery.

Complexity is a byproduct of uncertainty, which is compounded by the numerous interactions between disaster management stakeholders. Without timely information generation and exchange as well as effective communication and collaboration, it is difficult to reduce complexity or have the system adapt. This importance of information and communication or collaboration in the structuring and functioning of complex systems is stressed by many scholars.[11] Geoinformation helps to curtail this complexity

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[11] Edward W. Ploman. 1995. Introduction. The Science and Praxis of Complexity: Contributions to the Symposium Held at Montpellier, France. 0-11 May 1984. S. Aida et al. (Tokyo: The United Nations University (UNU), 1985). 7-22; Espejo; Luhmann.

through effective design or planning (Simon, 1981) including a clear conceptualization of the disaster recovery process, rapid information sharing and analysis.

Comfort (2005) further adds that "dynamic environments require learning processes that enable flexible adaptation and collective action rather than attempts to exert control through an administrative hierarchy of rules and constraints." Geoinformatics present an approach for centrality of information flow among human actors and technology systems with flexibility in decision-making based on desired models and outcomes. This centrality of information flow may reduce the asymmetry of information among organizations and communities with shared risks and responsibilities. It may also promote participation of those with implicit knowledge in the knowledge storage and communication tasks. Such a system requires adequate infrastructure (both system and technology) to be efficient and to promote accelerated learning, flexibility and adaptation. Having prior knowledge on safe building practice and siting at the individual house and national level can easily provide important information for decision making on damaged properties during the recovery as well as mitigation phases if geoinformation is maintained and utilized. In this research, geoinformatics is used to examine the recovery process as well as create a tool for enhancing the integration of mitigation into the disaster recovery process.

The communication process that is critical to effectiveness of mitigation in the disaster recovery process depends not only on networks, relationships and interagency cooperation, but it also relies on the communication infrastructure and its related technologies. Bardach (1998) stressed that the communication infrastructure plays an even greater role in geographically-based and dependent networks. The effective use of technologies such as GIS and geoinformatics bridge the geographical and spatial gaps and provide critical spatial and attribute information that may not be readily available during the reconstruction and rehabilitation stages. Cahan and Cresswell also pointed out that information technology helps government and disaster management agencies to cope with the uncertainty in the complex disaster environment. The technology in itself does not create cooperation, but it enhances trust and the ability to coordinate easily across organizations in a more timely and accurate manner. In essence, technology fosters auto-adaptive processes within networks and the disaster recovery system.

Building resilient communities depends largely on effective risk management and disaster reduction. Disaster recovery provides an opportunity to build resilience against future disasters through effective communication and decision-making. Yet, disaster reduction can be more effectively achieved through mitigation: informed decisions during the planning and reconstruction of new and damaged structures; informed actions by the affected or risk-prone communities; and timely communication and information exchange among rehabilitation agencies, planners and affected communities. Sharing information in a timely manner will not only promote awareness, but will present options to avoid or reduce risks. In this sense, mitigation can become a way of life that individual households can understand and employ, and agencies can openly regulate and improve even in a changing complex disaster environment.

2.6 CONCEPTUAL MODEL: THE INTEGRATION OF GEOINFORMATICS AND SOCIAL NETWORKS TO INCORPORATE MITIGATION INTO DISASTER RECOVERY

The conceptual model for this study is based on the integration of the four concepts discussed earlier in this chapter: the concepts of complex adaptive systems; small world networks and self organizing systems; governance and interagency coordination; and geoinformatics, information/knowledge management and collaboration. This study proposes to integrate organizational networks with geoinformation to deal with the complex information sharing and decision-making problems that exist in the disaster recovery environment. In doing so, the study will need to integrate mitigation activities into the disaster recovery process through existing or new mechanisms. In essence, the study designs a socio-geotechnical framework to include mitigation activities into disaster recovery. The challenge of different islands with differing systems of comprehensive disaster management remains at the forefront of this study. Information sharing and exchange are critical not only during the actual recovery phase, but also in training, planning and learning programs. Therefore, mutual understanding and clear definition of roles are critical, as well as the communication infrastructure to support decision-making. Disaster recovery can become more efficient if collaboration among rehabilitation agencies is well structured. Figure 2.4 illustrates the role of rehabilitation agencies in the mitigation mechanism.

A network approach not only seeks to find the appropriate level for interagency coordination and information sharing and but also fosters community participation in the recovery process. Comfort's model of four types of adaptation in disaster management identifies a set of components that are critical for effective disaster recovery. This study applies the factors of technical infrastructure, organizational flexibility and cultural openness to further identify the more appropriate mechanism to integrate mitigation into disaster recovery activities. This study also utilizes Comfort's (2005) bow-tie model for information sharing model in identifying the appropriate mitigation integration mechanism. The study reviews existing comprehensive disaster management mechanisms in the Eastern Caribbean region and identifies how these models can be made more efficient in integrating mitigation into disaster recovery.

The following chart outlines a scalable approach to incorporate mitigation into disaster recovery regardless of the existing mechanisms and the type of hazard. While existing mechanisms are successful in handling various aspects of disaster management, they may be deficient in integrating mitigation during disaster recovery. This approach takes the existing mechanisms for mitigation integration and adds a capability to incorporate mitigation. It brings together fragmented elements of managing risks and disaster management into a single approach. It uses GIS to generate and analyze spatial information that is stored in a database. This GIS includes data that generates non-real-time information such as vulnerability assessments, hazard maps, building vulnerability indices and real-time information such as damage assessments. Once this information is generated, queries are completed that enable disaster managers and rehabilitation agencies to determine the appropriate mitigation strategies for disaster recovery. Such information is then distributed through the mitigation network. The efficient mitigation network is however, identified from past disaster experiences and management structures through network analysis. By passing the mitigation strategies to the right network, both structural and non-structural mitigation can be implemented during the disaster recovery process, which leads to mitigative action. This approach is designed to function at both the macro (country) level and the micro (community) level.

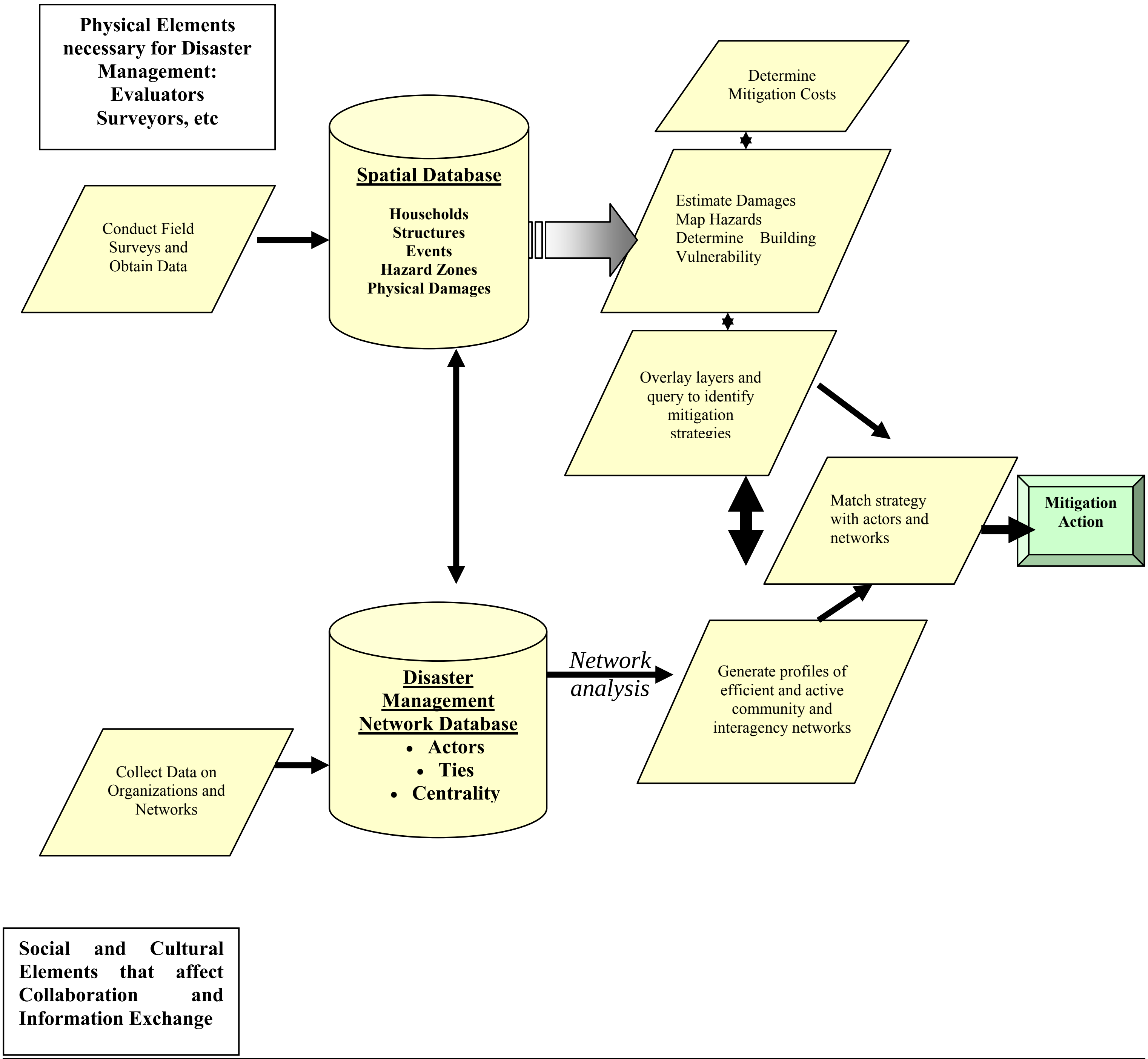

Figure 2.4 Architectural approach for integrating mitigation into disaster recovery activities

This architectural approach also integrates existing hazard maps with building application maps and poverty maps to identify communities most in need of disaster-related mitigation (initial risk assessment). It also integrates hazard maps with poverty, building maps and damage assessment maps to identify structures with urgent disaster-related mitigation in the rehabilitation and recovery phase of the disaster recovery (real-time risk management).

2.7 SUMMARY

Disaster risk reduction and risk management depend not only on preparedness, but also on effective mitigation. Effective mitigation in the disaster recovery process can reduce risk against future disasters, minimize losses and save property. Although disasters are complex and unpredictable, structure can be incorporated into the disaster recovery process to integrate mitigation into disaster recovery activities. It relies on communication, knowledge generation and information exchange, good governing mechanisms as well as effective utilization of advanced technologies. This study builds its conceptual model on integrating mitigation into disaster recovery on the concept of comprehensive disaster management, complex adaptive systems and the above concepts. Previous studies have shown that advanced technologies within an efficient communication infrastructure can increase performance and effectiveness in the disaster environment. This study builds on this research and emphasizes the need to incorporate these aspects into the mitigation and recovery process. The study proposes a model of technology integration within the auto-adaptation framework to improve the effectiveness of building more resilient communities following disaster events.

3.0 METHODOLOGIES

This chapter discusses the research methodologies employed in the data collection and analyses in this study. This research is an exploratory analysis of mitigation during the disaster recovery process across seven island states with somewhat similar vulnerabilities and context, but differing governance structures and mechanisms for dealing with comprehensive disaster management. The study employs eclectic methods of analysis including qualitative, quantitative, network and geospatial analysis to examine the complex system of comprehensive disaster management with respect to recovery from two hurricane disaster events in the seven Eastern Caribbean islands. The disaster events were Hurricane Lenny in November 1999 and Hurricane Ivan in September 2004. The island cases selected represent three distinct geographic areas in the Eastern Caribbean with varying frequencies for tropical storms and hurricanes: northern, central and southern regions. The study also utilizes spatial analysis to examine recovery patterns across the islands as well as develops a tool for enhancing mitigative recovery using St. Kitts-Nevis as a sub-case in the study.

This chapter is subdivided into the following sections to provide methodological context and validation to this study: 1) research design; 2) research questions; 3) selection of cases; 4) units of analysis and observation; 5) research methodologies; 6) data collection procedures; 7) detailed analytical procedures, and 8) summary.

3.1 RESEARCH DESIGN

This research is designed as an exploratory case study investigation of integration of mitigation into recovery after two hurricane events across seven islands in the Eastern Caribbean: 1) Hurricane Lenny (November 1999) and 2) Hurricane Ivan (September 2004). Both quantitative and qualitative methods were utilized to derive the best answers to the research questions in these cases (See pages 10 and 59). Martyn Hammersley and Roger Gomm (2000) describe case study research as inquiry that investigates a few cases in considerable depth, where the case is the object of the study. Case study research not only requires contextual description of the case (s) involved in a bounded system, but also examination of the actors, their responsibilities, their actions as well as their relationships over time and place (Robert Stake 2000; Lincoln and Guba 1985). Case studies help to capture the uniqueness of the study. Unlike experimental research, case studies are not created, but occur out of naturally occurring social contexts. They allow the researcher to describe complex and holistic variables about one instance of the object being studied, and explore a phenomenon in detail which might not be apparent from mass centered research studies. This particular study focused on the national and regional organizations instrumental in the recovery from hurricanes Ivan and Lenny.

This study of individual organizations (*Figure 3.1*) operating on individual islands within specific sub-regions (*Figure 3.2*) that were impacted by the particular hurricane event poses the opportunity for a nested analysis approach. Creswell (1998) stressed that deeper understanding can be achieved through within-case and cross-case analysis. The nested-set case study approach enables the researcher to better understand the interconnected social settings. In this study (like many such studies), the case has to be deconstructed into isolated factors in order to see how the whole functions. Households are central to implementing mitigation activities in reconstruction and rehabilitation actions, but they rely on designers and builders to provide sound advice and workmanship, as well as national rehabilitation agencies such as the Red Cross, Planning and the National Emergency Management Agency (NEMA) to provide guidance and support. While NEMA represents the core agency in disaster management on most of the islands, development planning, public works and non-governmental agencies such as the Red Cross play key support, and in some cases, core roles. Understanding the roles and interactions among these agencies will inform the scalable mechanism for efficient integration of mitigation into disaster recovery.

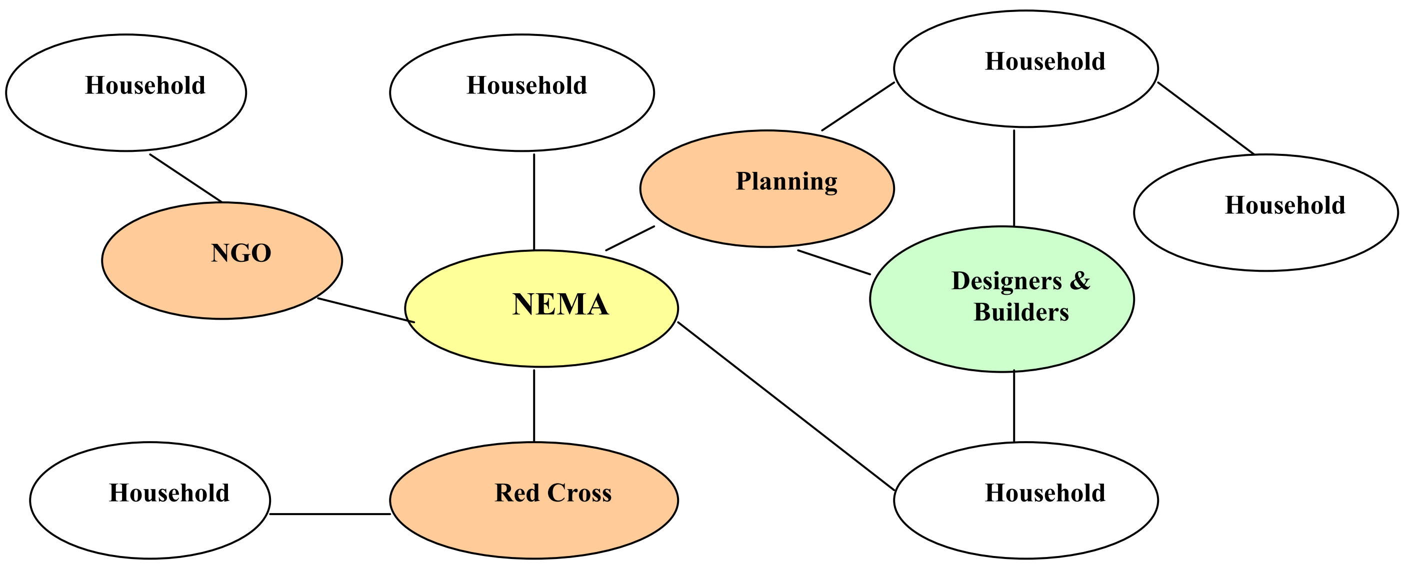

Figure 3.1 Relationships among organizations within each island case

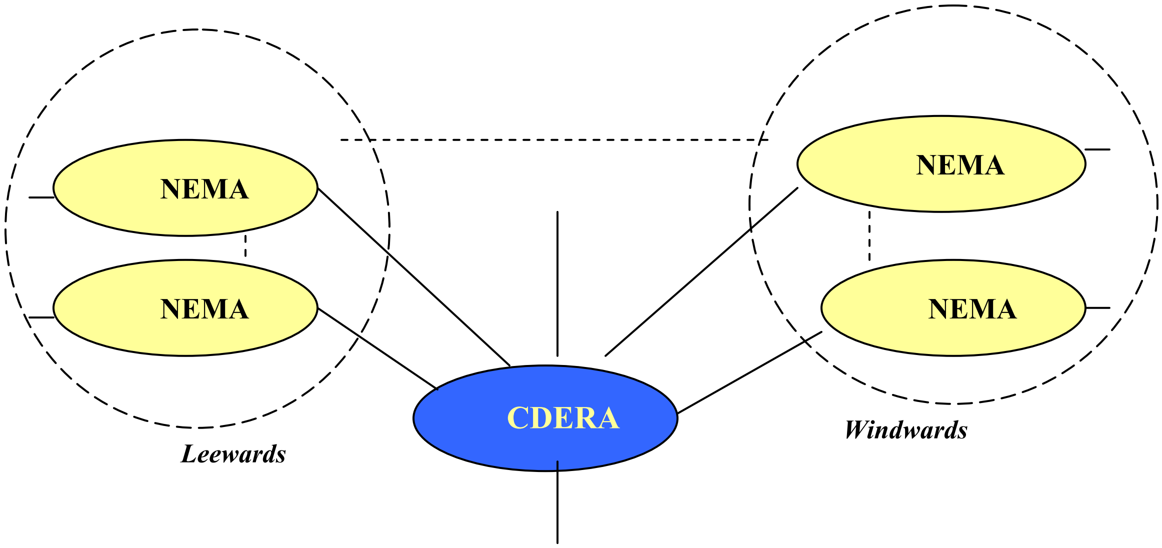

Figure 3.2 Nested case of national (island) emergency management organizations within OECS region

It is clear, as discussed in Chapter 2, that efficient disaster recovery requires cooperation and coordination at multiple levels across multiple jurisdictions. This case study allows the researcher to investigate the case at different scales of operation: 1) households at the community level; 2) organizations at the national (island) level and 3) the regional emergency response organization at the regional level. Efficient disaster recovery is expected to include the integration of mitigation strategies that build resistance into the society and economies of the affected communities. Contextually, the qualitative aspects of this study allow the researcher to understand the ties at various levels of jurisdiction from governing bodies, resource agencies, coordinating and rehabilitation agencies to affected households and communities. This case study seeks to identify the factors that influence these relationships and contribute to efficient disaster recovery, not only within a case, but also across the two cases of hurricane events.

Understanding the ties and the flow of information and resources between ties allows the researcher to determine the optimum patterns for information exchange and efficiency. The use of technology and geoinformatics as links between actors, for example, improves not only access to the geographical area, but also facilitates efficient and effective decision-making as well as communication among agencies, disaster managers and the affected. This case study explores the structures and limitations for geoinformatics and GIS application that are currently in practice in the disaster recovery process. As multiple agencies are working to rehabilitate the affected communities, they have a shared responsibility to build more resilient communities. Rehabilitation agencies including builders, planners, and funders as well as households need to understand their needs and capabilities in building resilience and avoiding damage or disruption to lives in future events. They also need to ensure that resources are channeled into the best option that provides a salient blend of rapid recovery and better, more resilient and safer structures. This knowledge and understanding will assist them to make better decisions when restoring buildings, infrastructure and utilizing resources, making the society and economy more resilient.

3.2 RESEARCH QUESTIONS

To explore the integration of mitigation strategies into disaster recovery activities in the comprehensive disaster management environment, this study will address the following three primary research questions:

1. To what extent do regional agencies, national governments, local builders, planners and households in the islands plan to integrate mitigation into recovery from hurricane-related disasters?

2. To what extent is an understanding of social networks and key actors in disaster recovery and mitigation important to, and utilized in, comprehensive disaster management?

3. To what extent does geoinformation shape the solution to the recurring failure of communities to mitigate following hurricane-related disasters?

Each of the above research questions require some additional questions to be asked. In this section, I outline the major tasks that I will undertake to answer the questions and highlight what each task is likely to contribute to the research questions. The research methods and data collection processes that are necessary to complete these tasks are further discussed in sections 3.5 and 3.6.

3.2.1 Research question 1: organizational-level mitigation integration

To address research question 1, I will utilize analysis of surveys and documents to perform the following:

- Characterize how households plan and manage mitigation,
- Conduct regression analyses of household responses to determine the impact of planning on disaster recovery and mitigation,

- Assess what measures household use to mitigate against damage and how many households use these measures.
- Identify what builders and designers use to build mitigation
- Determine how many builders use mitigation elements and the frequency of use.
- Determine how many national level rehabilitation agencies use mitigation activities, training and plans.
- Identify the types of mitigation plans and how they are implemented.

By completing these tasks, I will determine to what extent organizations at various level of society plan for mitigation integration and what steps, if any, need to be undertaken to improve integration.

3.2.2 Research question 2: understanding of disaster recovery social networks

To address research question 2, I will perform the following tasks:

- Examine a case study of disaster recovery following a hurricane-related disaster (Hurricane Ivan).
- Identify the key actors in the network and the role(s) they played in disaster recovery and mitigation.
- Identify the level of adaptation of the recovery system for each island.
- Determine if the type of network affects the level of self-adaptation of the disaster recovery system.
- Identify cliques which are likely to facilitate mitigation.

Upon performing these tasks, I will be able to characterize the disaster recovery system on each island as emergent, operative or adaptive. I will be able to identify the main actors through which information should be channeled as well as any network cut point that should be avoided or strengthened. Finally, these tasks will contribute to the knowledge of the existing networks and how they can be strengthened or tapped for mitigation integration. These tasks are addressed in Chapter 6.

3.2.3 Research question 3: role of geoinformatics

To assess how geoinformatics shape mitigation integration, I will first assess the geoinformatics capability among the various organizations and islands. This requires a survey of geoinformatics hardware and software, as well as human resource capacity. I will also identify the structure for use of geoinformatics and then inventory the current capacity for geospatial support in disaster management on the islands including the availability of geospatial datasets. Completing these tasks will enable me to determine if geoinformatics is used consistently in mitigation integration in the Eastern Caribbean. It will also enable me to identify gaps, strengths and weaknesses in the current disaster management system where geoinformatics can be relevant. These tasks are covered in Chapter 7.

3.3 SELECTION OF CASES

The selection of cases in this study was primarily based on 1) the event type and 2) the geographical area of concern. Hurricane events were selected as the hazard of concern because of several reasons:

1) Hurricane events have become more cyclical and tend to impact a significant population on an annual basis;
2) There were recent significant occurrences of hurricane events in the Eastern Caribbean over the past five years;
3) Hurricane events best reflect changes in disaster management policies in the Caribbean region;
4) Hurricane events have more distinct stages of preparedness, impact and recovery than most other cataclysmic events.

The two hurricane event cases: Hurricane Lenny (1999) and Hurricane Ivan (2004) were chosen because they were the most recent hurricane events to impact the geographical region of concern. They were also chosen because the path of the hurricanes enables the study to distinguish between events that impact different areas of the geographical region at different times. Hurricanes Lenny and Ivan unveiled the persistent lack of integration of mitigation into disaster recovery activities from past hurricanes. Significant damages were experienced on the affected islands despite previous occurrences of severe hurricanes and attempts to incorporate mitigation.

The Eastern Caribbean region was chosen as the geographical area for study because it represents one of the key areas of frequent hurricane activity that was readily accessible to the researcher. This study examines the recovery environment on seven islands in the Eastern Caribbean. These islands were chosen because (1) they experienced a hurricane-related disaster within the last decade, and (2) they are representative islands from the north, central and southern regions of the Eastern Caribbean, with similar socio-economic characteristics and institutions. They include:

- Barbados, St. Vincent and Grenada in the South (which were impacted by Hurricane Ivan)
- Dominica in the Center (which was impacted by Hurricane Lenny)
- Antigua, St. Kitts and Nevis in the North (Hurricane Lenny)

Though St. Kitts and Nevis (2 islands) represent one nation, Nevis functions almost autonomously to St. Kitts, so its recovery operations were considered separately from St. Kitts.

Figure 3.3 Map of the Caribbean[12]

(Source: World Atlas, 2006. URL: www.worldatlas.com)

[12] Note: The OECS islands are located in the Lesser Antilles. Also, all independent Caribbean nations are highlighted in red.

These developing islands are all vulnerable to natural and manmade disaster events. Their economies are fragile. In fact, Rossi and Freeman (1993) warn that the "the same factors that lead to self selection by some participants in a program may also account for their subsequent improvement, a change that can easily be mistaken as an outcome of the program."[13] For example, diversification in the economy may signal improvements in recovery and resilience despite lack of change towards mitigation among households and rehabilitation agencies.

Hurricane Lenny was an unusual hurricane event because of its predominantly west to east track. Yet, it impacted the livelihood of St. Kitts, Antigua and Dominica significantly. Hurricane Ivan devastated Grenada and also impacted St. Vincent and Barbados. Both of these cases examine the experience of NEMA, rehabilitation agencies and households in incorporating mitigation into their recovery activities. The effective exchange of information between these units is vital to improve the delivery of mitigation into structural and non-structural recovery activities. The purpose of examining these two cases therefore is to determine what mechanism facilitates the mitigation process and how geoinformatics improves the efficiency of this process.

3.4 UNITS OF ANALYSIS AND OBSERVATION

The unit of analysis in this study is the organization. At the macro (regional) and meso (national) levels, the organization refers to the rehabilitation agency or a government agency department such as Public Works. At the micro-level, it refers to the

[13] Rossi and Freeman. 1993.

household. In both cases, the study focuses on the primary organization, the national emergency management agency. The interactions of this agency with other key developmental and disaster rehabilitation agencies are essential in understanding the disaster recovery process. Therefore, development agencies such as the Department of Planning and the Department of Public Works are considered as lead agencies for development and disaster recovery. These agencies together with NEMA form the core for the administrative implementation of mitigation on each island. Besides these agencies, community-based agencies such as Grencoda in Grenada and non-governmental rehabilitation agencies such as the Red Cross and local construction companies contribute to the physical implementation of mitigation because of their direct contact with and assistance to impacted households. By examining these groups of organizations, the study will be able to better describe the functional mechanisms to integrate mitigation into disaster recovery activities. Table 3.1 outlines the two cases by the organizations studied.

The unit of observation at the macro and meso- levels is the director of planning, the head of the national disaster response and rehabilitation agency or the manager or sole proprietor of construction and architectural companies. At the micro-level, the unit of observation is the head of the household. This study examined the actions, interactions and behavior of disaster recovery agents to determine how their organizations perform in integrating mitigation into disaster recovery. This in turn helps to determine how the disaster recovery functions and whether it adequately accommodates mitigation in the process.

Table 3.1 Outline of cases

	Case 1: Hurricane Lenny, 1999	**Case 2: Hurricane Ivan, 2004**
Islands	**St. Kitts Nevis Antigua Dominica**	**Grenada Barbados St. Vincent**
Primary Organization per island	**St. Kitts National Emergency Management Agency (NEMA) Nevis Emergency Management Agency (NEMA) Antigua National Office of Disaster Services (NODS) Dominica Emergency Response Agency (NERA)**	**Grenada National Disaster Management Agency (NaDMA) Barbados Central Emergency Response Organization (CERO) St. Vincent National Emergency Management Organization (NEMO)**
Rehabilitation Agency	*St. Kitts:* **Department of Planning St Kitts Red Cross** *Nevis:* **Department of Planning Nevis Historical & Conservation Society (NGO)** *Antigua:* **Development Control Authority Environment Action Group (EAG)** *Dominica:* **Public Works Public Utilities Dominica Red Cross**	*Barbados:* **Public Works Architect Association** *Grenada:* **Grenada Red Cross Grenada Housing Authority Grencoda (NGO)** *St. Vincent:* **Department of Planning St. Vincent Red Cross Project Planning (NGO)**
Analytical Framework	**CDERA Regional Structure Establishment of Disaster Management or Recovery Centers Disaster Management and Recovery Plans Mitigation Plans Responsibility and Coordination of NEMA Integration of Development Planning and Disaster Management Involvement of Support and Complementing Agencies Assessment and Involvement of Local Communities Integration of Structured Networks Use of Information Technology and Geocollaboration**	

3.5 RESEARCH METHODS

One of the greatest aspects of modern day social science research is its flexibility and ability to accommodate multiple research methods and multiple data sources. This research is conducted using qualitative, quantitative and spatial methods of observation within an exploratory framework of case studies. According to Denscombe (2000), case study research "allows the researcher to use a variety of sources, a variety of types of data and a variety of research methods as part of the investigation."[14] This design employs interviews, surveys, social network analysis, document analysis and spatial mapping to triangulate among different methods rather than use a single style of research. King, Keohane and Verba (1994) suggest that such cross-fertilization among different forms of analysis can increase the internal validity of the study while achieving more precise estimates of the social ends. Hinds & Young (1987) confirmed that "combining different methods in research enhances the description of a process under study; identifies the chronology of events and serves to corroborate or validate the process for study findings."

Quantitative and qualitative approaches are associated with distinct epistemologies, (positivist and non-positivists respectively), but can coexist in the same study (Yin, 2003). Reichardt and Cook [1979] defined quantitative methods as those which encompass "the techniques of randomized experiments, quasi-experiments, paper and pencil "objective" tests, multivariate statistical analysis, sample surveys, and the like", while qualitative methods as those which comprise "ethnography, case studies, in-depth interviews, and participant observation." Though they have different ontology,

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[14] Denscombe, *The Good Research Guide*, 31.

epistemology and methodological assumptions, quantitative and qualitative methods allow for a rich cross-fertilization of methodologies that make exploratory design more viable. In addition, spatial methods of observation combine both quantitative and qualitative methods on a spatial scale and are often reflected in maps and attributes related to the spatial distribution of data and information.

Quantitative and qualitative methods of inquiry have different strengths in research and hypotheses validation. The quantitative method of inquiry is more precise in terms of initial hypothesis formulation, measurement and evaluation (that is rejection or acceptance) while qualitative inquiry is more permissive in its formulation of new hypothesis. The strength of quantitative methods lies in the ability to identify correlations among socioeconomic and other characteristics. The strengths of qualitative methods rest on their ability to describe and contextualize phenomena, and their respective processes, motivations, events and actions. Qualitative methods also capture the interplay that occurs over time between structure and agency or agents. Together, these two approaches provide a clearer understanding and interpretation of the events and phenomena and their implications for societal change.

3.5.1 Quantitative Methods

In this study, I conducted surveys of three rehabilitation groups: households; designers and builders; and emergency management agencies. The household survey garnered information on experience with hurricanes and actions taken to recover if impacted by the hurricane event. This survey helped to identify the factors that influence household recovery and how households incorporate mitigation into structural recovery.

The second survey was intended to identify how designers and builders communicate and coordinate with households and planning authorities with respect to construction and reconstruction. The final survey of national emergency management agencies served to gather information on the status and utility of geoinformatics in disaster management on the island. All three surveys also served to crosscheck with the reports, observations and interviews conducted with local and national officials.

3.5.2 Qualitative Methods

I conducted interviews of emergency management agencies and other rehabilitation agencies to get an in-depth assessment of the recovery process and the role and responsibilities of these agencies. Semi-structured questions were developed from preliminary document review. Information from interviews was used to supplement findings from other methodologies as well as suggest new paths for analysis.

3.5.3 Mixed Quantitative and Quantitative Methods

In this study, I conducted a content analysis of the leading (weekly) newspaper on each of the islands for a period of 6 months, i.e. from 2 reporting periods before the event (usually two weeks) to 5 and 1/2 months after the hurricane event. For the islands that were directly impacted by Hurricane Lenny, the period November 1, 1999 to April 30, 2000 was used. For islands in the Hurricane Ivan case study, the period September 1, 2004 to February 28, 2005 was used.

Geospatial methods including both descriptive and quantitative data distributed spatially throughout the country. I collected data on digital census data as well as hazard maps, damage assessment maps and models throughout 2005.

3.5.4 Reliability and Validity

To improve the utility of this study, I took several steps to ensure the reliability, credibility and validity of the research findings. The credibility of findings in this case study was improved through extended engagement in the field face-to-face to build trust with participants, contact with interviewees to gather information and documents up to two months prior to the interviews, field observation to provide depth of understanding; and triangulation of data sources. Since the cases existed prior to the research project and the documentation remained after the research was completed, the findings based on documentation and accounts of the hurricane events are highly replicable and reliable.

Reliability

Reliability refers to consistency or replicability of the measure. Though there are several methods to test the reliability of the measurements, Cronbach's alpha value[15] for determination of internal efficiency best fits this study. It measures the ratio of the variance between the actual score and the measured score, where the closer to 1 the ratio is, the higher the reliability of the measure. For this study, I assumed the widely-accepted social science alpha value of .70. For internal consistency, pre-analysis data screenings

[15] Cronbach's formula: Alpha = Np/[1+p(N-1)], where N is equal to the number of items in a scale and p is equal to the mean inter-item correlation.

(missing value, outliers) were conducted to ensure the assumptions for correlations and multivariate analysis are met.

Internal Threats to Validity of Study

Analysis of the internal validity of the measures in this case study indicates that construct, context, instrumentation, history, selection and interaction may pose the most likely threats. However, all of these threats are minimized through rigorous research methods and analyses. The use of standardized interview and survey instruments reduces the threat of instrumentation. The threat of selection was addressed by the random selection of survey participants and the selection of interview organizations based on the historical records of participation in disaster recovery. The large sample sizes of 385 households and 58 designers and builders improve the statistical validity and reliability of the study.

The threats of construct and context validity were addressed by grounding the research in previous studies and practice in comprehensive disaster management. This research was constructed on systems theory, complexity and information and knowledge communication, mitigation and disaster recovery, which are well defined and validated in the literature (Mileti 1999; Rosenthal, Boin & Comfort 2001). Furthermore, the context of the study is relevant to the issue of disaster recovery and mitigation. The islands in this study are similar: geographically, geologically, culturally and politically. They also have similar socioeconomic conditions. All the islands are exposed to the same threat of hurricanes and storms during the hurricane season every year. They were affected by a single disastrous (hurricane) event in the last year and on similar occurrences over the last fifteen years (1989-2004). They all experienced moderate to severe level of damages and thus require at least a minimum level of recovery activity. Furthermore, the islands in the northern band or those in the southern band have also been struck by a single disastrous event for each occurrence over the last fifteen years. Therefore, any time-dependent differences are minimized in each band of islands and the sub-region as a whole. Finally, the proposed modified bow-tie model is validated through Comfort's (1999) model of Shared Risk.

External Threats to Validity of Study

The three most common threats to external validity include (1) the reactive effect of testing and experimental arrangements; (2) multiple treatment interference; and (3) interaction effects of testing. Since this study is not based on multiple experimentations, but rather on one-time case studies, the threats of multiple treatment and reactive effect are irrelevant. The third threat refers to the generalizability of the study due to the interactions between selection biases and the variables in the study. The analysis of quantitative aspects of this study that meet the assumptions for the statistical analyses performed allows some findings from this study to be generalized to other regions and hazards. The qualitative analysis in this study also allows the findings of these two case studies to be applied to understand similar situations in different locations through "naturalistic generalization."[16] Through this process, other researchers can use the same clearly defined research design and methodologies in this study to compare or translate situations to form useful generalizations for other cases and findings. Social network analysis draws on validations in both quantitative and qualitative methods to allow the study to make valid claims on statistical findings and network assessments.

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[16] Janet Schofield, "Increasing the Generalizability of Qualitative Research," In *Case Study Method* eds. Roger Gomm et al (London: Sage Publications, 2000: 75).

While I have narrowed this study to two particular hazard events, I also chose to consider recovery from a holistic, comprehensive disaster management perspective. This allowed for scaling-up to a regional level within the nested framework described earlier. Focusing on triangulation of methods and sources as well as a holistic approach increases the validity of this study.

3.6 DATA COLLECTION

Data for this case study research was collected from multiple sources using various instruments. These sources and instruments included both primary and secondary sources: survey questionnaires, semi-structured interviews, visual examination of geoinformation infrastructures for disaster management, observation of workshops and training exercises, observation of reconstruction activities, documents, numerical records, reports, published and unpublished articles and information networks. Creswell (1998) and Yin (2003) point out that case study research involves a diverse array of data collection tools, yet these tools do not have individual advantages, but complement each other in building an in-depth picture and finding truth. The initial focus of this study was on documentation review. This provided a foundation from which to develop protocols and instruments for interviews and surveys. This process also validated the relevance of this study, particular in the research overview.

3.6.1 Review of Documentation

This study reviewed historical and current documents that relate to comprehensive disaster management and the specific hurricane event on each island. Some of these records were primary source records as they included first hand written accounts from persons directly affected by the hurricane. Most of the records were secondary source historical records of the hurricane event including census data, annual reports, situation reports and management documents.

I reviewed and followed reports of the hurricane incidents via the Internet at ECLAC, CDERA, EM_DAT, World Bank, OAS and national websites from November 2004 through April 2005. This enabled me to develop field instruments for data collection. The survey and interview instruments were tested initially at the University of Pittsburgh and then field-tested in Nevis at the end of April before the final instruments were developed.

In 2005, CDERA established a comprehensive database which includes types of disasters, types of hazards, countries affected, numbers of casualties and fatalities, number of buildings/facilities lost or damaged, including schools, utilities, health care institutions, roads, hotels, commercial/industrial properties, parks and beaches and agricultural properties. CDERA plans to harmonize the database with the Global Unique Disaster Identifier Number (GLIDE) system and feed this information into the EM_DAT international database. These data were subsequently used to validate data on actual economic loss from other sources.

Spatial data collection

I reviewed spatial data available for hazard mapping, disaster assessment, damage assessment, disaster management and development planning for each of the islands. I obtained digital copies of detailed spatial data from three of the islands: Nevis, St. Kitts and St. Vincent. These data include satellite imagery and *shapefile* data that I utilized in spatial analysis and tool development in chapter 7. The other four islands either did not have data readily available or the process of acquiring the data was too time-consuming, expensive and complicated to follow-through.

3.6.2 Direct Observations

I conducted two official field trips for the data collection purposes in May 2005 and July to August 2005. However, I took photographs and made personal accounts of Hurricane Lenny through visits to the region in 2000, 2002, 2003 and 2004.

Field Trip 1: May 2005

I went to the Eastern Caribbean in May 2005 and spent three weeks on St. Kitts, Nevis, Antigua and Dominica to observe long-term recovery and rehabilitation activities on the islands as well as to administer surveys. During this period, I also collected copies of government documents such as disaster management and recovery plans, spatial data, statistical reports and newspaper articles from archives.

Field Trip 2: July – August 2005

I went back to the Eastern Caribbean in July 2005 and spent three weeks on Barbados, Grenada and St. Vincent to observe medium-term recovery and rehabilitation activities on the islands as well as to administer surveys. I observed reconstruction of homes, participated in ongoing training workshops and observed and documented recovery activities within the sample areas.

3.6.3 Semi-structured interviews

Formal and informal interviews were used in this study. Unlike documents, interviews provide face to face interaction, which allows the researcher to observe the emotions and reactions of the interviewee as well. Such non-verbal communication is essential in developing the full context of the study. In addition, more in-depth knowledge of the transactions that occur during the recovery period of the hurricane event could be obtained through the careful selection of interviewees. Each interviewee was audio-taped to allow the researcher to focus more on the interviewee as well as to provide the opportunity to replay interviews for clarity. At the national (island) level, I selected organizations based on reports of their participation or affiliation with the disaster recovery process (purposeful sampling). I attempted to interview the primary disaster recovery or management organization and two or three other key support rehabilitation agencies with at least one being a non-governmental or community-based organization (Table 3.3). All interviews were pre-arranged before the field visit, but some interviews were repeated rescheduled and final attempts to conduct telephone interviews were unsuccessful. At the regional level, I interviewed the designee of the director of CDERA and the information coordinator. The national and regional agency interview questionnaires are listed in Appendices C1 and C2, respectively.

Table 3.2 Number of organizations contacted & successfully interviewed

Island	National Emergency Response Agency Interview	National Rehabilitation Agency/ Affiliated Department Interviews	Regional Organization (CDERA) Interviews
Antigua	1 (1)	2 (3)	0
Barbados	1 (1)	1 (3)	2 (3)
Dominica	1 (1)	3 (3)	0
Grenada	1 (1)	3 (3)	0
Nevis	1 (1)	2 (3)	0
St. Kitts	1 (1)	2 (3)	0
St. Vincent	1 (1)	3 (3)	0
Organizations interviewed	**7**	**16**	**2**
NB: The number in brackets ( ) represents the number of organizations from which interviews were requested.			

Selection of Regional Organization

The regional organization, CDERA that will be studied in this research is selected through purposeful sampling because CDERA provides important information about disaster management in the OECS that cannot be obtained as well and as readily from other sources[17]. CDERA is the lead agency with an authorized mandate from all OECS islands and other Caribbean islands to oversee disaster management in the region. CDERA has been in existence since 1991 but grew out of older initiatives. It functions in the active, dynamic hurricane-related disaster environment and provides a rich source for understanding the critical issues associated with disaster recovery and mitigation from a regional perspective.

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[17] Maxwell, Joseph. "Designing a Qualitative Study." Handbook of Applied Social Research Methods. Ed. Leonard Bickman and Debra J. Rog (Thousand Oaks, CA: SAGE Publications, 1998) 87.

3.6.4 Structured survey design, sampling and process

I collected data using structured questionnaires to document and validate the experience of households, designers and builders during the recovery phase as well as determine the capacities of the national emergency agencies to utilize geoinformatics in disaster recovery. The surveys included both open- and closed-ended questions. All household surveys were administered by the researcher and a trained assistant (*Appendix E1*). The designer and builder surveys were first administered in person and then follow-up surveys were sent through fax or email to the sample list (*Appendix E2*). During the semi-structured interviews, I conducted surveys of national rehabilitation agencies (*Appendix E3*). The geoinformatics survey was conducted via email (*Appendix E4*). Copies of all survey instruments are included in Appendix E.

Sampling of Households

A cluster sampling approach was used to select households for the survey. An urban and a rural area were first purposively selected based on review of reports on the area impacted by the hurricane event. Once the area was selected based on stratification, the population size for the affected area was determined from the 2000 census distribution. The sample size for each affected area was set at 30 households. The area was divided into 4 quadrants. Two quadrants were then randomly chosen for survey purposes and the area population was halved. The resulting number was divided by 30 (the desired number of survey participants) to determine the sampling fraction. Table 3.3 shows the sampling fraction for each district within each island for a sample size of 30 per district. For example, for St. Vincent – Georgetown has 5,000 households. Therefore the sampling fraction will be one in every 83 households. A random number between 1 and 83 was used to generate the first household to survey. I first tried to survey the head of the household. However, if the head of household was not available, his or her partner or designated adult representative was surveyed.

Table 3.3 Household sampling calculation, by island and district

Country	Urban District	Households*	Sample	Rural District	Households	Sample
Antigua	St. John's	7,000	1:35	Swetes/ Liberta	3,010	1:15
Barbados	Bridgetown (Central)	14,000 (10,000)	1:50	St. Lucy	2,230	1:10
Dominica	Roseau	4,815	1:25	Soufriere	2,297	1:10
Grenada	Georgetown	9,985	1:40	St. John's (Guayave, Grand Roy, Concord)	2,740	1:11
Nevis	Charlestown	2,000	1:10	Gingerland	1,984	1:10
St. Kitts	Basseterre	8,500	1:40	Cayon	4,381	1:20
St. Vincent	Kingstown	10,000	1:50	Colonarie-Byrea	1,432	1:7

**Based on extrapolation of 2000 Census data for each island (See references).*

Sampling of Designers and Builders

I obtained a list of all designers (architects and draughtsman) and builders who have listed their intent of provide architectural or construction services through the building control or planning authority on each island. This list was derived from the forms that applicants for building permits must submit. The form requires the applicant to list the designer and proposed builder. The list was then substantiated with designers and builders listed in the local yellow page directory. A sample of 10 builders and 5 designers was chosen from the complete list using random number generator tables. The owner or head of each company was then surveyed.

Table 3.4 provides the final response rate to the surveys by island. Eighty-one percent of the households and builders surveys were successfully completed, while all (7) national emergency response agencies returned the geoinformatics survey.

Table 3.4 Distribution and response rate for surveys, by type and island

Island	Completed Household Surveys *(Island sample size = 60: 30 urban; 30 rural)*	Household Response Rate	Completed Builders' Surveys and Response Rate *(Island sample size = 15)*	National Emergency Response Agency Geoinformatics Survey
Antigua	51	85%	7 (47%)	1 (100%)
Barbados	30	50%	6 (40%)	1
Dominica	55	92%	8 (53%)	1
Grenada	56	93%	8 (53%)	1
Nevis	33	55%	11 (73%)	1
St. Kitts	60	100%	8 (53%)	1
St. Vincent	57	95%	10 (66%)	1
	342	**81%**	**58 (55%)**	**7**

3.7 DATA ANALYSIS

The data collected from the various sources was analyzed using various methods to determine the relationships among rehabilitation agents and answer the research questions discussed earlier.

3.7.1 *Analysis of Documents*

During the first phase of document analysis, I reviewed existing documents to determine the structure for management of recovery at the national and regional level. These documents included national disaster management plans, mitigation plans, recovery plans among others. Through this process, I was also able to identify the bureaucratic structure as well as normative structure for disaster recovery.

In phase 2, I examined the documents to decipher patterns of coordination and the relationships that were keys in the recovery process. In this phase, I utilized content analysis of newspaper and documents, and network analysis to identify network characteristics that hinder or facilitate efficient mitigation and recovery. I utilized inductive codes to examine the content data. I entered the data from newspapers in an Excel spreadsheet that listed the organization, jurisdiction and interaction; then used output from this spreadsheet to analyze networks in *UCINET 6.0*. Network analysis was used to analyze the social structure of the disaster recovery and mitigation processes by identifying the positions and roles of the different actors. Applying Social Network Analysis enabled the researcher to study the interactions among organizations and households. Organizations or processes with higher redundancies and higher levels of cognitive demand have higher resilience and adaptability (Carley 2004).

In phase 3, I utilized documents to investigate the status of geoinformatics in disaster recovery and comprehensive disaster management. I investigated the development and utilization of hazard mapping, vulnerability assessment, damage assessment and recovery mapping. This process fed the spatial analysis of data described later in this section. The results of this review and analysis are discussed in chapters 4, 5 and 6.

3.7.2 *Analysis of Survey Data*

Once the surveys were obtained, they were verified, cleaned, preliminarily coded and entered into SPSS. They were further coded in SPSS after preliminary analysis was conducted on the frequencies. Additional quantitative analysis, including multivariate analysis and comparison of means was then used to further identify the interdependence in relationships and how the various factors influenced the level and effectiveness of disaster mitigation and recovery as well as information exchange. The results of this analysis are fully discussed in chapter 5.

3.7.3 *Analysis of Interviews*

I transcribed all interviews and entered the closed ended portions of the interview (including frequency of information exchange) into SPSS. I collated the interactions with agents from the transcribed interviews in Microsoft Excel and exported the data to UCINET 6.0 for further analysis and illustration of networks. I also assessed the attitudes of participants toward mitigation and disaster recovery; information sharing and geoinformatics. Their attitudes may be dependent on jurisdiction as well as the culture of operations during a disaster event. I used simple networks to describe how they operate and interact during disaster recovery and the type of information exchange that occurs. The results of this analysis are discussed in chapters 5 and 6.

3.7.4 *Analysis of Spatial Data*

I analyzed all spatial data in ESRI ArcGIS 9.0 to examine the spatial distribution of factors related to disaster recovery and mitigation. By overlaying hazard maps, with actual damage assessment maps, I was able to identify the areas with the highest vulnerability to the hurricane event. I then used this information to develop a web-based tool (using *Postgres*, *PostGIS and webapp*) that may assist in synchronizing structural mitigation and development both before and after a disaster event. The results of this analysis are discussed in chapter 7.

3.8 SUMMARY

In this case study research, a multiple methods approach including qualitative and quantitative research adds reliability and validity to the findings. Triangulation of methods helps to cover gasps in research methods and eliminate threats to validity. Case study design allows the researcher to get an-depth understanding of the hurricane events of Lenny in 1999 and Ivan in 2004 to examine the mechanism for integration of mitigation into disaster recovery. Qualitative methods of inquiry were used to gather a deeper understanding of the characteristics of the organizations involved in disaster recovery and their interactions, actions and interoperability issues that influence the integration of mitigation. These findings can be applied to understand similar situations. Quantitative deductions provided scalable findings that influence policy and decision making in other islands and regions. The study of a single hazard does not restrict the generalizability of this research to hurricanes because the administrative structure utilized in the management of disasters in the Eastern Caribbean is the same for all hazards.

This exploratory study at different jurisdictional levels: local, national and regional allows this research to examine relationships within and between cases to determine what mechanisms are appropriate for mitigation integration. Analysis of each case allows the researcher to determine patterns of coordination and communication that would facilitate information exchange and in turn lead to mitigation and efficient disaster recovery. The next chapter discusses the two cases in detail while subsequent chapters elaborate on the research findings.

4.0 COMPREHENSIVE DISASTER MANAGEMENT IN THE EASTERN CARIBBEAN: LINKING MITIGATION AND RECOVERY

The "sustainability of the Caribbean islands is inextricably linked to how we managed hazard risks[18]." The economic disruption and social dislocation in Caribbean economies are highly associated with multiple, frequent and somewhat inevitable hazard events. This chapter discusses the state of disaster management in the Caribbean in reference to comprehensive disaster management, development and geoinformatics. The first section (4.1) provides useful context to understand the islands in this case study better. It provides an overview of the geopolitical structure of the Caribbean and the OEC sub-region in particular, as well as a description of the socio-economic conditions for the study area.

The remainder of this chapter is divided into seven sections. Section 4.2 gives an account of the recent history of hazards and disasters in the Caribbean with special focus on cataclysmic hazards including hurricanes, earthquakes and volcanic eruptions. It also provides an overview of the disaster management problems facing the Caribbean archipelago region, particularly the islands in this case study. In section 4.3, I discuss the national and regional mechanisms that have been institutionalized to manage disasters. I also discuss the various approaches to disaster management in the region. Then in

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[18] Remarks of Jeremy Collymore, the Coordinator of CDERA at the 15th CDERA Council Meeting on Friday June 30th, 2006 in St. Kitts and Nevis. Speech accessed from CDERA website (www.cdera.org/cunews/speeches) on July 1, 2006.

section 4.4 I explain the tools for hazard mitigation and disaster reduction that are employed in the region, particularly in the case of hurricanes. In section 4.5, I provide an overview of the utility of geoinformatics in disaster management in the OECS and the larger Caribbean. Section 4.6 discusses networks and the extent of capacity building for comprehensive disaster management and sustainable development in the region. Finally in section 4.7, the chapter concludes with a geospatial summary and major shortcomings and needs for comprehensive disaster management and how these relate to the overall goals of this study.

4.1 GEOPOLITICAL STRUCTURE & SOCIO-ECONOMIC CONDITION OF THE CARIBBEAN: THE OECS SUB-REGION

The Caribbean in this dissertation research refers to the insular Caribbean including the Caribbean Sea and its islands from Cuba and the Bahamas in the northwest to Trinidad and Tobago in the southeast (Figure 4.1). The Caribbean experiences a maritime climate with little seasonal temperature variation. The current geopolitical structure in the Caribbean was shaped by contiguity among the islands as well as historical interactions through political, economic, cultural and imperial associations.[19] This geopolitical structure influences the overall system of comprehensive disaster management. It shapes the system as well as leads it to new equilibria.

[19] Cohen describes this geopolitical structure as part of a global geopolitical structure where the maritime (regional) realm sits atop a hierarchical structure, and an intermediate (sub-regional) structure exists at a lower level, before the final level of hierarchy at the national state level. At the national state level, Cohen adds that the states are ordered hierarchically by power positions and functions.

There are two major political organizations that currently promote uniformity and integration of functions among the Caribbean island states: the Organization of Eastern Caribbean States (OECS) and the Caribbean Common Market (CARICOM). Caricom is the larger of the two organizations and includes islands from the wider Caribbean (including both Lesser and Greater Antilles) in figure 4.1. The OECS, on the other hand, concentrates on the smaller English-speaking islands in the Lesser Antilles.

Figure 4.1 Detailed Map of the Caribbean[20]
(Source: World Atlas, 2006. URL: www.worldatlas.com)

4.1.1 The Eastern Caribbean: The OECS and Barbados

This research focuses on the OECS and Barbados in the Eastern Caribbean sub-region. The Eastern Caribbean (EC) sub-region in the Caribbean is defined as the area geographically situated between of 19.5 degrees North and 10 degrees North, and 68

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[20] Note: The OECS islands are located in the Lesser Antilles. Also, all independent Caribbean nations are highlighted in red.

degrees West and 60 degrees West. The EC islands are washed by the Caribbean Sea on the west and the Atlantic Ocean on the east. The islands of Anguilla, Antigua-Barbuda, Montserrat and St. Kitts-Nevis lie to the north of the group above 17 degrees North. Dominica lies in the middle of the group just north of 15 degrees, while St. Lucia, St. Vincent and the Grenadines, Grenada and Barbados lie to the south of the group below 14 degrees north. Since Dominica lies in the center of general hurricane belt through this region, we will assume that it is impacted to some degree by the majority of storms that directly impact the EC islands. The group of islands to the North is also referred to as the Leewards while those to the south including Dominica are referred to as the Windwards. Montserrat and Anguilla are British dependencies, but the other islands: Antigua-Barbuda, Barbados, St. Kitts-Nevis, Dominica, St. Lucia, St. Vincent and the Grenadines and Grenada are all independent nations within the British Commonwealth.

Barbados is part of the Eastern Caribbean, but is not an official member of the OECS. Yet, it systematically engages in several initiatives with the OECS and is fittingly included in this study. It is also the headquarters of the regional disaster response agency (CDERA). Legally, the Eastern Caribbean Supreme Court presides over the Courts of Summary Jurisdiction in the OECS while the Barbados Supreme Courts presides over Barbados affairs. Barbados has its own currency that floats at about $2.00 BDS to $1US. The OECS islands, on the other hand, have a single currency that is pegged at EC$2.67 to the $US1.00.

4.1.2 Comparative Description of Islands in this Case Study

The majority of the Eastern Caribbean islands are of volcanic origins with central mountains, except Antigua and Barbados which are low-lying limestone islands (Table 4.1). The most prevalent natural disasters have been hurricanes and tropical storms, but landslides remain a critical hazard due to steep slopes and poor construction practices on most islands. Islands that are more mountainous are more likely to accentuate the effect of windstorms. On the other hand, islands that are more low-lying and have longer coastlines are more likely to be impacted by elevated waves.

Table 4.1 Comparative natural characteristics of Case Study Islands

Parameter	Antigua	Barbados	Dominica	Grenada	St. Kitts-Nevis	St. Vincent
Length of coastline	153 km	97 km	148 km	121 km	135 km	84 km
Comparative area	280 sq. km *(approx.1.5x Washington D.C.)*	431 sq. km *(approx. 2x Washington D.C.)*	754 sq. km *(approx. 4x Washington D.C.)*	344 sq. km *(approx. 2x Washington D.C.)*	261 sq. km *(approx. 1.5x Washington D.C.)*	344 sq. km *(approx. 2x Washington D.C.)*
Terrain	Mostly low-lying	Mostly low-lying	Rugged mountains of volcanic origin	Volcanic origins with central mountains	Volcanic with mountainous interiors	Mountainous of volcanic origins
Highest Point	402 m	336 m *Mt Hillaby*	1,447 m *(Morne Diablatins)*	840 m *(Mt Saint Catherine)*	1,156 m (*on St. Kitts, Mt. Liamuiga)* 1,000 m *(Nevis Peak on Nevis*)	1,234 m *(La Soufriere)*
Prevalent natural hazards (1980-2005)	Hurricanes, tropical storms, periodic drought	Infrequent hurricanes and tropical storms, periodic landslides	Frequent hurricanes, landslides & flashfloods	Infrequent hurricanes and tropical storms, periodic landslides	Frequent hurricanes & tropical storms	Hurricanes, tropical storms, volcanic threat

Antigua has a very high ratio of mobile phone users and Internet users (Table 4.3). This suggests that the technology exists for high level communication among households and disaster management agencies.

Table 4.2 Comparative descriptive statistics of Case Study Islands

Parameter[21]	Antigua	Barbados	Dominica	Grenada	St. Kitts-Nevis	St. Vincent
Population (2005)	69,108 (July 2006)	279,912 (2005)	68,910 (2005)	89,703 (July 2006	39,129 (July 2006)	117,848 (July 2006)
Per Capita GDP (PPP, 2005 est.)	$10,900	$17,300	$3,800	$3,900	$8,200	$3,600
Labor force	30,000	128,500 (2001)	25,000 (1999)	42,300 (1996)	18,170 (June 1995)	41,680 (1991)
Unemployment rate**	11% (2001)	10.7% (2003)	23% (2000)	12.5% (2000)	4.5% (1997)	15% (2001)
Population below poverty line (Est.) *	n/a	n/a	30% (2002)	32% (2000)	n/a	n/a
Mobile cellular***	54,000	206,200	41,800 (2004)	43,300 (2004)	10,000 (2004)	70,600 (2005)
Internet users****	20,000	160,000	20,500 (2005)	19,000 (2005)	10,000 (2002)	8,000 (2005)
Internet country code	.ag	.bb	.dm	.gd	.kn	.vc
Legislative branch	Bicameral: 17 member parliament	Bicameral: 21 member Senate; 30 member House of Assembly	Unicameral: 30 member House of Assembly	Bicameral: 13 member Senate; 15 member House of Assembly	Unicameral: 14 member House of Assembly	Unicameral: 21 member House of Assembly
Date of Independence	November 1, 1981	November 30, 1966	November 3, 1978	February 7, 1974	September 19, 1983	October 27, 1979
Administrative divisions (parishes)	6	11	10	6	13	6

[21] A nation's GDP at purchasing power parity (PPP) exchange rates is the sum value of all goods and services produced in the country valued at prices prevailing in the United States. Per capita is based on mid-year population.

*National estimates of the percentage of the population falling below the poverty line are based on surveys of sub-groups, with the results weighted by the number of people in each group. Rich nations employ more generous standards of poverty than poor nations.

**This entry contains the percent of the labor force that is without jobs. Substantial underemployment might be noted.

***This entry gives the total number of mobile cellular telephone subscribers.

****This entry gives the number of users within a country that access the Internet. Statistics vary from country to country and may include users who access the Internet at least several times a week to those who access it only once within a period of several months.

Almost 1/4 of the eligible workforce is unemployed (table 4.7). This is compounded by a low GDP per Capita and an economy highly dependent on agriculture. More than 30% of the population falls below the poverty line. Natural disasters often impact the banana-led economy heavily, and any economic loss through disasters is likely to affect the poor more adversely than others. Of note, however, is that Dominica has a good communication infrastructure that can facilitate rapid disaster response through Internet and mobile technology.

Antigua-Barbuda

Antigua-Barbuda is a twin island state that lies in the Leeward Islands between 61°30’ and 62°00’ West longitude and 17°00’ and 17°45’ North latitude (Figure 4.2). Households in the urban parish of St. John’s in the northwest and the rural parish of St. George, which includes the villages of Swetes and Liberta were surveyed in this case.

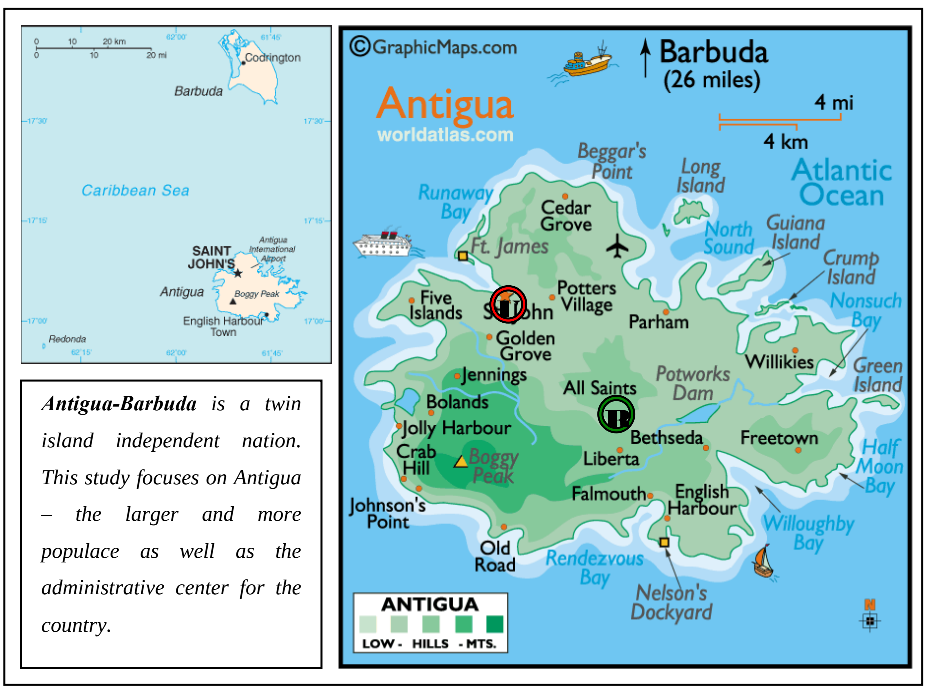

Figure 4.2 Location of the household survey study areas on Antigua

(Source: World Atlas, 2006. URL: www.worldatlas.com)

Barbados

Barbados is the easternmost Eastern Caribbean island and lies between 61°30’ and 62°00’ West longitude and 17°00’ and 17°45’ North latitude (Figure 4.3). It is a low-lying limestone island. The main urban area, Bridgetown and the rural parish of St. Lucy were examined in this case.

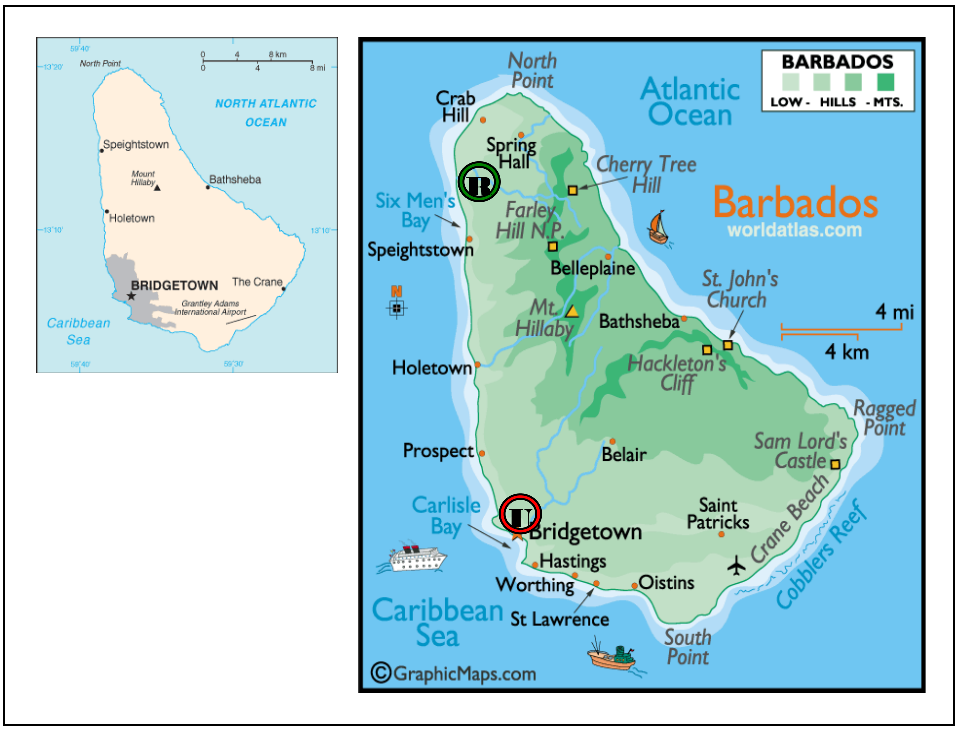

Figure 4.3 Location of Barbados and study areas

(Source: World Atlas, 2006. URL: www.worldatlas.com)

Dominica

Dominica lies at the northern tip of the Windward Islands between 61°10’ and 61°30’ West longitude and 15°10’ and 15°40’ North latitude (figure 4.4). Dominica is known as "The Nature Island of the Caribbean" due to its spectacular, lush, and varied flora and fauna, which are protected by an extensive natural park system; the most mountainous of the Lesser Antilles, its volcanic peaks are cones of lava craters and include Boiling Lake, the second-largest, thermally active lake in the world. The urban area, Roseau and the rural villages of Soufriere and Scotts's Head on the south of the island were examined in this case.

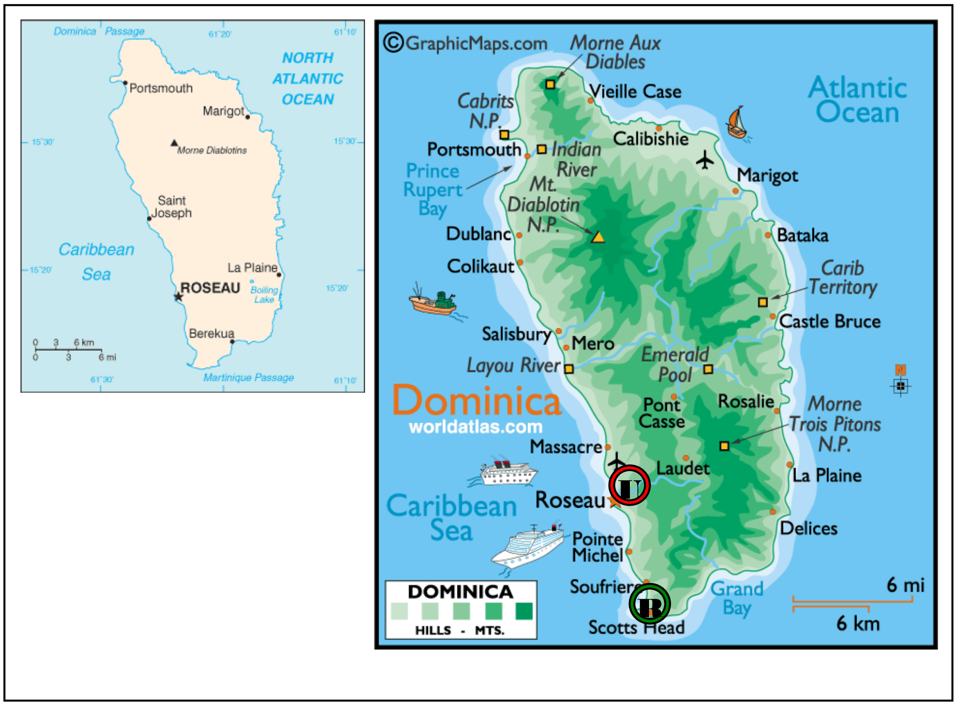

Figure 4.4 Location of Dominica and Dominica study areas

(Source: World Atlas, 2006. URL: www.worldatlas.com)

Grenada

Grenada is the southernmost of the Windward Islands and lies between 61°30' and 61°50' West longitude and 12°00' and 12°15' North latitude (figure 4.5). It lies at the southern most tip of the hurricane belt. Hurricane Ivan struck Grenada in September of 2004 causing severe damage. The urban parish of St. George's and the rural parish of St. John's (Guayave) were studied in this case.

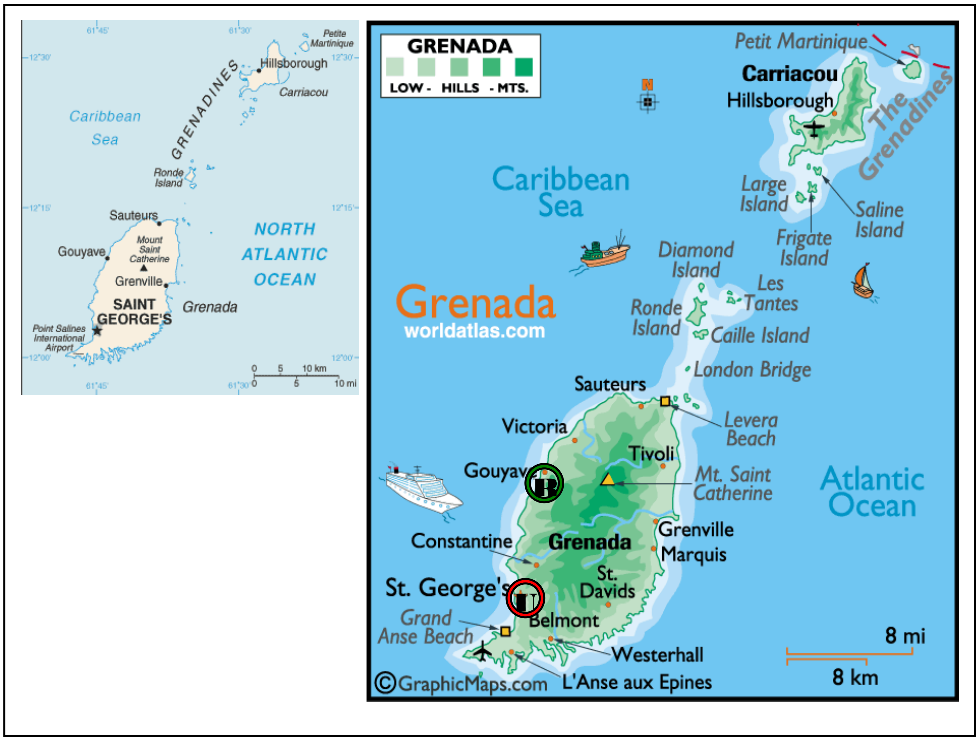

Figure 4.5 Location of Grenada and Grenada study areas

(Source: World Atlas, 2006. URL: www.worldatlas.com)

St. Kitts-Nevis

St. Kitts- Nevis is a twin island state that lies in the Leeward Islands between 62°30' and 63°00' West longitude and 16°30' and 17°00' North latitude (figure 4.6). St Kitts (168 sq km in area) is the larger island with coastline in the shape of a baseball bat while Nevis is 93 sq km in and shaped like a ball. The two volcanic islands are separated by a three-km-wide channel called The Narrows; on the southern tip of long, baseball bat-shaped Saint Kitts lies the Great Salt Pond; Nevis Peak sits in the center of its almost circular namesake island and its ball shape complements that of its sister island. On St. Kitts, I surveyed households in Basseterre (urban) and Cayon (rural); while I surveyed Charlestown (urban) and Gingerland (rural) on Nevis.

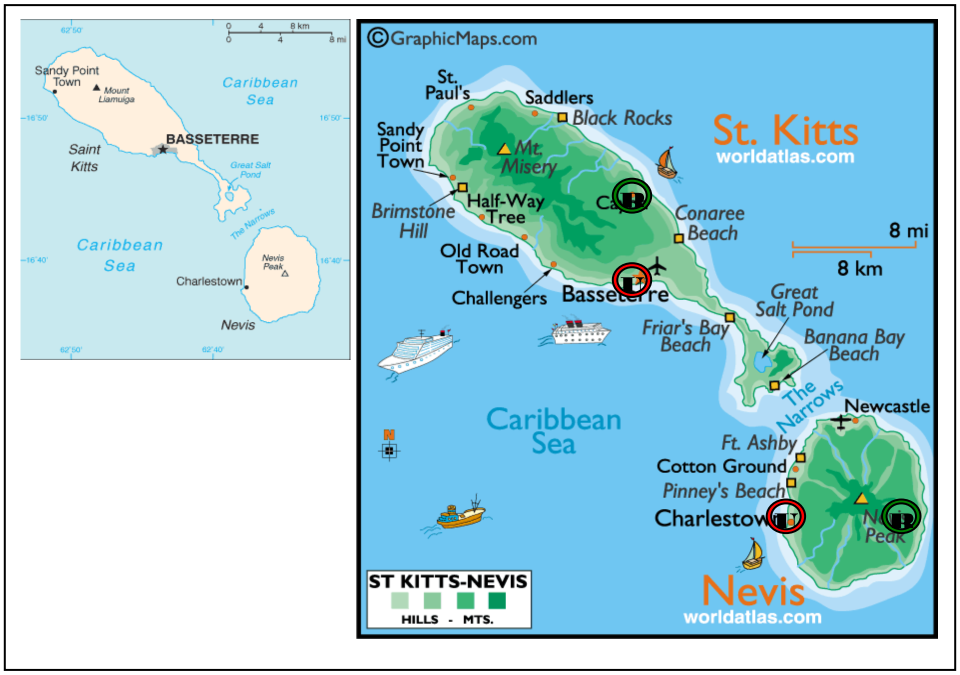

Figure 4.6 Location of the nation of St. Kitts-Nevis and study areas

(Source: World Atlas, 2006. URL: www.worldatlas.com)

St. Vincent

St. Vincent lies in the Windward Islands between 61°00' and 61°20' West longitude and 13°05' and 13°25' North latitude (figure 4.7). It is a mountainous island with rugged terrain even near the coastline. On St. Vincent, I surveyed the urban community of Kingstown and the rural community of Byrea.

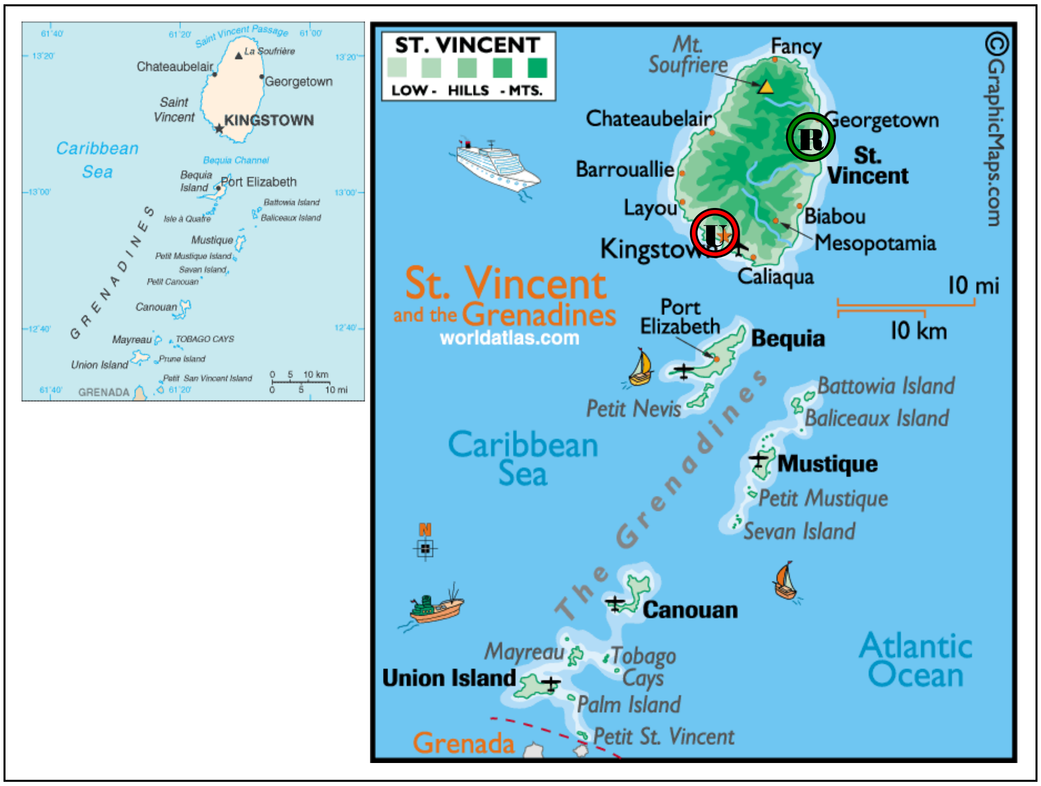

Figure 4.7 Location of St. Vincent and the Grenadines and St. Vincent study areas

(Source: World Atlas, 2006. URL: www.worldatlas.com)

4.1.3 Socio-Economic Characteristics of the Eastern Caribbean

The socioeconomic conditions of the islands can either accentuate or attenuate the effect of extreme natural events on the communities, individuals and households on the islands. Noticeably, the Leeward islands (in the north) and Barbados in the east have a statistically significant higher per capita GDP than the Windward Islands in the south (Figure 4.8). This stratification aligns well with the sectors that contribute most to the economy in these two regions. The Windwards are generally agriculture-dominant economies with high population and a high percentage of the workforce in agriculture compared to the Leewards and Barbados where the economy is more service-dominant with tourism, banking and finance among the top contributors to the economy.

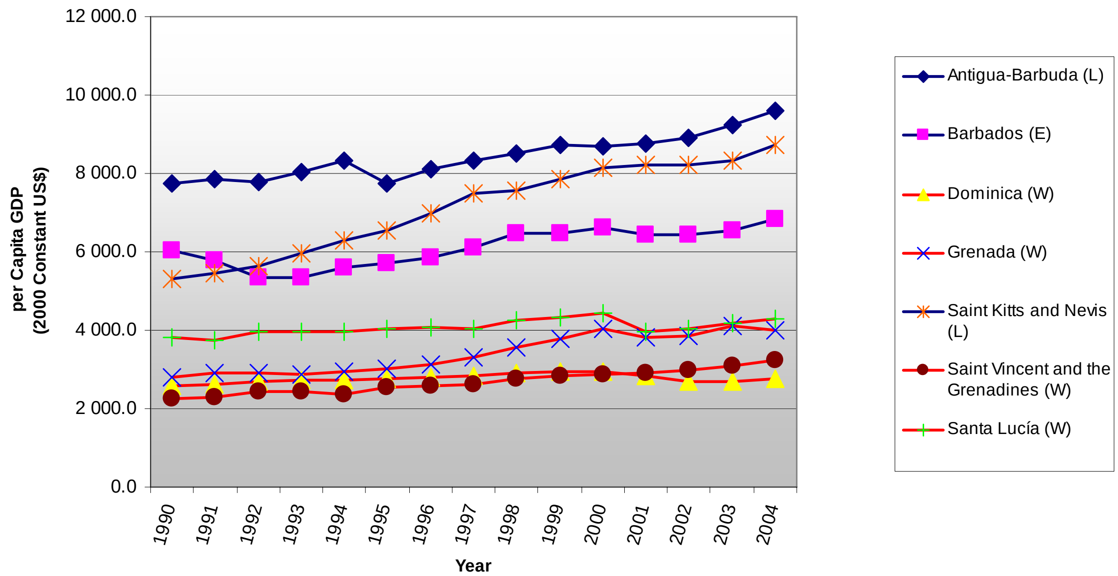

Figure 4.8 Gross Domestic Product per Capita based on 2000 Constant (US$) Prices[22]

(Raw data source: ECLAC, 2006)

The OECS has a unified currency called the Eastern Caribbean dollar which is pegged to the US Dollar at a rate of US$1 = EC$2.67. The Eastern Caribbean Central Bank, located on the island of St. Kitts, regulates monetary policy in the OECS and provides economic reports on each island's activity and performance as well as the sub-region. Barbados has its own currency which is adjusted to monetary terms and is currently at the rate of US$1 = BDS$2.00.

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[22] Note: The OECS islands are located in the Lesser Antilles. Also, all independent Caribbean nations are highlighted in red.

Economic Performance of Eastern Caribbean

The Eastern Caribbean region suffers from some exogenous shocks that impact the key economic contributors to the economy. The most noticeable is the 911-man-made disaster in the U.S.A. Trade and tourism suffered tremendously in the year following 911 leading to slowed growth in other spin-off activities such as services and hotels and restaurants. Improvements in growth were realized starting in 2003, but the region did not return to the pre-911 event growth rate until 2004. The dependence on tourism indicates the fragility of the economies in the Eastern Caribbean.

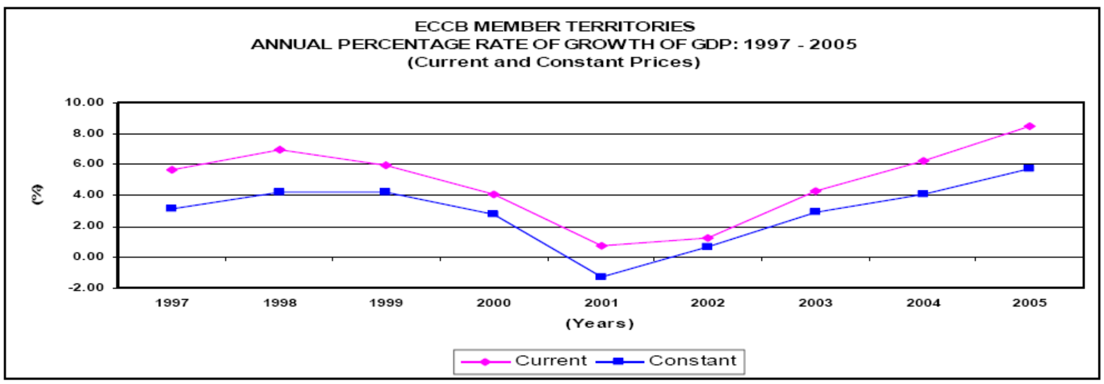

Figure 4.9 Annual GDP Growth rate for the OECS 1997-2005

(Source: ECCB, 2006a.)

The percentage contribution of the three main sectors to national GDP: agriculture, industry and service have remained fairly constant over the past five years (Table 4.3). In the Windward Islands of Dominica, Grenada and St. Vincent, agriculture is still a significant contributor to GDP despite some upward trends in the service sector (mainly due to tourism development, banking and finance). Appendix A2 provides a detailed list of contributions to GDP by sector.

Table 4.3 Percentage GDP and Annual Sector Growth Rate for Eastern Caribbean Study Islands

Sector	2005 Percentage GDP (%) and trend compared to 2000 percentage GDP (↑, ↓)						Annual Rate of Growth (%) 2000-2005 and trend compared to the 10 year period (1990-2000)					
	ANT	BAR	DOM	GRN	SKN	SVG	ANT	BAR	DOM	GRN	SKN	SVG
Agriculture	**3.7**	**6.1**	**18.7**	**8.5**	**3.0**	**8.9↓**		**-4.6**	**-3.4↓**	**2.4↑**	**4.1↑**	**0.2↑**
Industry	**22.9↑**	**20.5**	**23.0**	**23.1**	**28.3**	**24.3**		**2.1**	**-5.3↓**	**-0.6↓**	**-1.4↓**	**3.9↑**
Manufacturing	*2.1*	*10.5*	*8.1*	*5.5↓*	*9.3*	*5.7*		*0.9*	*-5.1↓*	*-6.3↓*	*0.4↓*	*0.2*
Services	**73.4**	**73.4**	**58.3**	**68.4**	**68.7**	**66.8 ↑**		**5.7**	**7.1↑**	**3.6↓**	**1.2↓**	**1.3↓**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**						

= Did not change or changed less than 1.0 percentage points
↑ = Increased 1.0 to 5.0 percentage points
↓ = Decreased 1.0 to 5.0 percentage points
↓ = Decreased more than 5.0 percentage points

ANT = Antigua
BAR = Barbados
DOM = Dominica

GRN = Grenada
SKN = St. Kitts and Nevis
SVG = St. Vincent

(Raw data source: World Bank, 2006)

4.2 DISASTER EXPERIENCE IN THE OECS: HAZARDS, RISKS AND VULNERABILITIES

The Eastern Caribbean is part of a band of high mountains that are exposed to seismic activity, volcanoes, and hurricanes spawned off the African coast. These hazards, particularly hurricanes, continually threaten the inhabitants of the Eastern Caribbean. Poverty is widespread and residents are particularly vulnerable to loss because they lack the resources to protect themselves against natural disasters (Berke and Beatley, 1997). The entire set of islands, because of their small size and economies, tends to be highly vulnerable to disaster. Often the amount of damage approximates or exceeds the island's annual GDP. For example,

- *1989 – Hurricane Hugo caused Montserrat losses of more than 200% of GDP.*
- *1994 – Tropical Storm Debbie caused floods and landslides that cost St. Lucia 18% of GDP.*
- *1995 – Hurricanes Luis and Marilyn caused Antigua and Barbuda losses worth 65% of GDP.*
- *1998 – Hurricane Georges affected 85% of the housing stock in St. Kitts & Nevis.*
- *2000 – Hurricane Lenny destroyed 50% of critical infrastructure in St. Kitts & Nevis.*
- *2004 – Hurricane Ivan affected 95% of the housing stock in Grenada.*

Unfortunately, the economic losses from natural disasters for the Eastern Caribbean islands illustrate that the problem has been a sustained one (Table 4.4). While the islands experienced several disasters over the period, the majority of the economic losses is associated with only one or two events. There is an urgent need to break this cycle of economic losses from natural disasters through effective mitigation mechanisms.

While several pre- and post-disaster programs exist with the intention to reduce risk, the Eastern Caribbean islands are still challenged to incorporate mitigation activities systematically into disaster recovery and pre-disaster planning activities. Since the United Nations International Decade for Natural Disaster Reduction (1990-2000) and the Millennium Goals Program, Caribbean governments have become more involved in disaster management activities. Yet, such efforts still lack consistently systematic, appropriate responses to the demands of comprehensive disaster recovery (IADB, 2000). Despite copious amounts of foreign assistance and concerted efforts by communities to restore physical, social and economic structures after tropical storms and hurricanes, several Caribbean-islands have still failed to reduce the impact of disasters. They also seem to take more time to recover from disaster events (Berke & Beatley, 1997)[23].

Table 4.4 Natural Disasters in the OECS: 1970 -1999

Country	Number of Occurrences	Total Fatalities	Economic Losses (1998 $m)	Economic Losses as % of GDP (1995)
Antigua & Barbuda	7	7	105.7	18.1%
Barbados	5	3	148.4	6.3%
Dominica	7	43	133.4	55.0%
Grenada	4	0	30.1	9.5%
St. Kitts & Nevis	7	6	312.5	116.5%
St. Lucia	8	54	1,554.6	272.3%
St. Vincent	9	5	47.0	16.5%

Source: Derived from IDB Research Department Report, "Natural Disasters in Latin America and the Caribbean: An Overview of Risk", October 2000: Table 1.10

[23] Berke and Beatley. 1997. *After the Hurricane*. They looked at the effect of international and domestic aid distributed to disaster-stricken people and their communities. They also explored how and why communities in the Caribbean recover from disasters and the opportunities offered by the disaster recovery period to strengthen the capacity of local institutions for long-term (sustainable) development.

4.2.1 History of Hurricanes & Disasters

4.2.1.1 Regional Trends

Over the past three decades, there has been a general upward trend in the number of Atlantic tropical storms and hurricanes (Figure 4.10). This period represents the most accurate and consistent process for naming and recording storms and therefore is most reliable. Though some scholars contend that this is not a trend[24], but rather inter-decadal variations caused by temporal fluctuations in atmospheric environment, the increased number of storms has generated increased recognition as a significant threat to development and poverty alleviation. Over the past three decades, only eight hurricanes directly impacted the Caribbean region as a Saffir-Simpson scale[25] category 3 or higher hurricane. Of these, 50% were within the last decade.

24

25 "The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity (Appendix A1). This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region. Note that all winds are using the U.S. 1-minute average." (US Weather Service, National Hurricane Center)

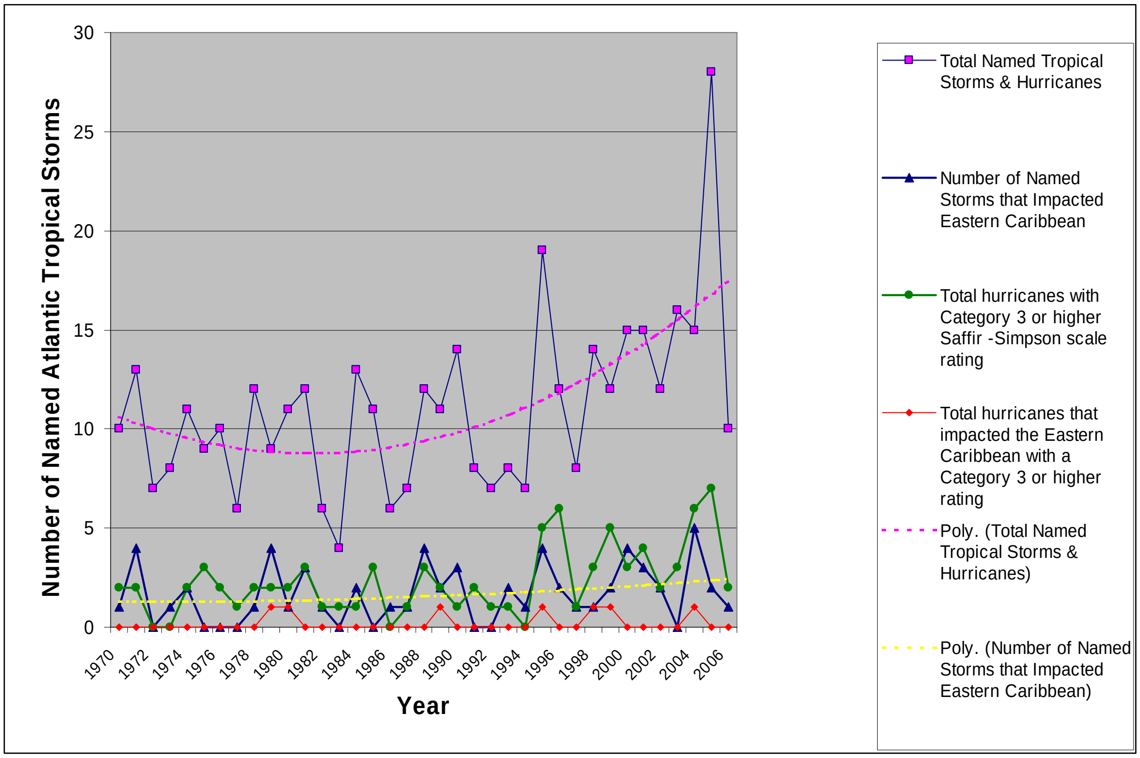

Figure 4.10 Trend in Number of Named Tropical Storms since 1970*

Data obtained on March 12, 2007- Data version: v0601 from "EM-DAT: The OFDA/CRED International Disaster Database. www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium"

Noticeably on average only 15% of the tropical storms that form in the Atlantic region including the Caribbean Sea and Gulf of Mexico impact the Eastern Caribbean islands. The rate of increase of named tropical storms that impact the Eastern Caribbean is significantly lower than the rate of increase for the entire Atlantic region.

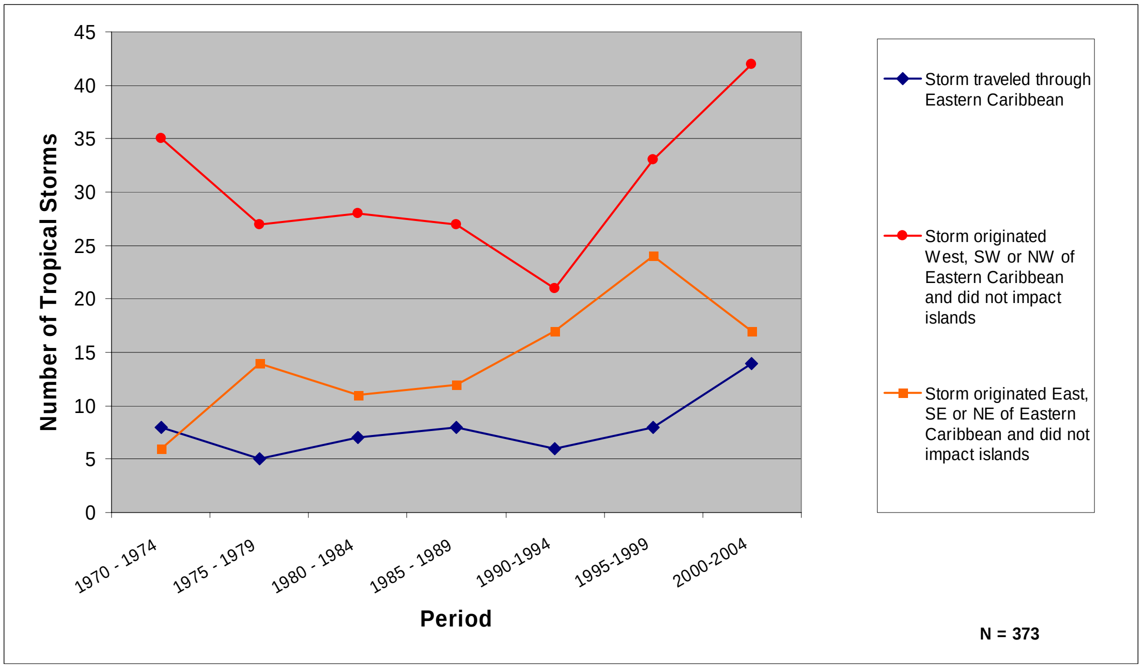

Figure 4.11 Path of Named Atlantic Tropical Storms Relative to the Eastern Caribbean region

The average Accumulated Cyclone Energy (ACE)[26] index for each hurricane season is generally highly correlated with the number of Atlantic tropical storms. The ACE index is a measure developed by NOAA that provides a single index of the sum of squares for the intensity and duration of Atlantic tropical storms. It is also well known that the ACE index is typically highest for the months of August and September. For the three decades from 1970 to 2000, this relationship has held true (Figure 4.12). However, since 2000, there has been significant variance between the ACE index and the number of tropical storms. Though there are more frequent occurrences of tropical storms in the last five years, the ACE has been lower than expected. This suggests that more storms do not necessarily indicate significantly more impact for the islands. Yet, the increase in storms poses potentially more risks and warrants urgency in building mitigation and resilience.

[26] The sum of squares

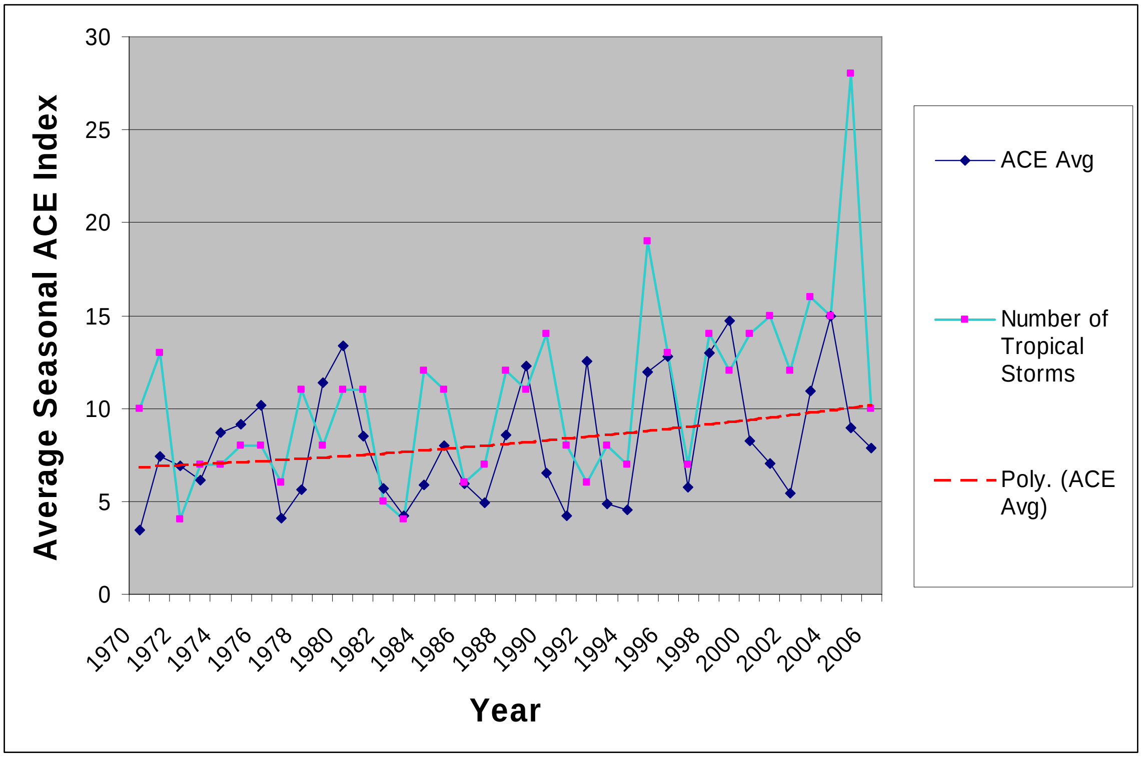

Figure 4.12 Relationships between Accumulated Cyclone Energy (ACE) and Number of Named Atlantic Tropical Storms

4.2.1.2 Intra-regional Trends

Since 1980, there has been significant difference in the seasonal track of hurricanes through the Eastern Caribbean. The seasonal level of risk and vulnerability may fluctuate according to this pattern. Either the northern or the southern sub-region is affected by significantly more tropical storms in a given season (figure 4.13). The Central region is aligned with either the northern or southern islands in a given season. This stratification correlates well with the economic stratification by GDP per capita discussed in Section 4.1. This combined stratification augers well for policy and resource sharing during hurricane recovery between the two sub-regions of the Eastern Caribbean (Huggins, 2001). For, example warehousing can be done in mini-regions to ensure efficient delivery of supplies to the affected area. In addition, the regions can purchase equipment and establish sub-regional leasing programs for periodic-use or project-related equipment, which can then be shared between regions based on the seasonal rotating patterns of hurricane recovery.

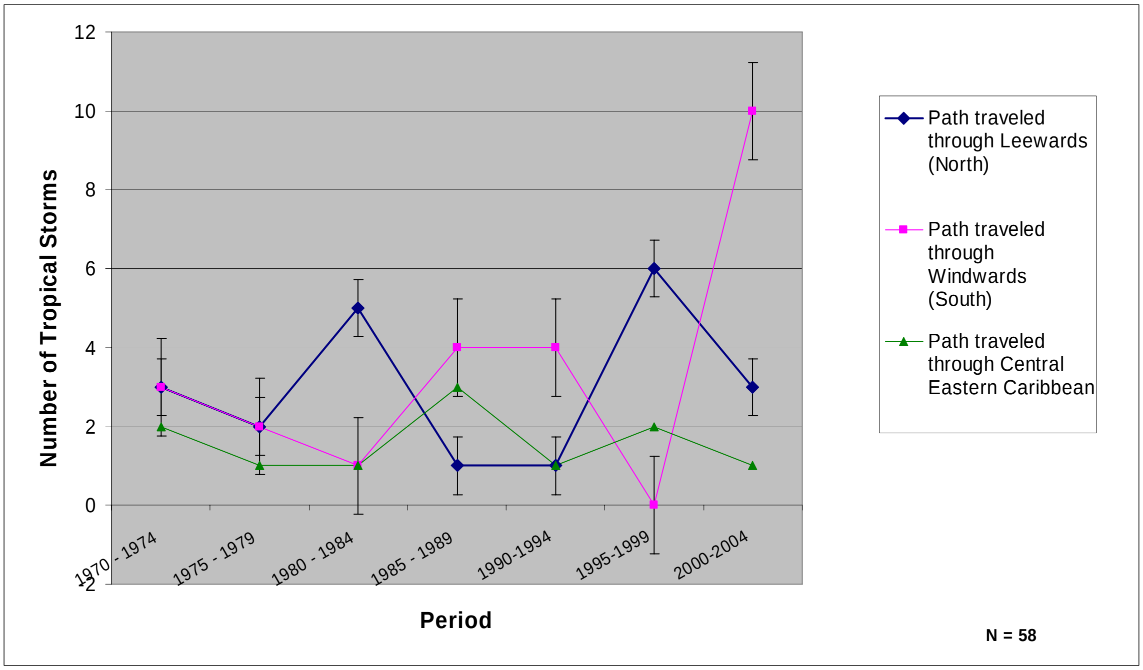

Figure 4.13 Path of Named Atlantic Tropical Storms Relative to the Eastern Caribbean sub-regions

4.2.2 Policies for Comprehensive Disaster Management in the OECS: Before and after hurricanes Lenny and Ivan

Prior to Hurricane Lenny (1999) and Hurricane Ivan (2004), the Eastern Caribbean sub-region experienced two hurricanes and a volcanic eruption in 1979 that triggered policy changes in the region. The La Soufriere volcanic eruption (in St. Vincent) in 1979 and the passage of Hurricanes David and Frederick triggered the establishment of central national disaster management agencies throughout the sub-region. From 1981 onwards, each island focused on disaster preparedness. This effort opened the door for international funding and technical assistance programs, which continued relatively unabated into the next two decades.

Ten years later in 1989, Hurricane Hugo devastated the Leeward Islands, and triggered a substantial call for reduction in vulnerability to disasters and safe building practices. Many of the islands heeded the initial calls on each of these occasions, but lapsed into inconsistent practices after the shock and reality of the events subsequently wore off. Building codes were developed, but there was no systematic process to monitor and enforce safe building practices nor were there adequate programs to physically ensure appropriate zoning and setback adherence. In fact, in countries where the program existed, much of the planning was overridden or curtailed in practice by political alliance/corruption and financial influence.

In Nevis, for example, a Zoning Ordinance with map was passed in 1990 and all coastline construction required a setback of 300 feet from the high water mark. Yet, the Four Seasons Resort was permitted to build beach restaurants within that designated setback zone due to political and economic influence/pressure. As shown in Figure 4.14, Hurricane Luis destroyed much of the structure and eroded a significant amount of the beachfront resulting in significant economic losses because the hotel had to be closed for a period of time.

Before Hurricane Luis

-

Four Season's Resort
Pinney's Beach,
St. Kitts-Nevis

August 1995

After Hurricane Luis

-

Four Seaon's Resort
Pinney's Beach
St. Kitts-Nevis

October 1995

Figure 4.14 Ineffectiveness of existing policies that are not enforced

(Source: Cambers & Huggins, 1995)

Table 4.5 Comprehensive Disaster Management Status for Study Area

	National Emergency Management Agency	National Disaster Management Plan	Hazard Mitigation Plan	Disaster Recovery Plan	Dedicated Full-time Technical Staff in NEMA Office other than National Coordinator	Formal Links with Planning	Community Preparedness	Full Political Support	Building Code	DM Legislation Enacted	Dedicated Equipment or EOC
Antigua-Barbuda	**Y**	**Y**	**Y**	**P**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Barbados	**Y**	**Y**	**Y**		**Y**	**N**	**N**	**Y**	**N**	**Y**	**Y**
Dominica	**Y**		**N**		**N**	**N**	**Y**	**Y**	**N**		**N**
Grenada	**Y**	**Y**	**Y**	**P**	**N**	**Y**	**N**	**N**	**Y**	**Y**	**Y**
Montserrat	**Y**	**Y**	**Y**		**Y**	**Y**	**Y**	**Y**	**Y**	**N**	**Y**
St. Kitts-Nevis	**Y**		**Y**	**P**		**N**	**N**	**Y**	**N**	**Y**	
St. Lucia	**Y**	**N**	**Y**	**P**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**
St. Vincent	**Y**	**N**	**N**	**N**			**N**	**N**			**N**

- P = partial or certain sectors only
- N = None or no
- Y = Present or yes

Modified and updated to 2007 from CDERA 1991

4.2.3 The Cases of Hurricane Ivan and Hurricane Lenny

Prior to Hurricane Lenny in November 1999 very few of the islands in the Eastern Caribbean had all the key elements of comprehensive disaster management in place (Table 4.6)

Table 4.6 Policy employed before and after hurricanes Lenny and Ivan

Country	**Pre-Lenny** *(Before November 1999)*	**Post-Lenny but Pre-Ivan** *(Nov 1999 – Sep 2004)*	**Post-Ivan** *(After September 2004)*
Antigua -Barbuda	Disaster Management Office Disaster Management Plan Disaster Management Legislation	Hazard Mitigation Plan (formally adopted July 2001) Shelter Management Plan (formally adopted July 2002)	
St. Kitts-Nevis	Disaster Management Office Disaster Management Plan (formally adopted July 1989; last updated) Disaster Management Legislation (formally adopted July 1998)	Hazard Mitigation Plan (formally adopted July 2001) Shelter Management Plan (formally adopted July 2001)	
Dominica	Disaster Management Office (No formally ratified or adopted plans)	Disaster Management Plan	Disaster Management Legislation (formally adopted July 2005) Hazard Mitigation Plan (being drafted 2007)
Barbados	Disaster Management Office Disaster Management Plan (formally adopted 1990)	Emergency Housing Plan (formally adopted 2002) Emergency Housing Policy (2002)	Disaster Management Legislation (formally adopted July 2005) Hazard Mitigation Plan (being drafted 2007)
St. Vincent	Disaster Management Office (No formally ratified or adopted plans)	Disaster Management Plan (formally adopted July 2004; last updated December 2006) Hazard Mitigation Plan (formally adopted July 2004) Shelter Management Plan (formally adopted July 2004; last updated April 2007) Emergency Evaluation Plan (formally adopted July 2004	Disaster Management Legislation (formally adopted Jan 6, 2006)
Grenada	Disaster Management Office (No formally ratified or adopted plans)	Disaster Management Plan	Disaster Management Legislation (formally adopted Dec2004) Emergency Housing Plan (formally adopted Jan 2005) Emergency Housing Policy (Dec 2004)
CDERA	Model Disaster Management Legislation	Model Hazard Mitigation Plan (2003) Model Shelter Management Plan	

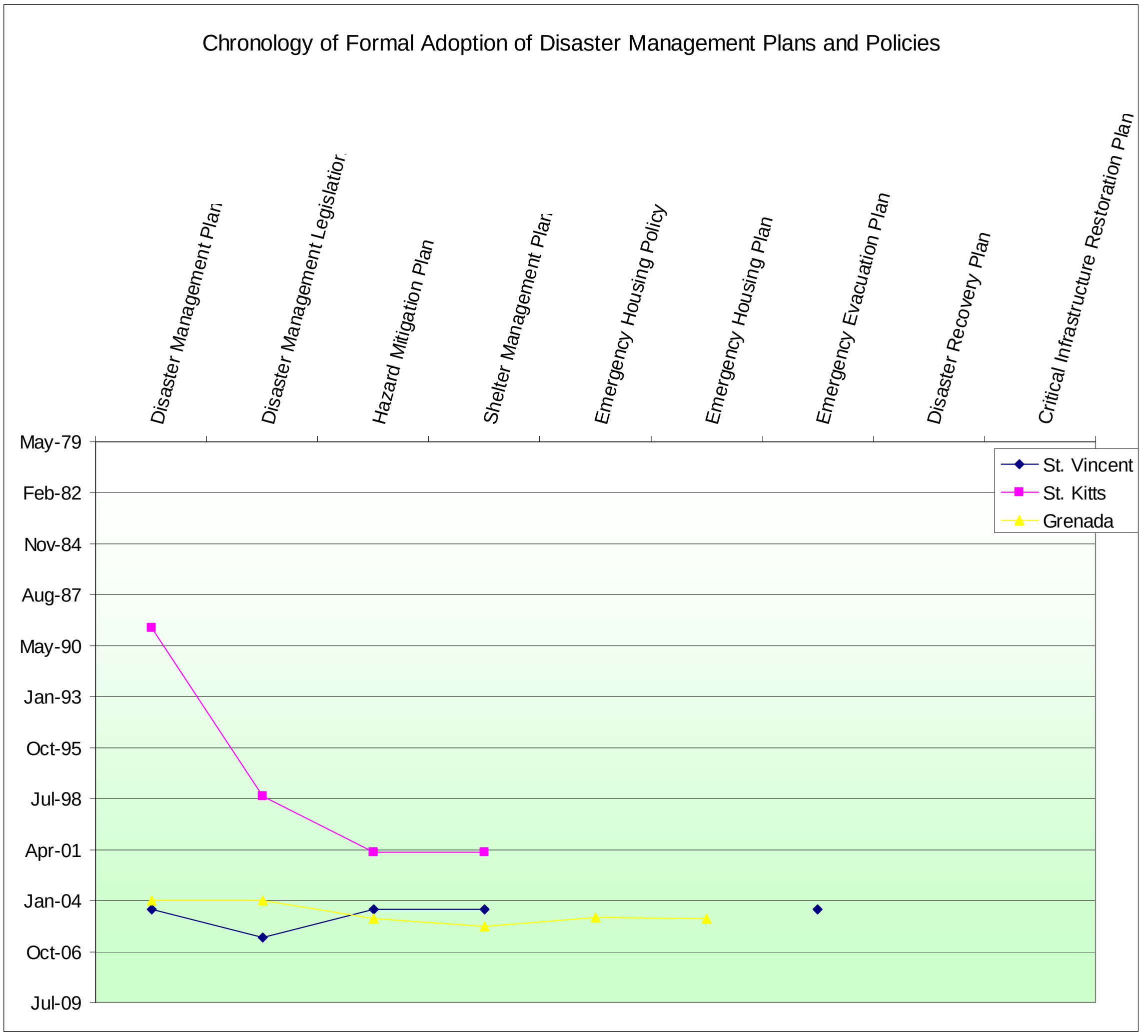

Figure 4.15 Chronology of formal adoption of disaster management plans and policies

4.3 APPROACHES AND MECHANISMS FOR COMPREHENSIVE DISASTER MANAGEMENT AND HAZARD MITIGATION

Approaches for Comprehensive Disaster Management

The Caribbean region employs three broad approaches in the implementation of comprehensive disaster management (Freeman et al, 2003). First and most common, is the expansion of the mandate of existing institutions and entities particularly to include mitigation and previously ignored stages of the disaster cycle (*Figure 4.19.1 – Approach 1*). Second, some countries such as Grenada create parallel institutions to the existing entities to undertake the additional responsibilities in comprehensive disaster management (*Figure 4.19.1 – Approach 2*). This approach could potentially lead to conflict in responsibilities and 'turf wars' where responsibilities overlap, rather than effective collaboration. Third, some countries rely on improved networks between new and existing institutions to implement CDM (*Figure 4.19.1 – Approach 3*).

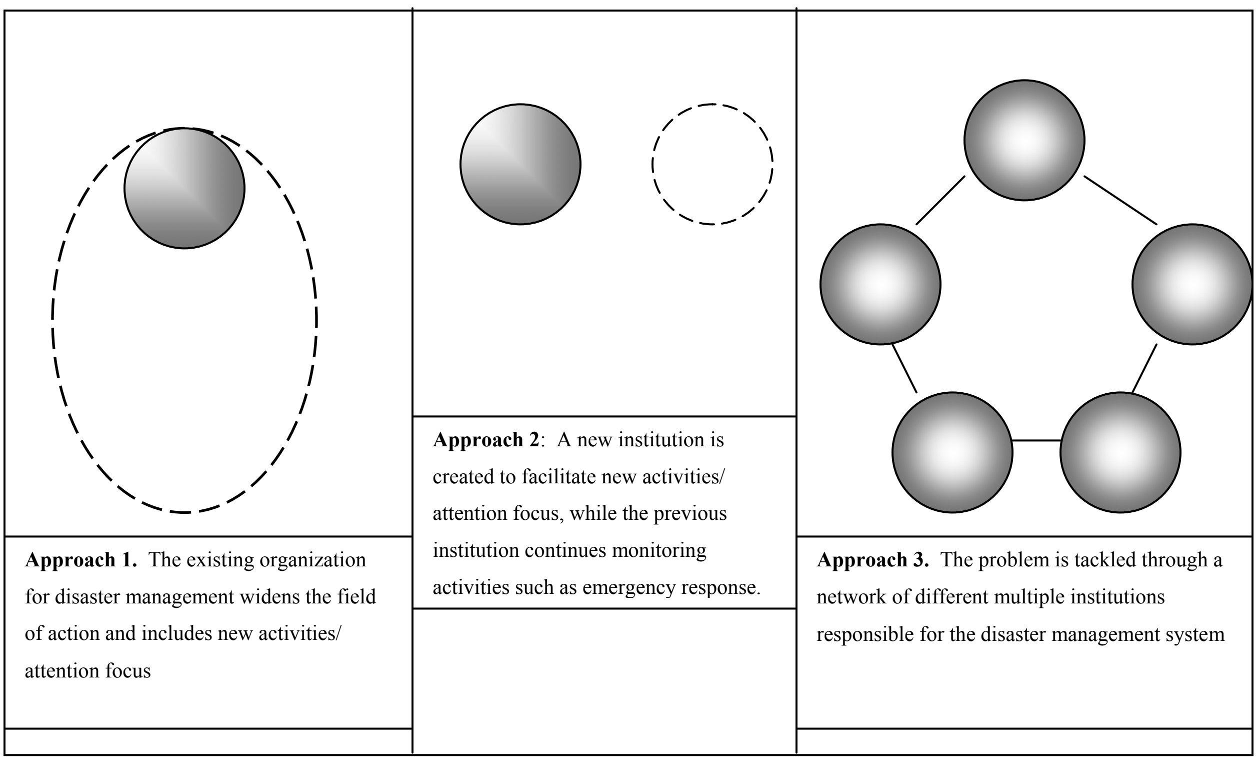

Figure 4.16 Approaches to Comprehensive Disaster Management in the Eastern Caribbean

4.3.1 Regional Mechanisms

Like the World Conference on Disaster Reduction, the Latin America and Caribbean region recognizes (i) the reduction of the underlying risk factors and (ii) knowledge management as two of the top five initiatives for "increasing the profile of disaster risk reduction in development planning and practice"[27] (ISDR, 2004). Historically, the OECS sub-region and the Caribbean, as a whole, began systematic disaster management in 1981 when USAID and UNDP supported disaster preparedness and helped to commission the Pan-Caribbean Disaster Preparedness Project (PCDPP). PCDPP helped to establish central government disaster management organizations and entities within several Caribbean islands during its 10 year (1981-1991) existence and executed several other initiatives. Its heavy reliance on unsustainable external funding led to the eventual decline in its reach and effectiveness, including the withdrawal of financial support for some national level activities and failure to establish a sustainable institutional regional mechanism for disaster response. However, in 1991, the government of Caribbean States signed an agreement and formally institutionalized a new regional disaster coordination agency, the Caribbean Disaster Emergency Response Agency (CDERA)[28], which was able to build on the work of PCDPP and facilitate immediate and coordinated assistance to Caribbean States[29] (CARICOM, 1991). CDERA, with support from UNDP, USAID/OFDA (including cost sharing), has executed several disaster reduction strategies and capacity building in the region. Though CDERA has been successful in supporting national level response activities, the problem of timely and accurate information for disaster response and mitigation remains a concern.

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[27] The World Conference on Disaster Reduction (WCDR) was recently held in Kobe, Hyogo, Japan from January 18-22, 2005. It builds on the 1994 Yokohama Strategy and Plan of Action and the Johannesburg Plan of Implementation for Sustainable Development (Millennium Development Goals) and focuses on the opportunity for action.

[28] CDERA is based in Barbados

[29] The agreement establishing CDERA provided for national governments to contribute to its administrative budget in accordance with a scale of assessment, which helped to reduce dependence on external funding and promote financial sustainability. States covered include Antigua and Barbuda, the Bahamas, Barbados, Belize, British Virgin Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago.

In 2001, CDERA expanded its focus to not only deal with disaster management but also the integration of comprehensive disaster management (CDM) into the development process of CDERA member states[30]. In fact, CDERA was also able to attract funding and other resources from other agencies including the governments of Japan (JICA) and Canada (CIDA), the Caribbean Development Bank (CDB), the European Union (EU) and the European Community Humanitarian Office (ECHO), the Organization of American States (OAS) and the Inter-American Development Bank (IADB) to support its CDM agenda. CDERA (with the increased occurrence and awareness of disasters throughout the globe) has been able to energize stakeholders, revive marginalized emergency managers and garner political support. These energies should now be utilized to develop the efficiency and sustainability of disaster management in the OECS. While CDERA continues to expand its agenda to make disaster management more holistic and sustainable, several deficiencies have emerged including a growing need for a more efficient and rapid transfer of accurate and appropriate information, and improved coordination, collaboration and integration at the national levels.

The Caribbean Disaster Response Agency has developed a model strategy for comprehensive disaster management. This CDERA has proposed a regional strategy for integration of comprehensive disaster management (CDM) into development processes at the national level. However, these strategies seek primarily to reduce the social and economic dislocation caused by the natural disasters. Development planning is not linked with the processes and organizations that deal with disasters. Since 1995, USAID has worked with several of the East Caribbean islands to develop housing recovery plans (USAID, 2000). These plans explain the role of various stakeholders such as the builders, homeowners, government and insurance sector. The plans provide guidelines for safe recovery; recommend education during

[30] The CDM project is an extension of an earlier UNDP-financed Disaster Emergency Response and Management Systems (DERMS) project which ended in 2000.

mitigation and enforcement during reconstruction, but they fail to identify a unified functional mechanism for integrating these measures into the sustainable disaster management process.

The regional and international partners in the Comprehensive Disaster Management program include CDERA, the Caribbean Development Bank (CDB), the University of the West Indies (UWI), the United Nations Development Program (UNDP), the Office of Foreign Disaster Assistance (OFDA), the Pan-American Health Organization (PAHO), and the World Food Programme (WFP).

4.4 HAZARD MITIGATION AND TOOLS FOR HAZARD MITIGATION IN THE OECS

This section summarizes tools for hazard mitigation on each island for all prominent hazards. The national governments of the Eastern Caribbean islands have been committed to dealing with the socio-economic hardships imposed by hurricanes and tropical storms. Yet, no comprehensive program exists to ensure that rebuilding after disaster events are conducted in a way that reduces overall vulnerability (USAID/OAS, 2002). Several programs, legislative initiatives and policies have been set in place to facilitate the development of hazard mitigation tools, but the challenge remains to effectively and systematically introduce mitigation activities and avoid being locked in the status quo of poor planning, coordination and enforcement.

Each island must have a written plan, an existing policy or operating procedure to gain points under any of the mitigation tools[31]. The following status was determined from existing

[31] Each score was determined from a scale of 0 to 3, where 0 = no existing plan, policy or operating plan/procedure; 1 = existing plan but no policy or operating procedure/plan; or a working procedure but no written plan or policy; 2 = existing plan and policy, but no operating (working) procedure/plan; 3 = existing plan with active policy and operating procedures and plan.

plans and policies, as well as reports from agencies for planning and disaster management and confirmation from interviews with the disaster management coordinators and planning directors. In chapter 5, I examine the utilization of these hazard mitigation tools in the households surveyed and provide quantitative scores for the islands.

4.4.1 Structural Mitigation Tools

Structural mitigation tools include both design and construction elements as well as actions that reduce the vulnerability of communities by armoring them against the elements (i.e., environmental interventions). The term, structural mitigation tools, commonly evokes images of seawalls, levees and other works of engineering. It can also describe efforts to reinforce nature's own mitigative abilities by restoring beaches or planting vegetation on loose hillsides. All of the islands in this study have some structural mitigation tools in place.

4.4.2 Non-Structural Mitigation Tools

Non-structural mitigation refers to techniques for avoiding hazards entirely. They include policies that lower hazard risk by directing a community's growth into less hazard-prone areas. These techniques are typically policies: communities must choose to apply zoning restrictions, to acquire land in the floodplain, to promote citizen awareness of hazard risk or simply to plan. Design and construction guidelines also fall into this category. There were varying degrees of non-structural mitigation tools among the islands in this study.

Building Codes and the Building Regulatory Mechanism

While several tools contribute to the overall success of disaster mitigation, the building regulatory system is the key to the systematic integration of mitigation into disaster management and development planning. This mechanism relies on enacted building codes; land use zoning and development plans; training and sensitization of designers, builders, inspectors and building owners as well as a viable enforcement system to ensure adherence to codes and plans. Often, the latter two elements are either missing, inadequate or are subject to political interference that limits effective building regulation. Several of the case study islands have recently established building codes, but many lack the required number of building inspectors to develop a comprehensive enforcement system.

The building codes adopted in the islands of the Eastern Caribbean (table 4.7) are largely based on the Organization of Eastern Caribbean States model building code which was based on the Caribbean Uniform Building Code (CUBiC), developed in 1983 to provide building standard for the Caribbean region.

Table 4.7 Status of building codes in the Eastern Caribbean
(Source: USAID/OAS, 2001)

Antigua and Barbuda	Completed, based on OECS model building code. Legislated in 1996 as regulations under the Development Control Ordinance.	Hardcopy can be purchased from the Government Printery	5 Building inspectors on staff. Training program to be developed.
Barbados	Draft Building Code developed in 1993. The Government is proceeding with the establishment of a Building Authority and the appointment of Building Inspectors. Technical provisions of the Code based on the standards contained in CUBiC Detailed recommendations for establishing the Building Authority and other mechanisms required for legislative review completed in 1999 with the assistance of the OAS/CDMP. The working papers for the enabling legislation and for the establishment of the Building Authority are now being discussed with the Minister responsible prior to submission to Cabinet.	Copies of the Code available for the Barbados National Standards Institute	Recommendations made for the engagement of an adequate number of building inspectors for monitoring residential construction. Other buildings will be monitored by professional engineers and architects engaged on a case by
Dominica	Code drafted, based on OECS model building code. Submitted for legislative review. OECS Model Planning Act being used as the basis of a new Dominica Physical Planning Act which will mandate the use of the Building Code.	Copies will be available from the Government of the Commonwealth of Dominica.	The Development Control Authority has 5 building inspectors of staff.
Grenada	Currently drafting code, based on OECS model building code.	Completed. Hard and electronic copies will be available from the Government of Grenada.	*No information available*
St. Kitts and Nevis	Building code approved by Parliament and mandated for use by the Development Control and Planning Bill which was gazetted in 2000. The building regulations include the Building Code and Building Guidelines as the second and third schedules.	The Code and Guidelines have been compiled in one book. This is available at the Government printery for EC.$ 300.00.	Four building inspectors are in place in St. Kitts and one in Nevis.

4.5 STATUS AND UTILITY OF GEOINFORMATICS IN DISASTER MANAGEMENT IN THE OECS

Though there are many types of information and communication technology used in the disaster management environment, this study focused on geoinformatics and geospatial data. Geoinformatics, also referred to as GIS relies on geospatial data and tools. In the Eastern Caribbean, geospatial data and tools have mostly been used in planning. Until recently after Hurricane Ivan in Grenada and Hurricane Georges in St. Kitts-Nevis and Antigua, very little GIS analysis has been used in disaster recovery until after Hurricane Ivan. Geospatial data are important not only in estimating the geographic distribution of risk, but also in supporting planning and recovery efforts in disaster management. This study assessed several key issues relevant to the effective use of geoinformatics to support disaster management in the Eastern Caribbean;

(a) the availability of equipment and resources

(b) the supply and use of geospatial data

(c) the supply and use of geospatial tools, including software

(d) adequate training of users

(e) planning and development of tools to meet country needs

(f) the sharing of geospatial resources and coordination among agencies

This section discusses the current status of geospatial data and tools in the Eastern Caribbean while Chapter 7 expands on this background, data security as well as a model for successfully integrating geospatial data (as a mitigation tool) into the disaster recovery process.

4.5.1 GIS Hardware and Software

While the Department of Planning on most of the islands is equipped with GIS equipment to predict and map vulnerabilities, only one of the disaster management offices has an operational GIS system (Table 4.8). Unfortunately, the Department of Planning is not directly responsible or involved in disaster recovery, and thus cannot provide the timely details to disaster management. The effectiveness of any technology is as much about the human systems in which it is embedded as about the technology itself. All GIS units on the islands utilize ESRI ArcGIS Suite of software. However, it must be noted that some islands namely St Vincent and Dominica once utilized SPANS GIS from Canada, which was not readily integrated with other software.

Table 4.8 Status of a complete GIS system in Disaster Management*

Island Nation	GIS System in Planning Department	GIS System in Disaster Management Office
Antigua & Barbuda	Y	Y
Barbados	Y	Y
Dominica	N	N
Grenada	Y	N
St. Kitts - Nevis	Y	N
St. Vincent	Y	N
**A complete GIS system refers to presence of dedicated GIS computers, digitizing equipment, data, maps, GIS software, and at least 1 active GIS technician*		

4.5.2 Geospatial Data

There were significant differences in the availability of data for geospatial analysis and disaster management planning. Two countries: St. Kitts-Nevis and Antigua had outstanding recent geospatial data while in countries such as Dominica, much of the geospatial data was outdated or was not readily available. In Barbados and St. Vincent, geospatial data were available, but it was tied to project specific objectives or was somewhat outdated. In Grenada, much geospatial data became available after Hurricane Ivan due to international assistance and concurrent rehabilitation programs. Table 4.9 summarizes that type of geospatial data available.

Table 4.9 Geospatial Data Available in Central Planning or Disaster Management Office

Island Nation	GIS System in Planning Department	GIS System in Disaster Management Office
Antigua & Barbuda	Y	Y
Barbados	Y	Y
Dominica	N	N
Grenada	Y	N
St. Kitts - Nevis	Y	N
St. Vincent	Y	N
**A complete GIS system refers to presence of dedicated GIS computers, digitizing equipment, data, maps, GIS software, and at least 1 active GIS technician*		

4.5.3 GIS Training

On each of the islands, there is at least one person in the planning department with GIS training. Most of the training has been on-the-job training by technical personnel from aid agencies. Only 4 of the 7 islands had personnel with formal GIS training.

4.5.4 Localization and Optimization of Geospatial Tools

Four of the seven islands: Antigua, St. Kitts, Nevis, Barbados and St. Vincent had fairly up-to date hazards maps. Grenada was in the process of updating maps after Hurricane Ivan and should have some of the better maps by 2007 based on the technical assistance stream forthcoming from post-Ivan reconstruction and mitigation policies. In fact, Grenada has already commissioned a new cadastral survey in hopes of making geospatial tools more readily useful to the Grenada context. There is still need for more optimization of geospatial tools for everyday usage on all the islands. This study found that there has been no customization or optimization of geospatial tools for handling disaster management on any of the islands beyond hazard mapping and zoning.

4.5.5 Geospatial Resource Sharing and Interoperability

Currently, most of the sharing of geospatial data occurs as hard transfers by disc, CDs or maps. None of the islands have an existing geospatial portal. However, the regional agency, CDERA is attempting to establish such a geospatial portal with technical assistance from JICA (Japanese International Cooperation Agency).

4.6 GOVERNANCE, NETWORKING AND CAPACITY BUILDING FOR DISASTER MANAGEMENT IN THE CARIBBEAN

4.6.1 Location of the National Disaster Management Office

The location of the national disaster management office has major implications for effective governance, communication, connections and timely decision-making across ministries. Research has shown that if the NDMO is located in the prime minister's or president's office, the prime ministry or his deputy, rather than the head of a line ministry, is more likely to assume the chairmanship of the national disaster management committee and effect more timely decisions. NDMOs that reside in the prime minister's ministry have greater coordinating and integrating power than those that reside in line ministries.

The islands in this study have a single level of government, that is, the national level of government. There is no district or local level of government, though representatives at the national level run local or district level offices. However, all of the islands have arrangements for the organization and governance of disaster management at the district and local levels as well as the national level. There is no vertical level of political governance that directly impacts the vertical level of disaster management.

4.7 GEOSPATIAL SUMMARY

There are several geo-spatial related needs and shortcomings:

- Enhancement of geospatial capacity of disaster management office
- Geospatial data integration for the purpose of disaster management support
- Standards for spatial data infrastructure
- Geospatial portal for geospatial data sharing across agencies and countries
- Cadastral surveys to enhance geospatial mapping with limited GPS resources
- Proper addressing system that is not dependent on familiarity with names

The Eastern Caribbean urgently requires a proper addressing system to aid emergency response and recovery, and most islands require an updated cadastral survey. These resources will also facilitate spatial analysis and geoprocessing for more efficient decision making. Too much is left to familiarity of the responder rather than a systematic approach to locating an incident and administering aid. The same is true for disaster recovery and mitigation. Such a system is necessary for proper and timely updates and effective coordination between rehabilitation agencies. This shortcoming is a major limitation to this study.

5.0 COMPREHENSIVE DISASTER MANAGEMENT AND MITIGATION INTEGRATION WITHIN AND AMONG ISLANDS: HOUSEHOLD, BUILDERS AND DESIGNERS.

This chapter is divided into three major sections to examine the pragmatic characteristics for comprehensive disaster management and mitigation integration among three study groups: 1) households, 2) builders and designers and 3) rehabilitation agencies. All three groups are analyzed through results of a survey instrument. I analyzed the experiences of the Eastern Caribbean islands in mitigation against hurricanes using three methods of investigation. I utilized household (organizational) analysis to characterize households on how they plan and manage mitigation and disasters as a whole. I used analysis of variance, simple regression analysis and graphical representation. Through this research, I was able to identify the gaps in mitigation implementation at the household level while generating information for a knowledge database that can improve future disaster management practices. Secondly, I utilized content analysis of news reports and documents to further validate findings from the surveys of households, designers and builders and rehabilitation agencies. More detailed content analysis is provided in chapter 6. This analysis is also supported by findings in detailed interviews with selected officials and managers within national rehabilitation agencies. Thirdly, I utilized geographical analysis to identify patterns of mitigation among the affected communities as well as within the Eastern Caribbean region. In chapter 6, I will further analyze the interactions among these groups through content and network analysis.

5.1 HOUSEHOLDS AND DISASTER MITIGATION

In order to analyze how households mitigate against disasters, I first characterized the disaster management culture among households before, during and after Hurricanes Lenny and Ivan. How households perceive risk affects how they mitigate against hazards as well as how they prepare for impending disaster. Households (196 – Hurricane Lenny and 129 – Hurricane Ivan) were asked about their type of concern, level of preparation for the impending hurricane as well as how they perceive mitigation.

5.1.1 Culture of Disaster Recovery among Households

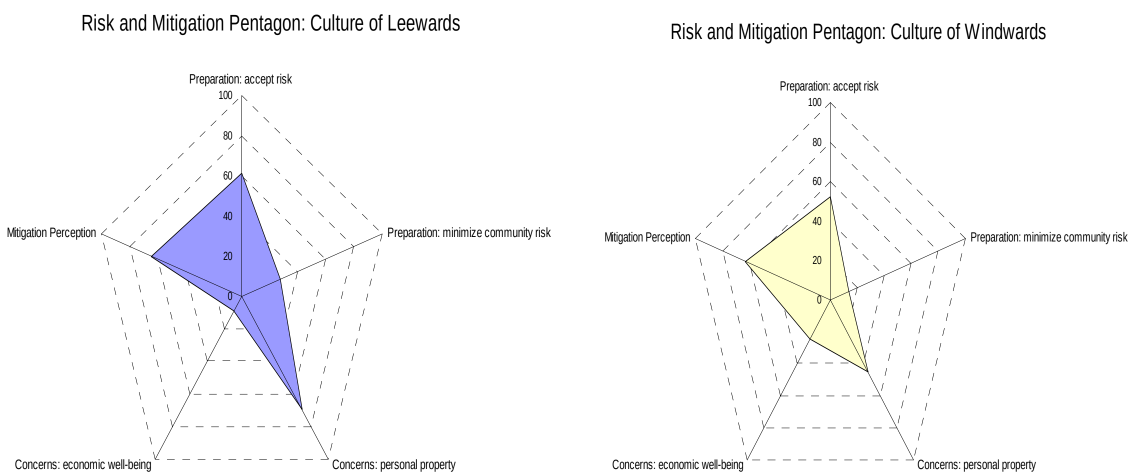

Figure 5.1 Pragmatic culture about perceived risks and mitigation

Overall, the pentagons (figure 5.1) indicate that the Leeward Islands have a more mature culture for disaster risk perception and mitigation than the Windward Islands. Identification of risks is a precursor to mitigation and acceptance of disaster risks often lead to more proactive steps to reduce or eliminate risks overtime (Haddow & Bullock, 2004). Over sixty percent of household respondents perceive that it is better to retrofit and make structural changes to damaged structures rather than rebuild them to previous form. Though the general (mitigation) perception is generally high among all the islands, there is a greater sense of risk acceptance among households of the Leeward Islands than the Windwards (figure 5.1). Perhaps, this stems from the fact that the Leeward Islands have been more affected by hurricane hazards in recent years than the Windward Islands and that households learn more from their own experiences than from others. This lack of experience for Windward Island households is more evident when households were asked how they prepared for a pending storm. In the Leeward Islands, there was a greater effort to jointly reduce personal loss and minimize the risk to others in the community through securing outside property and loose objects when compared to the Windward Islands. Finally, the culture about perceived risks and mitigation is evident in what people value and protect. In the Leeward Islands where economic well-being is more tied to the service sector as opposed to the agricultural sector there is less concern for economic well-being and a heightened concern for personal property and insurance related issues. In the Windward Islands, there is heightened concern for economic well-being and less focus on personal property. Other than Hurricane Ivan (2004), the Windward Islands and Barbados were hardly impacted by severe storms since 1979 while the Leeward Islands suffered from at least 5 destructive hurricanes. The mitigation culture may therefore be a dynamic element that fluctuates significantly overtime through experiences rather than education and should therefore be evaluated in greater detail in future studies of mitigation.

5.1.2 Impact of Hurricanes Lenny and Ivan on Households

Structural mitigation during the disaster recovery period applies more to damaged or impacted households than unaffected households. Only 19% of all the households throughout the study area suffered damage to their primary house from either Hurricane Lenny or Hurricane

Ivan. The combined heaviest damage caused by the two hurricanes was structural damage to the roof of (55.5%) houses (table 5.1). Noticeably, the southern islands suffered more structural damage due partly to the direct path of Hurricane Ivan, but also due to less rigorous roof construction associated with lack of recent disaster experience in this sub-region. Thirty-two (32) percent of houses suffered material damage to roof or wall material (Table 5.1). In essence, the higher material damage is compared to structural damage (*with all else being equal)* and indicates that houses have become more disaster resistant overtime. Islands in the north which have a more mature disaster mitigation culture because of more disaster experience and rigorous construction suffered almost one-and-a-half times as much material damage (58%) as structural damage (42%). Islands in the South and Central suffered almost four times more structural damage (78%) compared to material damage (22%).

Table 5.1 Extent of damage to primary house *(N=65)*

Extent of damage to primary house	Northern	Central	Southern	Entire Region
Material damage to roof or walls	57.8%	20.0%	22.0%	32.3%
Structural damage to roof only	31.6	40.0	68.3	55.5
Structural damage to both roof and wall	5.3	0.0	0.0	1.5
Destabilization or damage to foundation	5.3	0.0	0.0	1.5
Destruction of entire house	0.0	40.0	9.7	9.72
Total	*100.0*	*100.0*	*100.0*	*100.0*
Pearson's R value was significant: .312 @ .012 level of significance				

It is generally accepted that besides the intensity of the storm, three other (dependent) factors - number of hurricanes experienced (H), type of construction (C) and preparation for the pending storm (P) - affect the amount and level of damage than households suffer. I regressed the aforementioned independent variables first against the whether or not the household suffered damage (D), then against the level of damage the household suffered (L) as shown in tables 5.2

and 5.3 respectively. While having masonry external walls is generally accepted on the islands as a way to prevent damage, it was not a significant determinant of the damage suffered. Instead I used the connection between the roof sheeting and purlins as seen from the eaves as a simple indicator of type of construction. For each house, I determined whether the connection was poorly tied (e.g. unclenched nails), partially tied or well tied (e.g. screws/securely clinched galvanized nails with large washers; minimal eaves overhang).

After review of the regression, I found that the condition of the connection between roof sheeting and purlins was a statistically significant predictor of whether a household was damaged. I also found that the better the connection between the roof sheeting and the purlins, the lower the likelihood that households will suffer damage to their primary house. Finally, I found that the number of hurricanes experienced and degree of preparation for the pending storm had limited impact on whether households suffered damage when compared to proper connection of the sheeting to the purlins. Nonetheless, they all help to reduce the likelihood of damage to property if implemented.

$$D = 1.067 - 0.24C - 0.035P - 0.014H$$

Where D = the household suffered damage, H = number of hurricanes experienced, C= type of construction and P = preparation for the pending storm.

(Note: Equation was generated from household survey data where N = 65)

Clearly, the stronger the ties between purlins and rafters, and the more structural preparation that households conduct for the pending storm, the more households are likely to avert damages to their primary house. The equation also indicates households learn from experience, and there is likely to be less incidents of damage overtime as households with more hurricane experiences suffered less damage.

Table 5.2a Linear regression of predictors of whether households suffer damage (N=260)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.379	3	.793	4.086	.007[a]
	Residual	49.682	256	.194		
	Total	52.062	259			

a. Predictors: (Constant), Surveyor's observation of roof-to-purlins tie (C), Did you make any preparations for the hurricane (P), Number of hurricanes experienced (H)

b. Dependent Variable: Did you suffer any damage or loss from last hurricane (D)

Table 5.2b Linear regression of predictors of whether households suffer damage

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.067	.237		4.494	.000
	Number of hurricanes experienced (H)	-.014	.010	-.086	-1.395	.164
	Did you make any preparations for the hurricane (P)	-.035	.067	-.032	-.523	.601
	Surveyor's observation of roof-to-purlins tie (C)	-.240	.082	-.181	-2.934	.004

a. Dependent Variable: Did you suffer any damage or loss from last hurricane (D)

When I regressed the same independent variables against the level of damage suffered however, there were no significant relationships or predictors. So, I modified the preparation variable to include the type of preparation instead and found that as the type of preparation moves from personal survival activities to more holistic preparation including securing the entire house, making last minute repairs (rapid mitigation) and securing outside property, the level of damage sustained diminishes (table 5.3). While the type of connection between roof sheeting and purlins was significant in predicting damage, it was a non-factor in predicting the level of damage. It was removed from the model by stepwise regression. The remaining factorial model was significant at 95 percent level of confidence, though only 33.3% of the level of damage sustained was explained by the level of preparation and number of hurricanes experienced. The model also shows that the more hurricanes households experience, the more likely they are to adopt measures that reduce the level of damage from subsequent hurricanes.

$$L = 3.114 - 0.052H - 0.116P$$

Where D = the household suffered damage, H = number of hurricanes experienced and L = the level of damage the household suffered.
(R-squared = .332)

(Note: Equation was generated from household survey data where N = 64)

Table 5.3a Linear regression of predictors of the level of damage households suffer (N =64*)*

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.553	2	5.276	3.769	.029[a]
	Residual	85.385	61	1.400		
	Total	95.938	63			

a. Predictors: (Constant), Number of hurricanes experienced (H), Coded type of preparation (P)

b. Dependent Variable: Extent of damage to primary house (L)

Table 5.3b Linear regression of predictors of the level of damage that households suffer

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.114	.298		10.442	.000
	Coded type of preparation (P)	-.166	.078	-.270	-2.124	.038
	Number of hurricanes experienced (H)	-.059	.060	-.125	-.985	.328

a. Dependent Variable: Extent of damage to primary house (L)

5.1.3 How did households deal with displacement and recovery?

Impacted households often get displaced from their primary house during and immediately after the disaster. Long-term displacement causes stress on institutional infrastructures (primarily shelters) which are meant to be temporarily utilized. Those who stay in emergency shelters longer often do not have the resources to restore their households and often wait for government or community assistance for extensive help. *How did displaced persons fear during hurricanes Ivan and Lenny?* Though 19% of households were damaged, only 11% were displaced. There is an overwhelming preference for displaced persons to stay with families and friends rather than institutional shelters, especially after the storm (table 5.4). This suggests that the safety net within the islands is strong and there is significant community support for displaced persons. Also, on average displaced persons who stayed with families and friends (non-institutional settings) stayed longer (1.5 months) than did those who stayed at emergency (institutional settings) shelters (1 month). However, of the few (N=6) who were displaced for more than 6 months, those who stayed at institutional settings stayed more than one year on average compared to those who stayed at non-institutional settings (10 to 12 months).

Table 5.4 Displaced Households' Preference of Place to Stay *(N=36)*

Preference of Place to Stay for Displaced Households	Entire Region
Before the storm (N=26):	
Non-institutional	53.8
Institutional	46.2
After the storm (N=36):	
Non-institutional	63.9
Institutional	36.1
Total	*100.0*
Pearson's R value for comparison between three sub-regions was not significant: .218 @ .202 level of significance	

5.1.4 Assessing the quality of household level mitigation in disaster recovery

To further assess the ability of households to undertake effective mitigation in disaster recovery, I utilize a combination of six indicators and represent them in mitigation visualization hexagons. Most studies rely on a subset of indicators for mitigation mostly at the community and national level. This analytical framework provides a household level understanding of the mitigation quality on the islands. I used twice as many structural mitigation indicators compared to non-structural indicators because of my intent to emphasize mitigation implementation. The six mitigation indicators are:

1. level of awareness of building code changes among households (non-structural)
2. percentage of households that currently have home insurance (non-structural)
3. solid roof connection: tie of roof sheeting to purlins (structural)
4. solid foundation: tie of foundation to ground (structural)
5. past mitigation activity: made modifications from previous storm (structural)
6. willingness to implement future physical mitigation measures (structural)

While use of building codes started with the region wide CUBIC in the 1980s, adoption and institutionalization of national building codes in the Eastern Caribbean did not materialize until the 1990s and turn of the 21st century in some cases. Household level awareness of building codes and changes to the codes indicate how much buildings codes have influenced household construction. Most building codes have become more stringent over time to promote sustainable, safe-building practices. Noticeably, households in the north felt that building codes have become more rigorous than households in the south (table 5.5). Since changes in building codes reflect experiences and policies to prevent mistakes of the past, it is likely that the north would have more rigorous codes because of more recent disaster experiences. A significantly higher percentage of households in the South (24%) were unaware of building codes or changes in building codes compared to those in the North (2%). It is easier to implement policy changes in the policy window after disasters and so the North Islands may have experienced more opportunities to do so than the southern Islands because they experienced a higher number of significant hurricanes.

Table 5.5 Change in building codes over time *(N=101)*

How have building codes changed overtime?	Northern	Southern
More rigorous	70.0%	49.0%
More lenient	16.0	11.8
No change	8.0	15.7
Don't know	2.0	23.5
Total	*100.0*	*100.0*
Pearson's R value = .358 @ .000 level of significance		

Households were asked the best way to protect themselves against future disasters. The majority of households felt that safer construction was the most important method to build resilience. On the Southern Islands, insurance was seen as the second most popular means of protection against future hazards. This probably stems from the fact that this is the first time most of the households were damaged and they generally think of insurance as saving money. In the Northern Islands, less than 5 percent of households ranked insurance as the top measure to protect against future hazards. In fact, many commented that insurance was either not affordable or they were very skeptical after some tried it. Northern island households rank relocation to a less vulnerable place on the island higher than insurance, which indicates the desire to comply to hazard mapping to minimize insurance and damages as much as possible.

Table 5.6 Best measure to protect against future hazard risks, by subregion *(N=188)*

How to protect household against hazard risks?	Southern	Northern
Use hazard-resistant building guidelines	50.6%	75.2%
Use insurance	32.2	4.0
Relocate to less vulnerable part of island	2.3	5.9
Relocate off island	1.1	0.0
None	13.8	14.9
Total	*100.0*	*100.0*
Pearson's R value = .358 @ .000 level of significance		

Noticeably, 85% intend to use better construction or mitigation measures in the future rather than rely on insurance (table 5.7). Only 5.3% plan to use insurance in the future. Most households felt premiums were too high or insurance companies were unreliable.

Table 5.7 Best measure to protect against future hazard risks, entire region *(N=188)*

	How to protect household against hazard risks? (N = 217)	Actual protective measure households used (N = 93)	Future protective measure household will use (N = 113)
Use hazard-resistant building guidelines	67.7%	49.5%	85.8%
Use insurance	14.7	25.8	5.3
Relocate to less vulnerable part of island	4.1	3.2	2.7
Relocate off island	0.5	-----	-----
None	12.9	21.5	6.2
Total	*100.0*	*100.0*	*100.0*

Mitigation is understood as actions taken towards loss prevention including changes in attitudes and behavior. While households in the Eastern Caribbean have demonstrated strong commitment to ensuring that the roof connection and foundation soundness are fairly well secured, they remain skeptical or ignorant of insurance and reluctant to commit to future mitigation changes without being forced to (figure 5.2). Positively, this research found that 80%

of affected households have retrofitted or restored their homes (with some elements of mitigation) from past storms. This suggests that mitigation in the recovery or rehabilitation phase can be successful if valid and timely information is provided. The Eastern Caribbean mitigation hexagon also indicates that households in the region are already well involved in mitigation, but may need to be better persuaded about the benefits of insurance and the commitment of resources to future resiliency work before another disaster strikes.

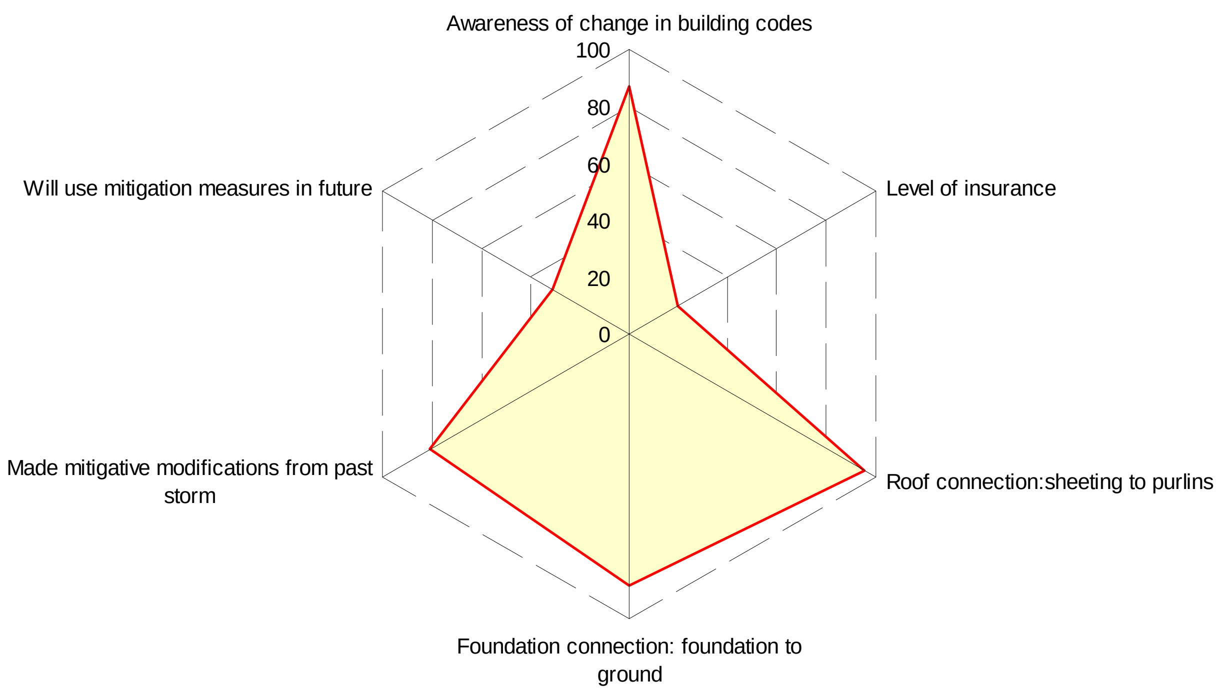

Figure 5.2 Mitigation effectiveness in the Eastern Caribbean

There are, however, some distinctions in mitigation effectiveness between the Eastern Caribbean sub-regions that must be noted. While the roof and foundation connectedness is comparably the same, households in the Northern islands were more likely to make mitigative modifications from past storms than those in the Southern islands (figure 5.3). This is so primarily because of more storm experiences in the north and possible a more mature culture of safe building construction as discussed in section 5.1. This experience is reflected in a greater commitment by Northern island households to use mitigation measures in the future to prevent or reduce future losses. They are also more aware of the changes in building codes or building requirements that stimulate mitigation. Negatively, households in the North are less committed to insurance due primarily to bad experiences and skepticism.

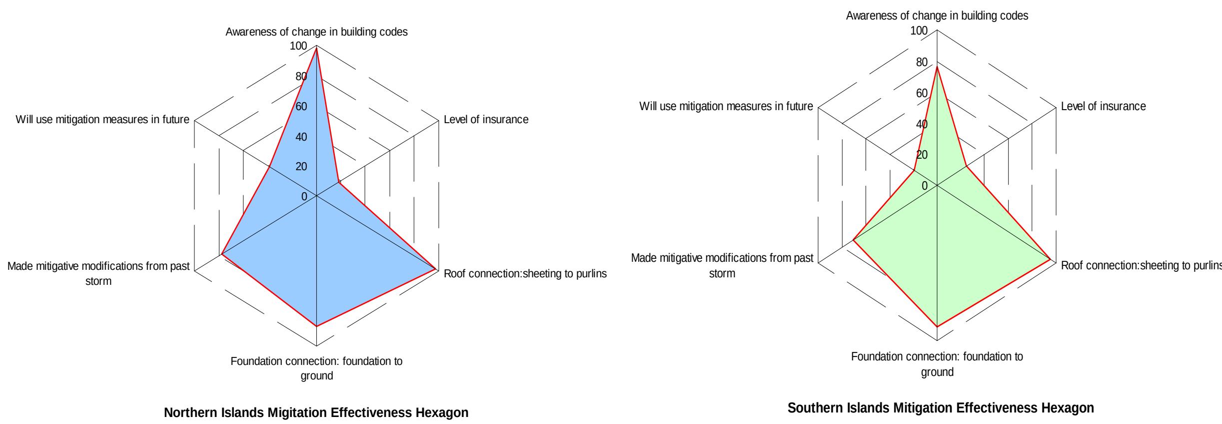

Figure 5.3 Mitigation effectiveness in the Northern and Southern Eastern Caribbean households

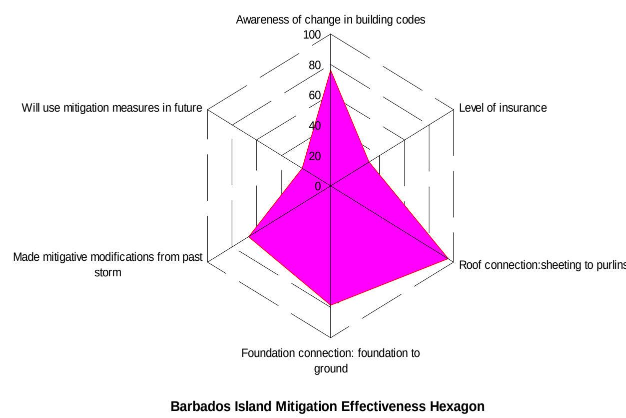

Figure 5.4 Mitigation effectiveness on Barbados Island

Among the differences between islands, the most significant to note is the foundation connection. In Barbados and Antigua, less than 80% of households had well secured foundations compared to the other islands. In fact, the other islands boosted the sub-regional levels to above 90%. I believe this anomaly is due to the low-lying and limestone nature of these two islands. Several homes in the survey area on Barbados and Antigua are loosely secured to porous concrete blocks or sit on wooden pilings. There is generally a greater degree of sensitivity when dealing with sloped areas and poorly drained soils on the other islands.

The final major difference is between rural and urban areas. While both areas are comparably cognizant of building code requirements and changes, urban areas have a higher percentage of households with well secure secured roof and foundation connections than rural areas (figure 5.5).

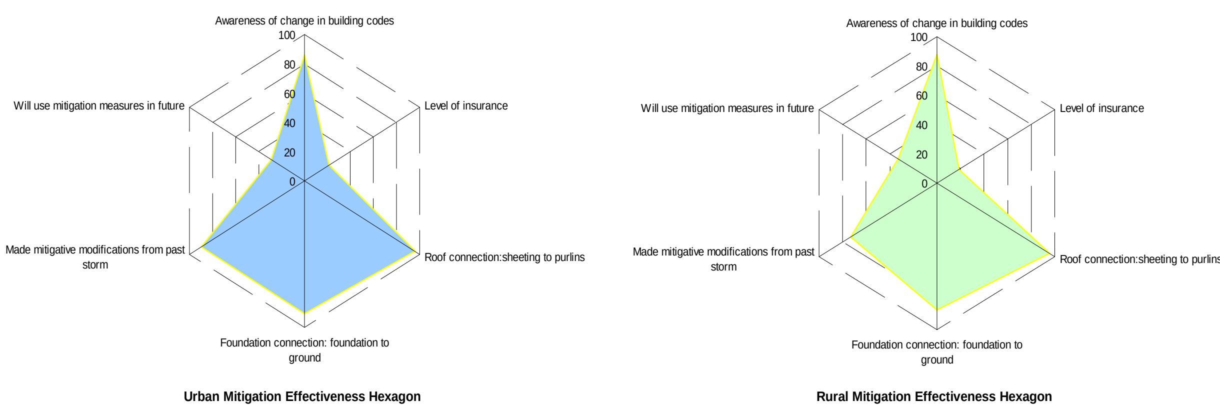

Figure 5.5 Rural vs. Urban Household Mitigation Effectiveness

5.2 MITIGATION AMONG BUILDERS AND DESIGNERS

I surveyed 58 builders and designers from the seven study islands (*response rate of 55%*). While statistically significant comparisons could not be made between islands or sub-regions, the completed surveys allow us to draw conclusions about how building designers and builders mitigate against disasters in their line of work. For the two hurricanes, builders and designers in St. Vincent and Barbados were hardly engaged in any rehabilitation of households because most of the few affected households used self-help or were relocated to new structures through government programs.

5.2.1 Both Designers and Builders

Designers and Builders engaged in positive practices can lead to more efficient mitigation in the disaster recovery phase (figure 5.6). All the building designers and builders state that they are aware of the building codes and changes over the past 15 years. However, not all of them comply with the building codes fully and less than 90% communicate building code requirements with their clients on a regular basis. Designers and builders retrofit existing buildings with stronger and more hurricane resistant design and construction about 75% of the time. Sometimes, they are forced by economics to restore buildings to pre-disaster conditions without mitigation. Additionally, only 60% of designers and builders participate in hazard and disaster management workshops. Recent projects such as the Post Georges Mitigation Project and the Post-Ivan Grenada contractors' certification projects have been successful in gathering builders and designers together for disaster management and safe building workshops. However, this must be an ongoing process with re-certification or required updates to maintain certification. Such programs and processes allow for currency of mitigation practices.

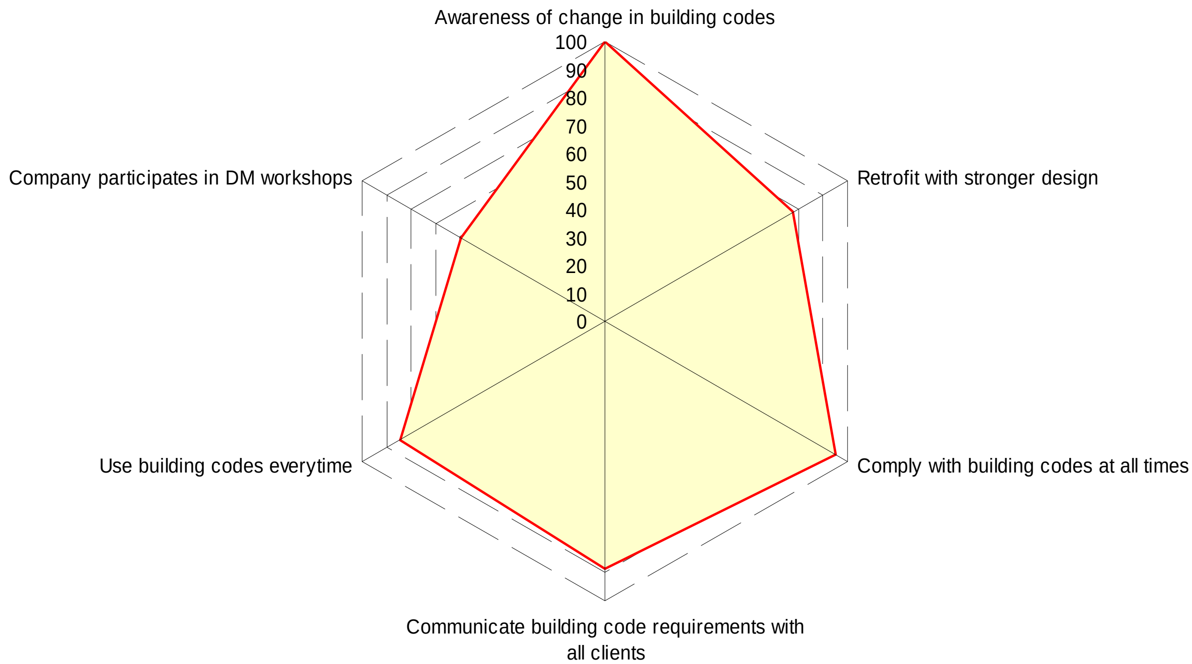

Figure 5.6 Builders and Designers Mitigation Effectiveness Hexagon

I asked designers to state the top three areas where they emphasize most with the application of the building codes and guidelines. Fifty percent stated that the roof connection and structure was the most important element, twenty percent said the entire structure while 14 percent emphasized the foundation footing and connections.

Table 5.8 Top building code measures implemented

Top Building Code Element	Frequency	Valid Percent
Roof connection and structure	22	50.0%
Entire building structure	10	22.7
Foundation footing and construction	6	13.7
Eaves and overhang design	3	6.8
Rafter spacing	3	6.8
Total	*44*	*100.0*

Mitigation and disaster reduction can become more effective if planners, regulators and disaster management agencies reduce the focus on alternative shelter and promote safer building. A building designer from Dominica who also engages in construction suggests that they should "*promote that the safest place to be should be your home'* not necessarily shelters. Households would then *put things in place to strengthen their home*. Another designer suggested the development of a "Construction Information Bank" where construction information can be shared on a regular basis.

5.2.2 Designers – Architects and Draughtsmen

Architects and draughtsmen generally are well aware of building code requirements and factored them into their designs and plans (figure 5.7). However, they only communicate the building code requirements to clients 90% of the time. Every client deserves to be made aware of building code required design. With more information, households will make well-informed decisions on blending cost savings with hazard-resistant design. Designers have not been as involved in the disaster management educational and awareness process as builders. Their participation in such training is below par and they need to be further sensitized to local requirements in building design.

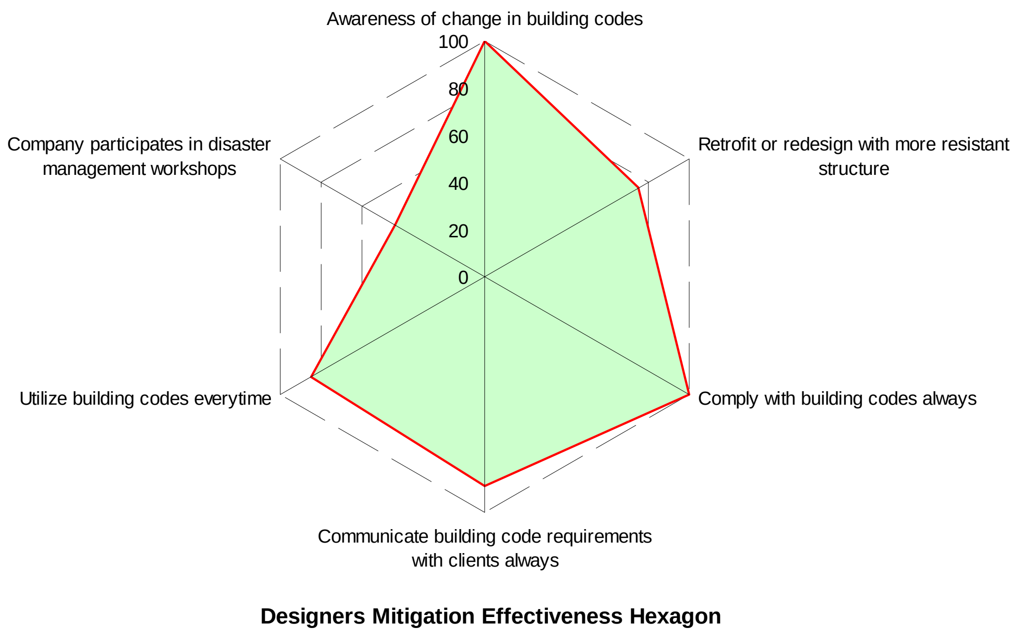

Figure 5.7 Mitigation Effectiveness Hexagon for Building Designers

The chief complaint of designers is the influence and "free-reign" of the informal designer. "*Informal designers often take short-cuts and neglect critical mitigation aspects of building to satisfy the "pocket" of households*," complained one architect from Dominica. He further stated that "*… a license and registration structure is badly needed to ensure fairness, but more importantly to maintain integrity in building design…"* Grenada planned on developing a certification and registration structure for designers in 2006, and is still completing this process. The other Eastern Caribbean islands are yet to engage in such a process though there are formal associations of architects and engineers on each of the islands.

5.2.3 Builders and Contractors

Builders and contractors expressed similar views to designers. They however have a fuller mitigation hexagon because of their participation in disaster management workshops and have a tendency to retrofit building that are damaged rather than restore them to pre-disaster conditions. (figure 5.8). They also must commit to communicating building code requirements with clients at all times so as to minimize the gap between cost-effectiveness and hazard-resistant construction.

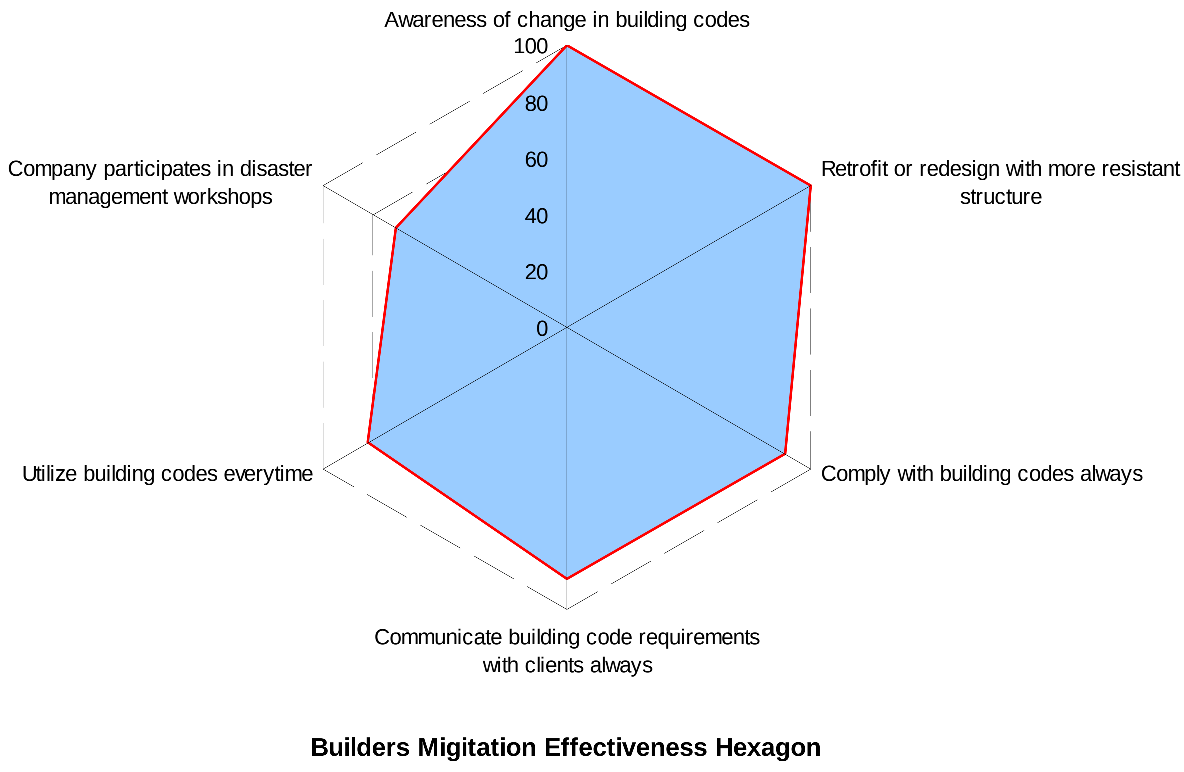

Figure 5.8 Mitigation Effectiveness Hexagon for Builders and Contractors

I also asked builders and contractors why they utilize the building codes and guidelines. Almost 50% of the respondents stated that they utilize building codes because they are essential to completing a good job (table 5.9). Yet almost 30% said they do it because it is required and another 12% do it because of governmental approval or inspection. Regulation and enforcement therefore play essential roles in hazard-resistant construction and mitigation. While regulation and enforcement are essential, it must be coupled with greater awareness at the household levels. In fact, some builders in St. Vincent and Nevis commented that discounts on insurance or lower premiums would encourage households to have better attitudes towards insurance and mitigation as a whole.

Table 5.9 Why do builders use building codes and guidelines?

Top Building Code Element	Frequency	Valid Percent
Essential, important or recommended	19	48.7%
Required	11	28.2
Inspection and governmental approval	5	12.8
Standard or normal practice	4	10.3
Total	*39*	*100.0*

5.3 ORGANIZATIONAL CHARACTERISTICS FOR INTEGRATING MITIGATION

I conducted 20 out of 22 structured interviews with 6 national disaster management agencies (DMOs), 6 other government (or public) rehabilitation agencies, 7 non-governmental organizations and 1 regional disaster management agency (CDERA). Based on the information provided in the interviews and the documents obtained from the respective agencies, I used a five-point scale to determine levels of different mitigation programs for government rehabilitation agencies, non-governmental agencies and the regional disaster response agency (table 5.10).

Table 5.10 Five-point scale to assess levels of mitigation programs

Description	Score
Not in place	0
Exist but not implemented	1
Partially in place but not fully functional	2
Fully in place, functional but irregular	3
Fully functional, updated, regular	4

5.3.1 Role of disaster management organizations in mitigation

The national disaster management organization (DMO) has been established as a key coordinator for disaster management on the islands. The function of many DMOs now includes mitigation, but a wide range of mitigation activities are outside of their regulation. While four of the seven islands have mitigation committees that are managed through the national DMO, three of them have separate mitigation councils that are managed by different government agencies. For example in St. Kitts, the Mitigation Council is under the purview of the Department of Planning. Nonetheless, both structures require substantial collaboration between national DMOs, other government rehabilitation agencies and NGOs for effective mitigation implementation. All islands have mitigation, including its governance and regulation as a definitive task under a sub-committee. However, not all of the mitigation committees or council are functional:

> In St. Vincent, according to Michelle Forbes the deputy director of NEMO, mitigation was hampered by the ineffectiveness of some disaster management committees. "*Most persons who are on the committee do not know their roles and responsibilities. It basically hinders us… So, a lot of persons come, not knowing their roles and functions so they don't know what to do. So that's very important. ...That's one of our hindrances - You have people on the committees but they don't function. So we are really trying to get them involved especially in training."*

> In St. Kitts, the national DMO coordinator, Carl Herbert, states that "*Impact don't take place in isolation – it occurs at the community level, so all of our committees need to function and work together with all the agencies involved.."*

Sadly, it is the dysfunction of the mitigation committee and councils that affect mitigation policy and its currency as well as the eventual transformation of mitigation policy into mitigation activities. In figure 5.9, this research shows that across the islands, the mitigation committee's function and performance is very average (50%). Despite this, the DMO has been able to adopt the model mitigation policy from CDERA; some have incorporated it into also policies while others have adopted it as a stand alone policy. However, besides Grenada who directs funds for this policy through the Agency for Reconstruction and Development (ARD), the other island islands do not sustainable and dedicated mitigation funding that is established through legislation. The national agencies have a strong focus on disaster recovery and emergency housing and there are established hazard mapping for all of the islands. Some hazard maps are not updated however. This hexagon mitigation framework indicates that there is room to improve mitigation capability and effectiveness among all the national DMOs.

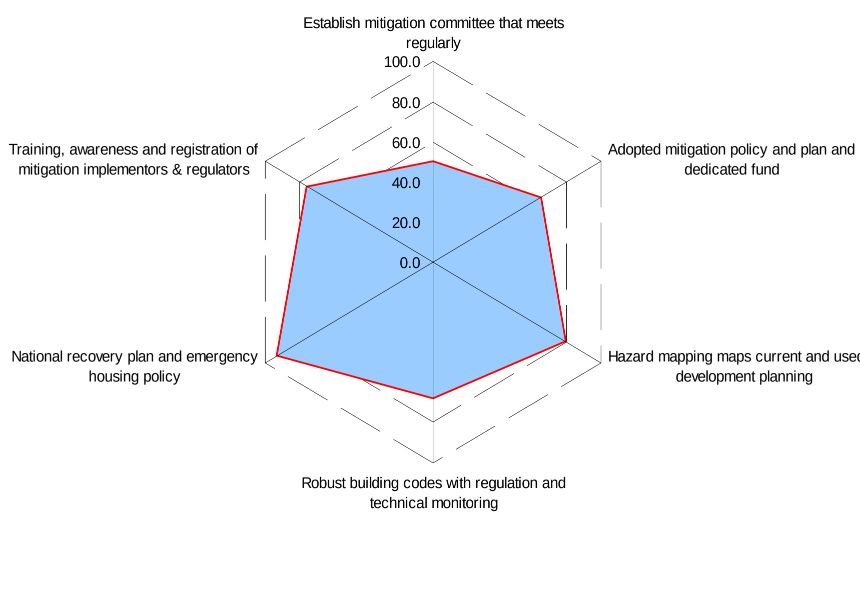

Figure 5.9 Mitigation Effectiveness Hexagon for National Disaster Management Agencies

5.3.2 Mitigation among National NGOs

The mitigation picture is much brighter with non-governmental agencies who secure funding and other resources specifically for such projects (figure 5.10). The Red Cross, for example, has developed mitigation guidebooks that they distribute with each project or housing assistance program they conduct. They conduct training on the islands and consistently utilize the disaster management policies in administering aid and assistance to clients. However, they are also plagued by the inadequate levels of communication and collaboration on mitigation committees.

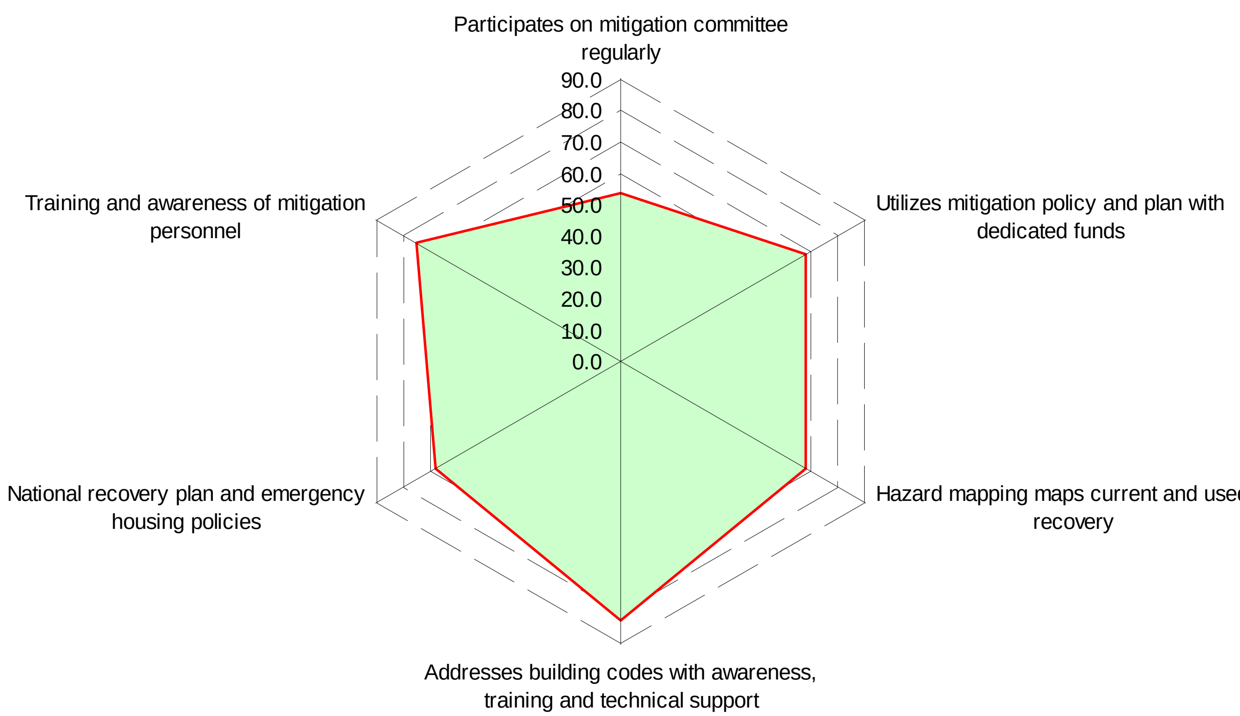

Figure 5.10 Mitigation Effectiveness Hexagon for National Non-Governmental Rehabilitation Agencies

Collaboration between the DMOs, other government agencies and NGOs can strengthen the countries ability to mitigate effectively. This is further discussed in chapter 6, but is nicely summed up by NADMA (Grenada's DMO) coordinator, Sylvan McIntyre:

> *"…We think that there are a lot of other persons out there doing stuff (mitigation). There are still some grey areas in the collaborating area. There is still need for us to come together to (as a community) communalized what we want to put towards mitigation. To ensure that is captivated holistically and in the kind of way that we need to. Collaboration is one of the things that we should do. I think from the disaster management point of view, our internal capacity at the moment does not afford us to release the amount of information and within the kind of times we would want it. We do have some limitation in terms of financing to do these promotions because money talks – and if you have the money, you can buy the prime spots and times to get the information across. We feel that if we have that kind of financing; people are able to sponsor more spots; that there is an allocation for public education information, we'll be able to finance and get the kind of prime spots that we would want. I think also it has to be a cultural awareness, even for the media houses. They themselves and the relationship are improving, but we haven't gotten to the stage where we can be satisfied that people who are involved in public information are bold enough that they would see that every opportunity that they get, they should promote it (disaster management) themselves. So rather than just waiting on us to buy a spot and say do it, I hope they will reach a stage where people (the media) can buy into it and just speak it out and say this is what people need to do. It is beginning to happen now in a small way, but I think that will help us as a nation much more – if people involved in that medium can step up."*

5.3.3 CDERA's Connection in Mitigation and Disaster Recovery

The regional disaster response agency (CDERA) has broadened its scope from preparedness and response at its birth in 1991 to comprehensive disaster management (CDM) at the turn of the 21st century. CDERA's framework now includes mitigation at the national and regional levels. National disaster management organizations are the national focal points for CDERA under the regional agreement that established the agency. The CDERA inceptional agreement mandated the creation of national level disaster management agencies where they were not in existent. These national focal points coordinate national needs and requests through CDERA.

Mechanism for regional and international assistance in disaster recovery

CDERA has an established regional response mechanism that has been set up (figure 5.11). The mechanism is supported by donor groups and the Caribbean Disaster Relief Unit (CDRU). The two donor groups are the Eastern Caribbean Donor Group and the Western Caribbean Donor Group, which are coordinated by UNDP. CDERA serves as the conduit for feeding information. Once an island is impacted, the national focal point would collate the damage information and transfers this information to CDERA, which in turn reports it to the donor group. The donor groups consist of regional and international donors such PAHO, FAO, UNDP, USAID, CIDA, etc. This coordinated information sharing allows the donor to determine where their expertise and support are most needed and to allocate and mobilize accordingly. According to Ms. Riley, "*It allows all donor group members to look at the same picture and determine what pieces of the puzzle to deal with. It makes coordination and mobilization easier, faster and efficient*." In Carriacou (an *island of the nation of Grenada)* for example, the hospital was destroyed by Hurricane Ivan. PAHO, through the donor group coordination, was able to channel its resources to facilitate the quick recovery of this facility as a top priority.

The Caribbean Disaster Relief Unit (CDRU) provides security and other support such as relief distribution and coordination. This is coordinated through the Regional Security System (RSS). Depending on which sub-region is affected, the CDRU will mobilize from any of its four bases that are not affected. These four bases correspond with CDERA's four sub-regional focal points on the same islands, which act as strategic warehousing centers for goods, medical supplies, emergency shelter supplies for the impacted sub-regions. Sub-regional focal points are activated based on the track of storms and the area impacted.

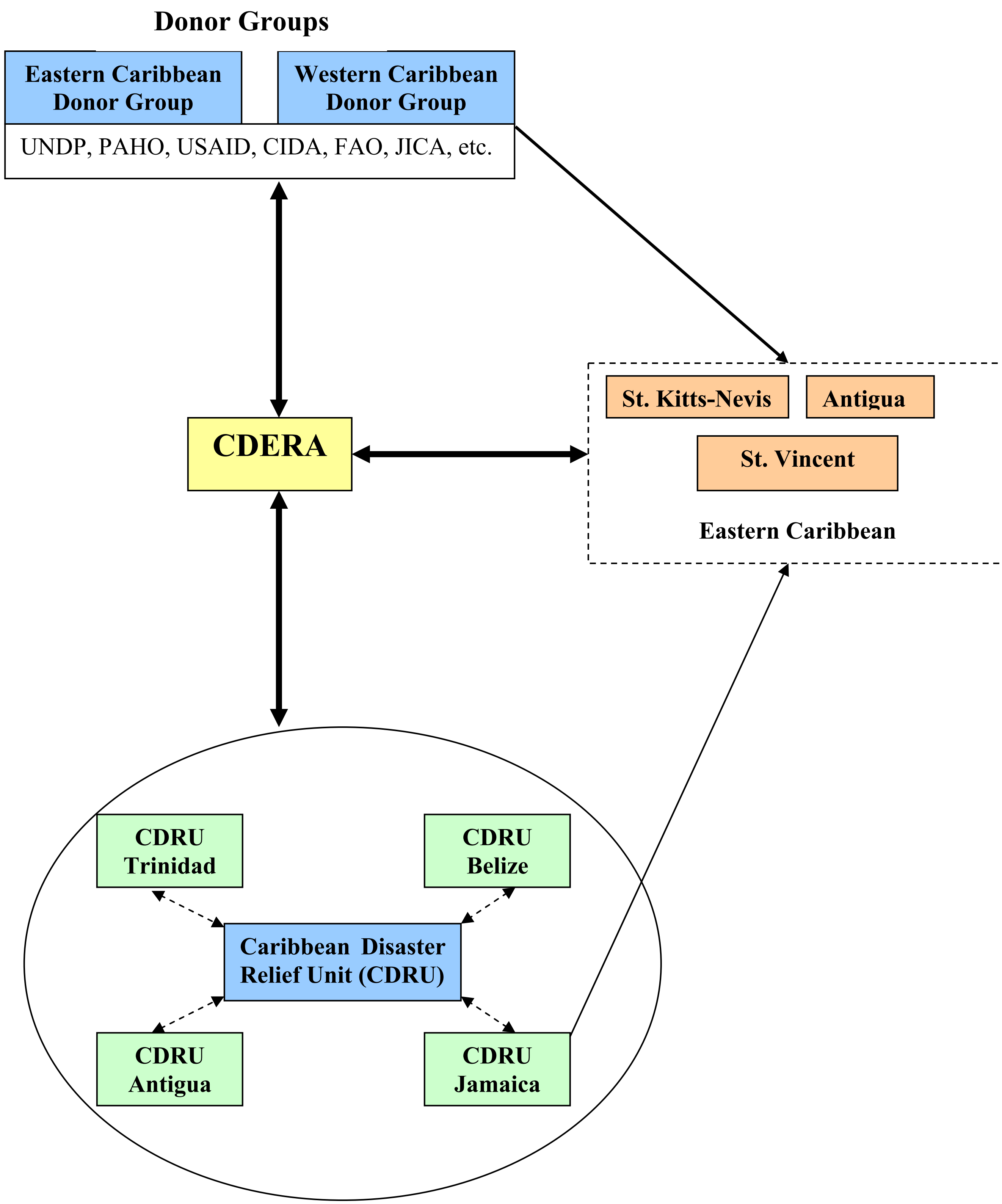

Figure 5.11 Mechanism for disaster recovery at the regional level

At the regional level, extensive work has been conducted since the turn of the century to build mitigation regionally and within the member states. CDERA has developed model mitigation policy and legislation, which were piloted in three member states before they were extended or offered to all members (figure 5.12). They have developed several joint programs with ECLAC, OECS, CDB, CDRU and other regional partners to facilitate both structural and non-structural mitigation at the national level, but this area still has greater potential for resource generation and technology development. CDERA has garnered a significant repository of expertise to assist in mitigation from both regional and international sources. Recently, the World Bank announced the development of the Caribbean Insurance Fund to facilitate mitigation and disaster recovery. This research indicates that mitigation initiatives are well established at the regional level. However, they, like most initiatives, are susceptible to the availability of sustainable financing. In June 2006, CDERA's coordinator – Jeremy Collymore again called on national governments to meet their financial obligations to keep the agency fully functional.

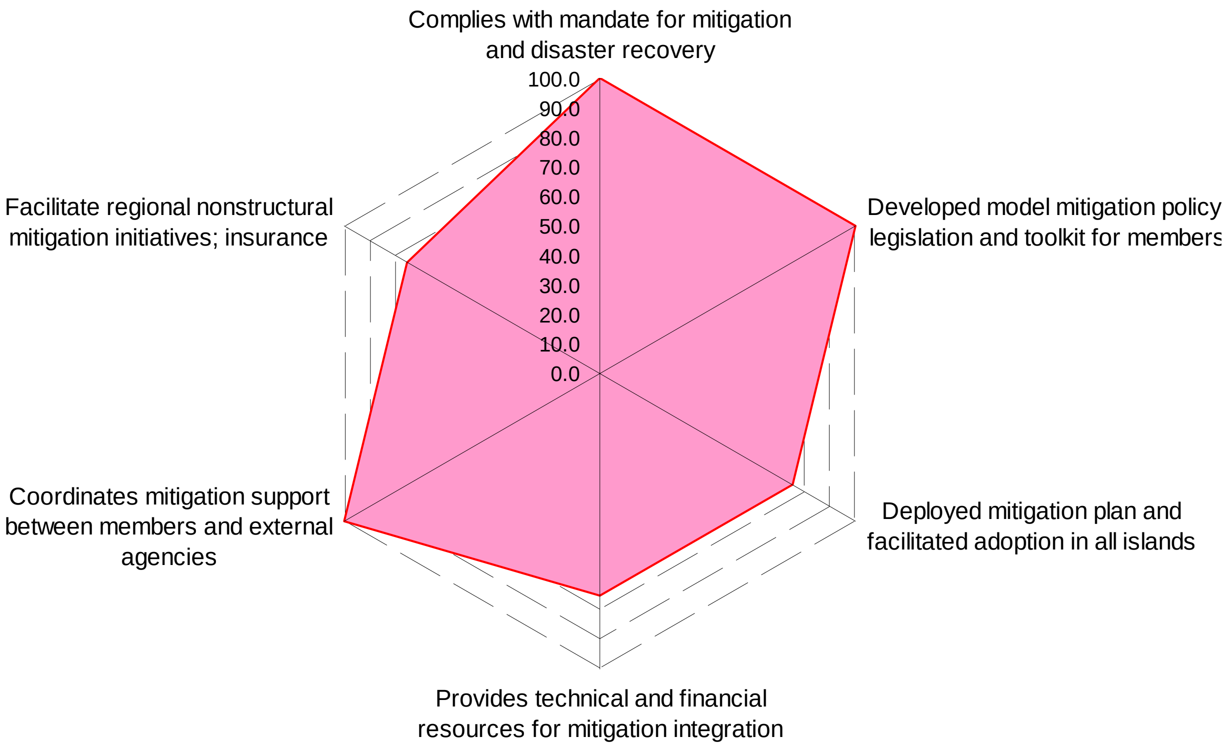

Figure 5.12 Mitigation Effectiveness Hexagon for CDERA

5.4 OVERALL MITIGATION IN THE RECOVERY PROCESS

Effective mitigation requires a holistic effort from all stakeholders. From the analysis in sections 5.2 and 5.3, I consolidated the mitigation effectiveness for each of the six organization types: (1) households, (2) building designers, (3) builders and contractors, (4) national governmental rehabilitation agencies, (5) national non-governmental rehabilitation agencies and (6) CDERA, into a single un-weighted average for each organization type. The average reflects the percent level of mitigation effectiveness based on the factors such as use of building codes, use of mitigation measures and level of insurance, described in section 5.2 and 5.3. From this analysis, I found that at both the national and regional levels there needs to be a shift in the focus of mitigation awareness and effectiveness more towards households (figures 5.13 and 5.14). While training and regulation of builders and designers must continue, DMOs and national rehabilitation agencies need to better educate households of the benefits of both structural and non-structural mitigation. This will place less pressure on builders and designers to shortcut building code integrity based for cost savings because of household requests, and provide greater consensus for them to design and build more resilient structures. Builders and designers are caught in a web of integrity and ethics to meet the demands of households to be cost-effective and yet comply with the more costly demands of hazard resist design and construction.

At the national level, implementers and regulators interact and collaborate to effect mitigation. National disaster management agencies, other governmental rehabilitation agencies and non-governmental rehabilitation agencies are at a satisfactory, but not excellent level of mitigation effectiveness (figure 5.13). As regulators, they need to ensure more access to resources, better information transfer to implementers as well as better structures for compliance and monitoring. Better information sharing, regular meeting and output from standing committees need to be addressed to advance mitigation. In Barbados, for example, by August 2005 the mitigation committee had only met once since its inception in 2001. In St. Vincent, the local Red Cross contends that its roles and mandates conflict with the national emergency management organization because NEMO assumes the responsibility of national focal point. This reduces cooperation and commitment on the common goal of mitigation. In St. Kitts, the national emergency management organization is not part of the board of the development board, which has foremost responsibility for planning and mitigation. These factors limit coordination and mitigation effectiveness because relevant organizations are not updated, informed or involved on a consistent and timely basis.

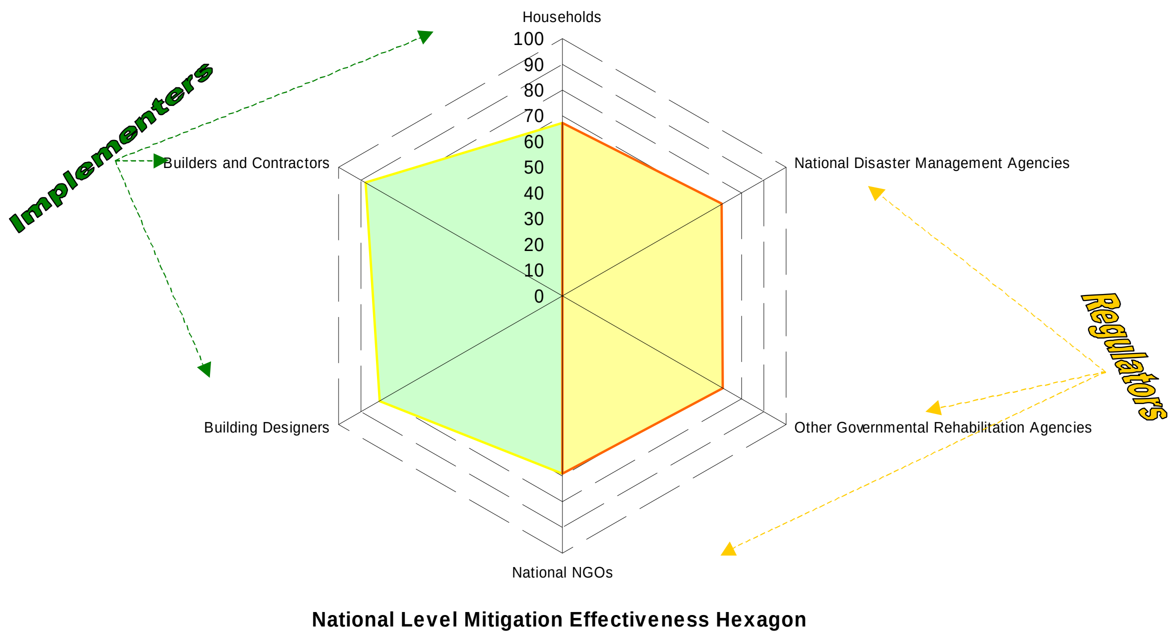

Figure 5.13 National Level Mitigation Effectiveness Hexagon

In addition, several key ties between regulators and implementers are not fully institutionalized. There is no established system for registration and certification of designers and builders on any of the islands, though Grenada began developing a system in 2006. There is also no established system to incorporate informal builders into the mitigation process through systematic training and certification for specific level of rehabilitation, despite project-specific efforts under the Post-Georges Mitigation Project in St. Kitts-Nevis and Antigua and the Post-Ivan effort in Grenada. This results in deficiencies in the mitigation implementation process.

At the regional level, CDERA initiatives are seemingly leading the way to a good mitigation system in the Eastern Caribbean (figure 5.14). However, they either need more authority to require action at the national level or they require more secure and sustainable funding to transfer model programs to national level on a more consistent and thorough basis. This will enable national agencies to function better and allocate more resources and time to mitigation development and implementation. While national agencies are lagging behind in meeting mitigation effectiveness goals and connecting effectively with mitigation implementers, designers and builders have shown that they are up to the task to comply with mitigation requirements. Households remain the key partner in implementing mitigation and need more direct involvement in mitigation awareness and requirements as well as better education on nonstructural mitigation benefits.

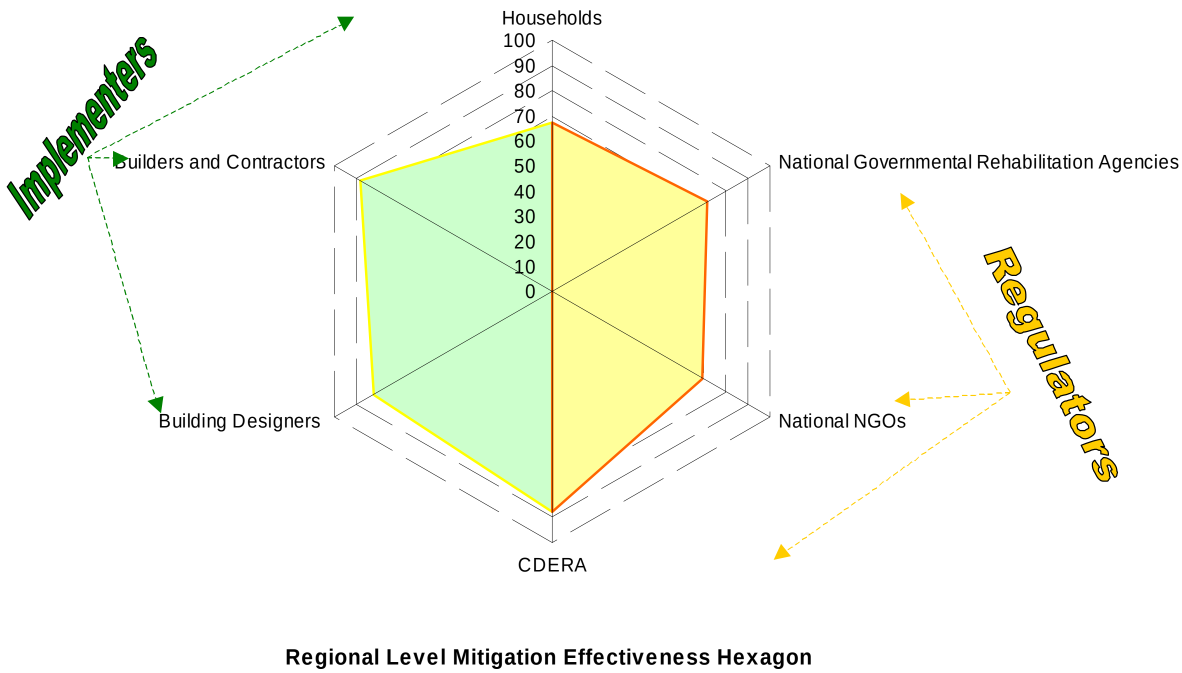

Figure 5.14 Regional Level Mitigation Effectiveness Hexagon

5.4.1 Factors that affect disaster recovery and mitigation

By extension, the factors that affect disaster recovery also impact mitigation effectiveness. Households were asked what factors facilitate or hinder recovery from hurricane-related disasters. Of the 179 that responded, 22 percent felt that working together as a community was the number one factor to facilitate efficient and rapid disaster recovery while the availability of resources, materials and money (21%) was a close second (table 5.11). Also, among the key factors that facilitate disaster recovery are better communication and information sharing and awareness (21%) and improved planning and construction practices (15%). While international relief, government assistance and insurance are needed and helpful, most households view them as secondary to other top parameters.

Table 5.11 Factors that facilitate disaster recovery among households

Factors that facilitate disaster recovery	Frequency	Valid Percent
Working together and community help	39	21.8
Resources, materials and money	37	20.7
Communication, awareness and information sharing	28	15.6
Improved planning and construction practices	27	15.1
Government assistance	13	7.3
Quickly restored utilities	8	4.5
International relief or aid	7	3.9
Hazard related factors	5	2.8
Insurance	4	2.2
Other: counseling, health, courage, God, self-help	11	6.1
Total	**179**	**100.0**

It is well documented that the poor are the most affected by disaster. Many households (47.1%) felt that through government assistance and community help, the poor could be made better off during the disaster recovery phase.

Table 5.12 Factors that affect disaster reduction for the poor

	Frequency	Valid Percent
Government assistance	18	25.7
Working together or community help	15	21.4
Money or financial help	7	10.0
Education or self-help	6	8.6
Provision of housing and shelter	6	8.6
Food and personal resources	6	8.6
Provision of jobs	4	5.7
Better preparation and construction	3	4.3
Recovery planning and communication	3	4.3
Other	2	2.9
Total	**70**	**100.0**

5.5 SUMMARY AND RECOMMENDATIONS

This research indicates that existence and knowledge of safer building codes, guidelines and practices at the household level; advanced technology for knowledge transfer and communication; access to rehabilitation resources and a functional quasi-regulated rehabilitation system are essential for incorporating mitigation into the disaster recovery process. There is a comfortable starting point for mitigation among households in the Eastern Caribbean, but much training, awareness, and up-to-date, readily accessible information must continue on a regular basis. Certification of builders and designers for different levels of work must be undertaken to ensure that the process engages informal builders at the local level. This research shows that regulation of building construction is limited in the disaster recovery environment if it is kept to the normal process. Islands must develop a special distributed system for emergency or disaster building rehabilitation at the local level that facilitates rapid recovery. Currently, building regulating and permitting authority is centrally located in the urban center of all the islands. Adequate monitoring, permitting and support should be more readily available at the community level where it is most needed, especially during the disaster rehabilitation periods.

The regulatory process often fails to link policy objectives to the actual implementation (USAID, 2001; Parker, 1994). While construction codes promote key techniques for safer building, it can not guarantee that workmanship will utilize the appropriate techniques. Unfortunately, many buildings in the Eastern Caribbean have been constructed outside the formal construction process despite pressure from lenders, regulators, insurers, the availability of trained builders and designers and the availability of quality materials. More awareness at the household level, continuous training and improvement of all designers and builders within a system that enables participants to work together and have access to information and share resources are likely to improve performance. Chapter 7 expands on the development of a system or mechanism to foster more household and community level involvement in the mitigation process.

6.0 MECHANISM FOR DISASTER MITIGATION: THE ORGANIZATION IN THE CASE OF HURRICANE IVAN

The Eastern Caribbean islands have adopted the model hazard mitigation plan developed by the regional disaster management coordinating agency (CDERA) in 2003 (See Chapter 4). This plan is comprehensive in its scope, but it lacks a comprehensive, standardized geospatial infrastructure to support its sustainability. A working mechanism exists for regional and international support during disaster recovery as discussed in chapter 5. In this chapter, I will discuss the disaster recovery networks that emerged after Hurricane Ivan at both the national and regional levels. These networks inadvertently impact the effectiveness of integrating mitigation into disaster recovery activities.

The findings in this chapter are based on content analysis that was conducted on situation reports from CDERA on Hurricane Ivan from September 3, 2004 to March 3, 2005. I conducted analysis on all the news articles and situation reports (sitreps) that were channeled through CDERA and published on its webpage for the aforementioned period. This six-month period captures the advisory period and preparations for the pending storm as well as the immediate and short term relief, recovery, reconstruction and rehabilitation periods. This analysis was further supported by analysis of interview transcripts from the national and regional agencies interviewed in this study. The analysis focused only on the aftermath of Hurricane Ivan because records were not available for Hurricane Lenny for the period before January 1, 2000 (2 months after Hurricane Lenny). In the future, a more comprehensive comparative analysis could be done between the sub-regions.

To perform content analysis on the sitreps, I coded the relevant material in a Microsoft Excel spreadsheet by organization and level of jurisdiction, source of funding, date of entry into the system and scope of function. I also coded the interactions among the organizations by date of occurrence, frequency and type of transaction before I converted the data into relational matrices for analysis in the UCINET network analysis software program. This allowed me to examine both the meta-network across the region and international arena as well as the sub-networks within the islands. This nested approach helps to identify the density and scale of interactions during the recovery phase. Through this analysis, I also coded each transaction based on the stage of the comprehensive disaster management cycle to determine how communications progressed over the period and how organizations filtered out or into the mainstream recovery communication framework and activities.

For future studies, it will be beneficial to also analyze national newspaper reports and national sitreps to provide a better picture of the nested relationships following a disaster. I tried to obtain these data, but none of the other islands (except St. Vincent) had coherent archives of any one leading newspaper that was necessary for a comparative analysis. In Barbados, archived copies of the "Nation News" were only available from June 2005, while newspaper reports for Grenada were very sporadic and inconsistent over the study period. The islands affected by Hurricane Lenny were not included in this chapter's analysis for similar reasons. In St. Kitts and Nevis, neither the Labor Spokesman, St. Kitts-Nevis Observer or Democrat were available for the time frame of September 1999 to March 2000, (up to six months after Hurricane Lenny) even after an initial order was placed to purchase such alleged archives. Nonetheless, the findings in this chapter shed light on the dependencies and interdependencies in the disaster management system that would enable policy- and decision- makers to improve the recovery system so that it is capable of efficiently self-organizing and adapting in the complex, non-linear disaster environment.

6.1 DISASTER RECOVERY STRUCTURE AND ORGANIZATIONS

Based on the post-Ivan findings of the study, the disaster recovery system in the seven islands ranges from emergent adaptive systems to operative or semi-adaptive system (Table 6.1). None of the recovery systems have transitioned to a fully auto-adaptive or fully self-organizing system. Yet, several steps have been taken since 2004 to accelerate progress towards auto-adaptive recovery systems on the islands. The two most significant of these steps have been (1) the formalization of several aspects of the comprehensive disaster management model proposed by CDERA through the adoption and implementation of various plans and policies at the national and local levels, and (2) the incorporation of technology into recovery planning and management. These aspects reflect varying levels of organizational learning and technical capacity that enables efficient decision-making (Comfort, 2005).

At the regional level, I characterized the CDERA headquarters as an auto-adaptive recovery system (Table 6.1). Adaptive capacity includes the ability to facilitate innovativeness, responsiveness, motivation, learning and collaboration, and extends beyond high level program and management skills (Comfort 2005). CDERA not only has established several sub-regional focal points, but it also effectively coordinates warehousing for recovery and develops plans and policies that can be adopted at the local level (See Sections 5.3 and 5.4). During and after Hurricane Ivan, the organization mobilized the donor community to provide not just relief aid, but technical support to improve the system of disaster management and rehabilitation over all. This system, according to Liz Riley (Program Manager, CDERA), is informed by all sixteen participating states and members of CDERA which sit on the CDERA Board:

> *"It is through that Board forum that many of the needs, capacity-building needs, training needs, any kind of needs you could think of, are flagged to us as a regional agency. So our programming is very much guided by what the country needs are, and we then try to mobilize funds to support the countries in their own programming but through regional mechanisms."*

In the aftermath of Hurricane Ivan, CDERA activated its mechanism for support and assistance through the Eastern Caribbean Donor group (ECDG) as well as its technical and physical support mechanism through the Regional Security System's Caribbean Disaster Relief Unit (RSS_CDRU). According to Liz Riley, such mechanisms are intended to create more structure in the recovery process, and reduce chaos and uncertainty following a disaster:

> "*We have a regional response mechanism that has been set up. It is a structure that is already in place, which is supported by (1) the Eastern Caribbean Donor Group, which consists of a number of donors and it has representation across a number of the sectors which operate within the Eastern Caribbean itself…. The donor group is headed by UNDP. They do the coordination. CDERA serves as the conduit for feeding information. Let's say for example, St. Vincent was impacted by Hurricane Emily. They would collate their damage information, feed it to CDERA and we would report it to the donor group – because CDERA sits on the donor group. The donor group would consist for example of PAHO, FAO, UNDP, USAID, CIDA, all the major donors and actors in the various sectors. For example in Carriacou, the hospital was lost and PAHO stepped in to see how they could help to facilitate the quick repair of that. So, the members on the donor group have their own particular niche and area of expertise that is brought to bear…."*

Ms. Riley also explained:

> *"The other thing on the response side has to do with the Caribbean Disaster Relief Unit (CDRU). And this is really an arm that is coordinated for us through the Regional Security System (RSS). And we would put the CDRU on standby if there is a serious threat to any of the territories. Every year, the CDRU identifies and will train a body of persons that is their team that could be sent out to countries. So in the Ivan scenario last year, we had put the CDRU on standby and we had to mobilize them. Strategically, CDRU deploys forces from islands that are not in a danger zone. In the case of Grenada, we needed support in terms of security issues, but they are principally there for the purpose of doing the relief coordination in country."*

Table 6.1 Characterization of the post-Ivan disaster recovery system in the Eastern Caribbean

System	Characterization of recovery system	Key System Attributes	Salient requirements for auto-adaptive system
Antigua	Operative Adaptive	EOC; functional and updated equipment; fairly well staffed with trained personnel	Requires ready sustainable access to geoinformation knowledge base to better inform decisions; more community training and participation also required
Barbados	Operative Adaptive	EOC; well situated within key Ministry; access to geoinformation knowledge base through private contractor	Requires better communication technology and readily accessible geoinformation that is updated through the comprehensive disaster management process and ongoing physical planning activities
Dominica	Emergent Adaptive	No dedicated EOC; seriously understaffed disaster management office (does not have EOC capability)	Requires a dedicated structure for full level of DMO activities and a fully equipped EOC with professional knowledge base, communication and geocollaboration technology
Grenada	Operative Adaptive	Functional EOC; sufficient training of existing personnel to use updated equipment;	Expand personnel capacity and professional knowledge base
Nevis	Emergent Adaptive	No dedicated EOC; frequently updated website accessible to the public; close ties to physical planning	Requires a functional EOC with professional knowledge base, communication and geocollaboration technology
St. Kitts	Operative Adaptive	Functional EOC; access to geoinformation products; close ties to physical planning	Requires an improved mechanism for inclusion of mitigation; ready access to geoinformation technology.
St. Vincent	Operative Adaptive	Functional EOC; relatively updated equipment, but quantity is inadequate; organized community based shelter management	Requires informed knowledge base; better communication equipment and access to geoinformation; more structured and matured networks with rehabilitation agencies.
CDERA (region)	Auto Adaptive	Central operation center; access to advanced technology for digital mapping; sufficient training of personnel; technical equipment to improve communication; informed knowledge base; effective outreach mechanism; organizational strategies to respond to recovery needs; systematic resourcing and warehousing for recovery.	This system can be further advanced through technology and training for geocollaboration.

While CDERA clearly demonstrates highly adaptive capability in its disaster management operations, the national disaster management organizations generally lack the framework for auto adaptation, primarily because of deficiencies in their professional knowledge base, communication and geoinformation technology as well as fragmentation in the rehabilitation networks. They have been therefore characterized as emergent or operative adaptive systems of recovery (Table 6.1). Adaptive capacity for recovery and mitigation activities requires multiple agencies to perform and coordinate many tasks in different areas concurrently to effectively build resilience into communities. Knowledge and information from professional staff as well as local personnel and organizations enhance the mitigation process. However, without the appropriate technology for rapid information sharing and the established collaboration structure for mitigation, operations may remain disjointed and ineffective in integrating mitigation into disaster recovery. An environment that facilitates coordination and effective communication not only enhances decision making and mitigation, but it also encourages self-learning among rehabilitation agencies, disaster management personnel and households.

6.2 COMMUNICATION, COORDINATION AND RECOVERY NETWORKS

In the complex and stressful disaster recovery environment, effective communication and coordination are essential to a successful and efficient recovery process which incorporates mitigation activities. The connectedness and density of the recovery networks affect the sharing and transfer of information on a timely basis. One measure of connectedness is centrality. It identifies the primary actors in the network; those that are most connected to other members of the network, i.e. have more ties. Degree of centrality therefore reflects the popularity of an actor among other actors within the network. This measure indicates how well connected the network is. The more central a network is, the easier it may be to develop a structured approach for the sharing of information.

Another measure of connectedness within a network is distance. This measure provides the average number of nodes through which information should pass so that all members of the network are informed. It therefore provides a picture of the density of the network and how coordination among the network members could be achieved efficiently. Typically, the shorter the distance measure, the better it is for coordination of activities among the network members (Wasserman, 1994).

I used UCINET software (Borgatti et al, 2002) to analyze the interactions for degree centrality, fragmentation and network distance once the interactions among the organizations were coded. I dichotomized the data to show whether interactions was present or not and then normalized this data for statistical analysis. I then used Netdraw in UCINET to illustrate the relationships pictorially. The tables and figures subsequently included in this chapter were created using primary data obtained from the CDERA website[32].

6.2.1 Coordination in the Case of Hurricane Ivan

Figure 6.1 shows a map of the organizational coordination network for disaster response and recovery for Ivan. This is a nested set of responses within and among islands within the region. Clearly, CDERA is the main actor for this disaster (Table 6.2). For Hurricane Ivan, all external operations had to be channeled through CDERA. This explains the high degree centrality of 87% that CDERA accounted for in the network. Overall, the Hurricane Ivan recovery network had a medium high Freeman's degree centralization index of 65.31% (Table 6.4). This indicates

[32] Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org

that the network was well connected. This degree centrality also indicates that CDERA was likely the gatekeeper in this context and that most information was more likely disseminated through CDERA. The Caribbean Disaster Relief Unit of the Regional Security System and the Caribbean Electricity Utility Services Corporation were also fundamentally centered in the recovery network with 7% degree centrality.

Table 6.3 and Figure 6.1 also indicate that the Government of Grenada was highly central to the Hurricane Ivan recovery network with a Freeman's degree centrality index of 64%. The Government of Grenada was the lead agency at the national level which was well supported by the Grenada Emergency Operation Center and the Grenada National Emergency Relief Organization.

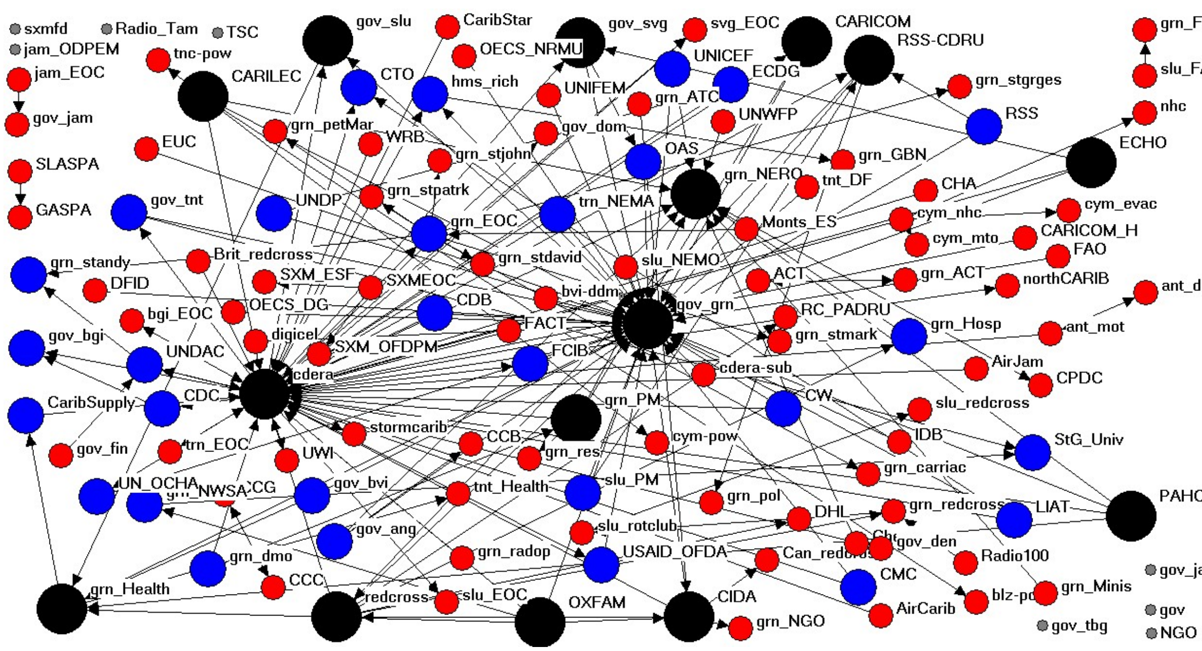

Figure 6.1 Chart of the Overall Organizational Coordination for the Response and Recovery following the Hurricane Ivan impact on Grenada, St. Vincent and Barbados
(Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org)

At the international level, the International Federation of the Red Cross had the highest degree of centrality among international agencies at 13.0%. This exceeds the degree centrality of several sub-regional and national agencies which suggests that the recovery effort required a large international focus as well.

Table 6.2 Acronyms list for organizational coordination chart in figure 6.1, by jurisdiction

Jurisdiction	Main Actors	Key Secondary Actors
National and Sub-regional	Gov_grn – Government of Grenada Gov_slu – Government of St. Lucia Gov_svg – Government of St. Vincent Grn_NERO – Grenada National Emergency Relief Organizatio Grn_Health – Grenada Ministry of Health Grn_PM – Prime Minister of Grenada	Grn_NWSA – Grenada National Water and Sewer Authority StG_University – St. George's University Carib Supply – Carib supply Grn_Hosp – Grenada Hospital Gov_ang – Government of Antigua and Barbuda Gov_bgi – Government of Barbados Gov_bvi – Government of the British Virgin Islands Gov_tnt – Government of Trinidad and Tobago Slu_PM – Prime Minister of St. Lucia Trn_NEMA - Trinidad National Emergency Management Agency
Regional	CDERA-Caribbean Disaster Emergency Response Agency RSS_CDRU – Regional Security System – Disaster Response Uni CARILEC – Caribbean Electricity CARICOM – Caribbean Common Market ECHO	CTO – Caribbean Tourism RSS – Regional Security System CDB – Caribbean Development Bank ECDG – Eastern Caribbean Donor Group CMC - Caribbean LIAT – Leeward Islands Air Transportation CDC – Caribbean Development Cooperation
International	Redcross – International Federation of the Red Cross CIDA – Canadian Agency for International Development OXFAM PAHO – Pan American Health Organization	UNDAC UN_OCHA USAID_OFDA OAS – Organization of American States UNDP – United Nations Development Programme UNICEF – United nations Children and Education Fund CW – Cable and Wireless Hms_rich – HMS Richland (British Naval Vessel)

Table 6.3 Degree centrality of Ivan Response and Recovery Network (calculated using UCINET Software program, Borgatti et al, 2002)

ORGANIZATION	DEGREE	NRMDEGREE	SHARE
Caribbean Disaster Emergency Response Agency (CDERA)	87.000	66.923	0.196
Government of Grenada (gov_grn)	64.000	49.231	0.144
Grenada Emergency Operation Center (grn_EOC)	16.000	12.308	0.036
International Federation of the Red Cross (redcross0	14.000	10.769	0.032
Grenada National Emergency Relief Organization (grn_NERO)	13.000	10.000	0.029
Canadian Agency for International Development (CIDA)	9.000	6.923	0.020
Grenada Ministry of Health (grn_Health)	8.000	6.154	0.018
Government of St. Vincent (gov_svg)	8.000	6.154	0.018
United Nations DAC (UNDAC)	8.000	6.154	0.018
Britain's Naval Vessel HMS Richland (hms_rich)	7.000	5.385	0.016
Regional Security System – Caribbean Disaster Relief Unit (RSS_CDRU)	7.000	5.385	0.016
Caribbean Electricity Utility Services Corporation (CARILEC)	7.000	5.385	0.016
Prime Minister of Grenada (grn_PM)	7.000	5.385	0.016
ECHO	6.000	4.615	0.014
Pan American Health Organization (PAHO)	6.000	4.615	0.014
Caribbean Development Bank	6.000	4.615	0.014
Government of Saint Lucia (gov_slu)	5.000	3.846	0.011
Government of Barbados (gov_bgi)	5.000	3.846	0.011
OXFAM	5.000	3.846	0.011
USAID Office of Foreign disaster Assistance (USAID_OFDA)	5.000	3.846	0.011

Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org

Table 6.4 Statistical description of centrality of Ivan Response and Recovery Network (calculated using UCINET Software program, Borgatti et al, 2002)

STATISTIC	DEGREE	NRMDEGREE	SHARE
1 Mean	3.389	2.607	0.011
2 Std Dev	9.464	7.280	0.022
3 Sum	444.000	341.538	1.000
4 Variance	89.566	52.998	0.000
5 SSQ (Sum of Squares)	13238.000	7833.137	0.055
6 MCSSQ	11733.146	6942.690	0.044
7 Euclidean Norm	115.057	88.505	0.234
8 Minimum	0.000	0.000	0.000
9 Maximum	87.000	66.923	0.172

Network Centralization = 65.31%
Heterogeneity = 6.72% *: MCSSQ = Mean Centered Sum of Squares*

At the sub-regional level there was a high affinity for bi-lateral assistance between national organizations and sub-regional organizations (Figure 6.2). CDERA and the Government of Grenada were the central organizations in the recovery network, with many sub-regional organizations collaborating with both organizations. Three major types of networks emerged at the sub-regional level. First, there were bilateral networks between the government of the islands

(St. Vincent: gov-svg; Grenada: gov-grn; Barbados: gov-bgi) as well as bilateral networks between the government of the affected islands and sub-regional private and public organizations.

Second, there were isolated and direct peer-to-peer networks between national level and sub-regional organizations, but which were also not part of the predominant network. For example, the Caribbean Conference of Churches (CCC) communicated directly with the Grenada Conference of Churches (CCG). Third, the Grenada EOC and the national NERO were the nuclei of a localized network with local parishes and communities. They were pivotal and sometimes the only points for collaboration with all local parishes. The tie that the EOC shared between the local parish and CDERA reflected what Wasserman (1994) termed as a cut-point. If this tie was severed, then it would be difficult to coordinate activities and flow of resources at the community level. This relationship is critical for information transfer and must be acknowledged when constructing a mitigation mechanism.

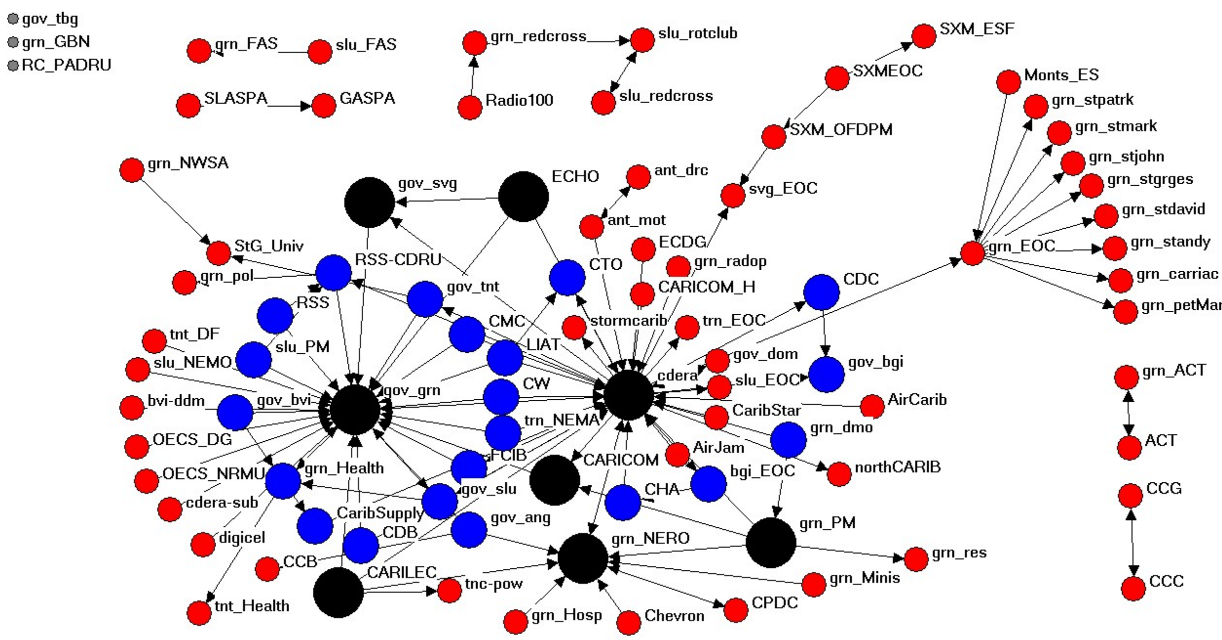

Figure 6.2 Chart of the Overall Organizational Coordination for the Response and Recovery within the Eastern Caribbean sub-region following the Hurricane Ivan impact
(Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org)

In Grenada, the lead agency to coordinate response, recovery and rehabilitation was the Grenada National Emergency Response Organization (NERO).[33] While in St. Vincent, the lead agency to coordinate response, recovery and rehabilitation was the St. Vincent National Emergency Management Agency (St. Vincent NEMA). These lead agencies needed to understand the nature and scope of the disaster, as well as how effectively they can apply existing plans and policies in order to conduct an efficient and timely recovery operation. However, once the disaster was declared a national emergency beyond the scope of the island system, CDERA was activated as the lead agency to coordinate activities both within and outside the island. CDERA communicated directly with NADMA, St. Vincent NEMA and the government of the two islands to coordinate response and recovery on the islands.

Table 6.5 Degree centrality within Eastern Caribbean sub-region for Ivan Response and Recovery Network (calculated using UCINET Software program, Borgatti et al, 2002)

ORGANIZATION	DEGREE	NRMDEGREE	SHARE
Caribbean Disaster Emergency Response Agency (CDERA)	35.000	38.043	0.172
Government of Grenada (gov_grn)	25.000	27.174	0.123
Grenada Emergency Operation Center (grn_EOC)	10.000	10.870	0.049
Grenada National Emergency Relief Organization (grn_NERO)	8.000	8.696	0.039
Regional Security System – Caribbean Disaster Relief Unit (RSS_CDRU)	5.000	5.435	0.025
Grenada Ministry of Health (grn_Health)	5.000	5.435	0.025
Caribbean Electricity Utility Services Corporation (CARILEC)	4.000	4.348	0.020
Prime Minister of Grenada (grn_PM)	4.000	4.348	0.020
CARICOM	3.000	3.261	0.015
Government of Saint Lucia (gov_slu)	3.000	3.261	0.015
Government of Antigua and Barbuda (gov_ant)	3.000	3.261	0.015
Government of Trinidad and Tobago (gov_tnt)	3.000	3.261	0.015
Leeward Islands Air Transportation (LIAT)	3.000	3.261	0.015

[33] Please note that in 2005, NERO was renamed NADMA (National Disaster Management Agency). The popular chant "NERO to Zero", which reflected the negative way that the public felt about the timeliness of NERO's response to the situation may have catapulted this change quicker than anticipated. In NERO's defense, the name was changed to NADMA to better reflect the expanded responsibility of the organization to engage comprehensive disaster management and not emergency response and relief only.

Table 6.6 Statistical description of centrality within the Eastern Caribbean sub-region for Ivan Response and Recovery (calculated using UCINET Software program, Borgatti et al, 2002)

STATISTIC	DEGREE	NRMDEGREE	SHARE
1. Mean	2.194	2.384	0.011
2. Std Dev	4.437	4.822	0.022
3. Sum	204.000	221.739	1.000
4. Variance	19.683	23.255	0.000
5. SSQ	2278.000	2691.399	0.055
6. MCSSQ	1830.516	2162.708	0.044
7. Euc Norm	47.728	51.879	0.234
8. Minimum	0.000	0.000	0.000
9. Maximum	35.000	38.043	0.172
Network Centralization = 36.44%: MCSSQ = Mean Centered Sum of Squares Heterogeneity = 5.47%. Normalized = 4.45% ; SSQ = Sum of Squares			

At the national level in Grenada, it is clear that the emergency management organizations are central to all operations. In the situation reports, there was no indication of collaboration between local level organizations other than through the national emergency organizations or CDERA. However, such communications likely occurred, but were not captured in the formal situation reports. The low degree of centrality of the local level network however suggests that the local level network was fragmented (Table 6.7). There were uncertainties on who was responsible for what in the recovery period, which supports the low centrality score. It also may have led to the creation of the new Agency for Reconstruction and Development in Grenada in January 2006.

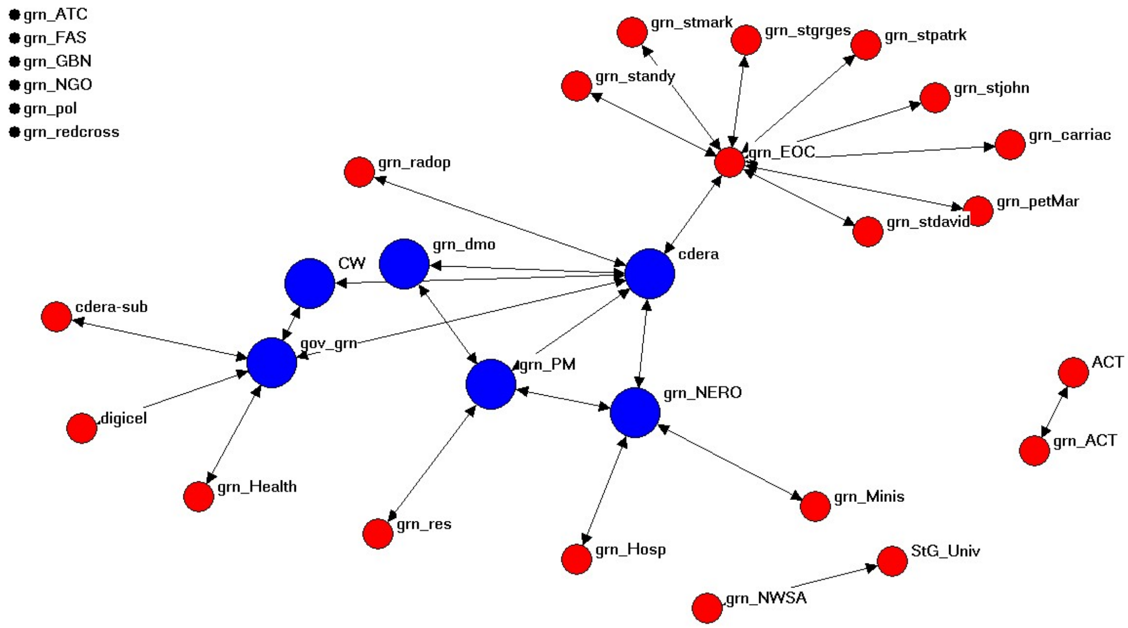

Figure 6.3 Chart of the Overall Organizational Coordination for the Response and Recovery following the Hurricane Ivan impact within Grenada
(Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org)

Table 6.7 Degree centrality within Grenada for Ivan Response and Recovery Network (calculated using UCINET Software program, Borgatti et al, 2002)

ORGANIZATION	DEGREE	NRMDEGREE	SHARE
Grenada Emergency Operation Center (grn_EOC)	9.000	29.032	0.188
Caribbean Disaster Emergency Response Agency (CDERA)	6.000	19.355	0.125
Government of Grenada (gov_grn)	5.000	16.129	0.104
Grenada National Emergency Relief Organization (grn_NERO)	4.000	12.903	0.083
Prime Minister of Grenada (grn_PM)	3.000	9.677	0.063
Cable and Wireless – Grenada (CW)	2.000	6.452	0.042

Table 6.8 Statistical description of centrality within Grenada for Ivan Response and Recovery (calculated using UCINET Software program, Borgatti et al, 2002)

STATISTIC	DEGREE	NRMDEGREE	SHARE
1. Mean	1.500	4.839	0.031
2. Std Dev	1.920	6.194	0.040
3. Sum	48.000	154.839	1.000
4. Variance	3.688	38.371	0.002
5. SSQ	190.000	1977.107	0.082
6. MCSSQ	118.000	1227.888	0.051
7. Euc Norm	13.784	44.465	0.287
8. Minimum	0.000	0.000	0.000
9. Maximum	9.000	29.032	0.188
Network Centralization = 25.81% *Heterogeneity = 8.25%. Normalized = 5.29%*			

6.2.2 Communication: Type of Interactions

I coded the interaction based on the type of interaction that occurred using the stages of the comprehensive disaster management cycle (Table 6.9). Based on this coding I was able to isolate which organizations facilitated response, recovery, rehabilitation or a combination of the three as well as how these stages transitioned into being for the Hurricane Ivan event. Mitigation and comprehensive disaster management interactions were very limited in the early stages of the aftermath (Figure 6.4). Interactions related to restoration and relief distribution in the recovery process spiked one week after the passage of Hurricane Ivan, when initial assessments and search and rescue operations were reported. While the initial interactions in the response and early recovery stages were dominated by national and regional organizations, international organizations were more prevalent in the restoration and relief stages of recovery and sub-regional organizations in the rehabilitation and reconstruction phase of recovery (see also figure 6.5).

Table 6.9 Transaction type coded by comprehensive disaster management phase

Code	Transaction Type
1	Preparedness: prediction, early warning and advisories
2	Preparedness: preparations and activations
3	Response: assessments and search and rescue
4	Response: clean-up, relocation, procurement, warehousing and logistics
5	Recovery: relief distribution, logistics
6	Recovery; rehabilitation and reconstruction
7	Mitigation: hazard analysis, building compliance, communication improvement
8	Comprehensive disaster management and associated funding

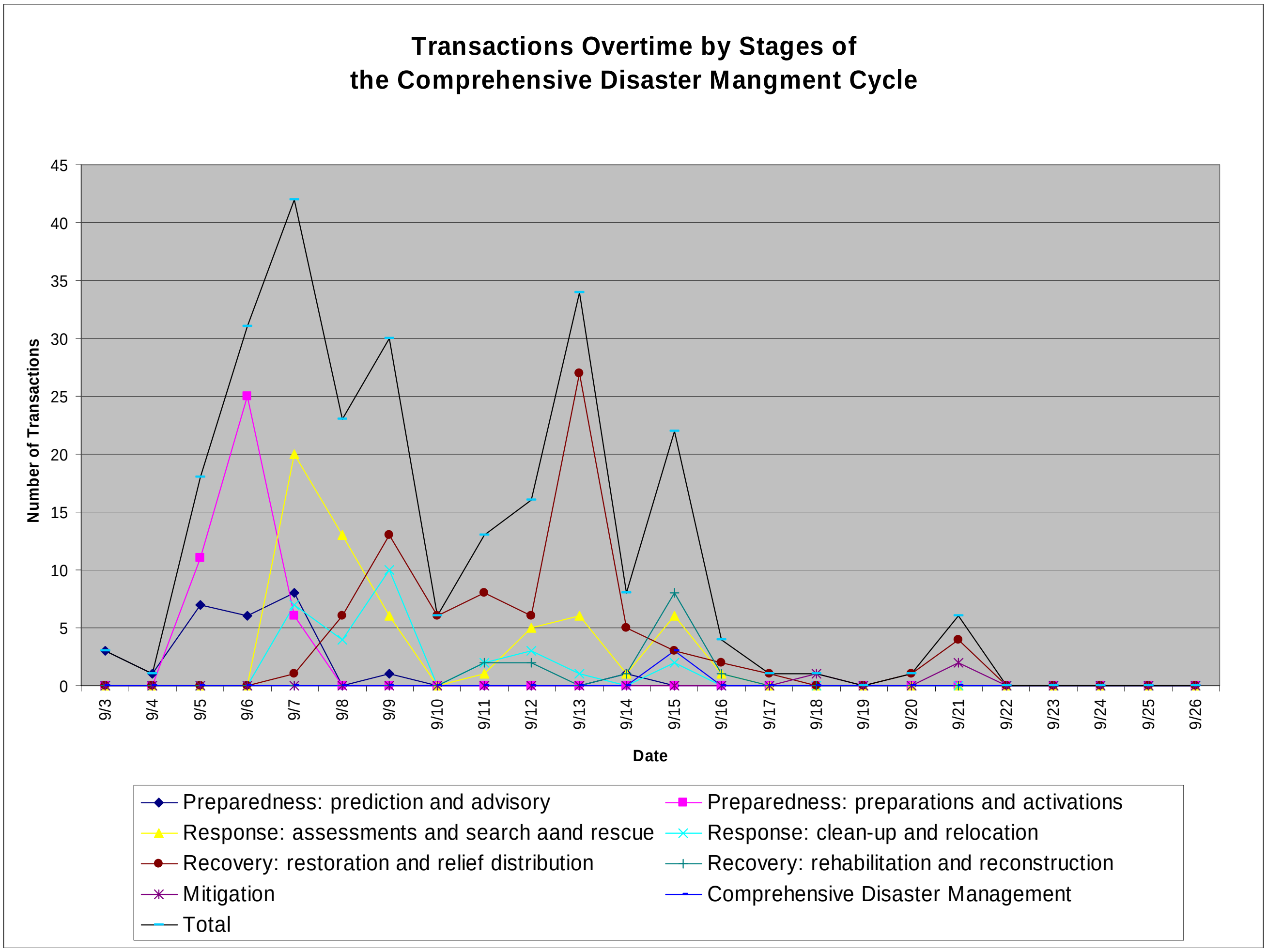

Figure 6.4 Graph of the Transactions Overtime for Hurricane Ivan for Various Stages of the Comprehensive Disaster Management Cycle
(Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to October 31, 2005. URL: www.cdera.org)

6.2.3 Communication: Network Connectivity

Network connectivity affects the rate at which information flows through the network. The more compact the network and the shorter the geodesic distance between actors, the quicker the whole network will be informed. In the complex disaster recovery environment, speed and validity of information is essential for timely and informed recovery. At the regional level, the network was only 24% compact, which means it was too fragmented to always guarantee validity of information flow (Table 6.9). The network is better organized at the sub-regional, regional and international level because of the existing regional and sub-regional mechanisms for assistance discussed in Chapter 4. This indicates a scale-free network because the network is not consumed at one level of jurisdiction, but it emerges to its highest degree of cohesiveness as it expands to the highest (international) level (Barabasi, 1999). The network connectivity is enhanced by the short average geodesic distance of 2.874 ties or connections to reach all actors in the network. Though the network is still somewhat fragmented, the short connectivity distance allows for rapid information flow if the key actors are involved in the first stages of the information sharing process.

Table 6.10 Compactness and Geodesic Distance between actors for entire Ivan network
(calculated using UCINET Software program, Borgatti et al, 2002)

Geodesic Distance	Frequencies	Proportion
1	324.000	0.026
2	3960.000	0.313
3	5308.000	0.419
4	2360.000	0.186
5	528.000	0.042
6	174.000	0.014
7	10.000	0.001
8	2.000	0.000
For each pair of nodes, the cohesion distance algorithm finds the # of edges in the shortest path between them. Average distance (among reachable pairs) = 2.951 Distance-based cohesion ("Compactness") = 0.282 (range 0 to 1; larger values indicate greater cohesiveness) Distance-weighted fragmentation ("Breadth") = 0.718		

Table 6.11 Compactness and Geodesic Distance between actors for Ivan sub-regional network (calculated using UCINET Software program, Borgatti et al, 2002)

Geodesic Distance	Frequencies	Proportion
1	204.000	0.040
2	1778.000	0.346
3	1982.000	0.386
4	874.000	0.170
5	222.000	0.043
6	66.000	0.013
7	6.000	0.001

For each pair of nodes, the cohesion distance algorithm finds the # of edges in the shortest path between them.
Average distance (among reachable pairs) = 2.874
Distance-based cohesion ("Compactness") = 0.237
(range 0 to 1; larger values indicate greater cohesiveness)
Distance-weighted fragmentation ("Breadth") = 0.763

Table 6.12 Compactness and Geodesic Distance between actors for Ivan Grenada Island National Network (calculated using UCINET Software program, Borgatti et al, 2002)

Geodesic Distance	Frequencies	Proportion
1	48.000	0.113
2	130.000	0.307
3	132.000	0.311
4	114.000	0.269

For each pair of nodes, the cohesion distance algorithm finds the # of edges in the shortest path between them.
Average distance (among reachable pairs) = 2.736
Distance-based cohesion ("Compactness") = 0.187
(range 0 to 1; larger values indicate greater cohesiveness)
Distance-weighted fragmentation ("Breadth") = 0.813

6.3 INTER-ORGANIZATIONAL DISASTER RECOVERY

After the passage of Hurricane Ivan, a number of organizations, agencies, community groups and individuals began the recovery and rehabilitation of the lives and livelihood of individuals and communities on Grenada and St. Vincent and the Grenadines (Table 6.12). Sixty-nine percent were organizations with funding received in approximately equal (15%) shares from public sources: among international, regional, sub-regional and national organizations. Privately funded organizations accounted for 17% of the organizations in the post-disaster network while 13.8% were non-profit organizations. Noticeably, public organizations especially at the local level were the key and most popular organizations in the disaster recovery process.

Table 6.13 Funding Source for Organizations within the Ivan Response and Recovery Network

	Public		Nonprofit		Private		Total N of ALL Organizations	
	N	%	N	%	N	%		%
International	19	14.6%	4	3.1%	7	5.4%	**30**	23.1%
Regional	21	16.2%	7	5.4%	11	8.5%	**39**	30.0%
Sub-Regional	20	15.4%	2	1.5%	2	1.5%	**24**	18.5%
National	22	16.9%	4	3.1%	2	1.5%	**28**	21.5%
Local	8	6.2%	1	0.8%	0	0.0%	**9**	6.9%
Totals	**90**	**69.2%**	**18**	**13.8%**	**22**	**16.9%**	**130**	**100.0%**

There was a significant overlap in time between response and recovery and blurred a transition between these phases in the case of Grenada (figure 6.5). In St. Vincent, however, where the amount of damage and disturbance was significantly less, there was a more distinct transition from response to recovery.

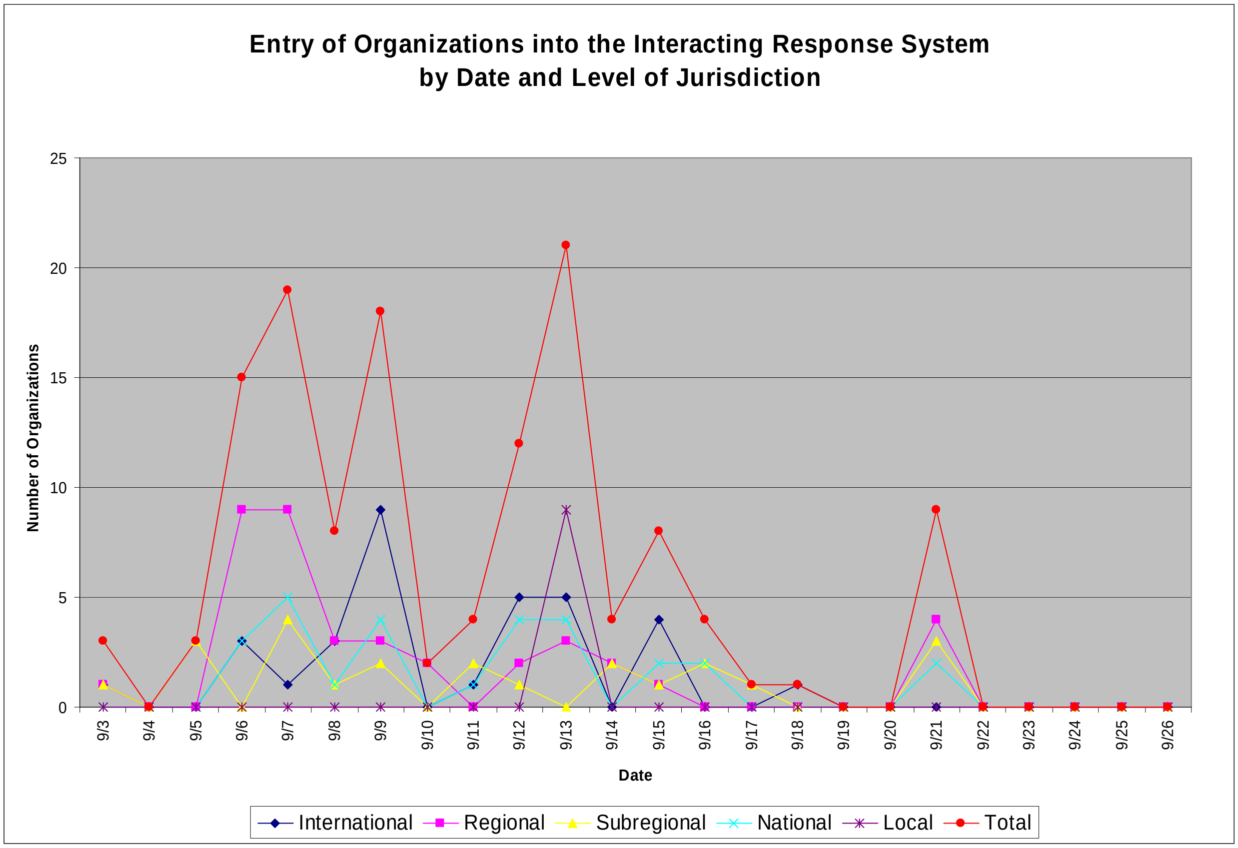

Figure 6.5 Entry by date and source of funding/jurisdiction (by island by region)

(Primary Data Source: CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to October 31, 2005. URL: www.cdera.org)

6.3.1 Importance of Cliques

Wasserman and Faust (1994) suggest that information spreads quicker through densely connected subgroups. The higher the number of cliques, the more responsive the network is expected to be, and the more efficient the information sharing. Again, CDERA and the government of Grenada are central to most of the cliques and thus information is expected to transfer quickly if these two organizations are the key initiators in the communication link (Table 6.11).

Table 6.14 Analysis of Cliques for Ivan Response and Recovery

Analysis of CLIQUES: Cliques with regional focal point
1: CDERA, CIDA, Government of Grenada, OXFAM
2: CDERA CIDA, Government of Grenada, International Red Cross
3: Caribbean Electric Utilities Corporation (CARILEC), CDERA, Government of Grenada
4: Caribbean Development Bank (CDB), CDERA, Government of Grenada
5: CARICOM, CDERA, Government of Grenada
6: CDER,A Caribbean Marketing Corporation (CMC), Government of Grenada
7: CDERA, Cable and Wireless Telecommunications (CW), Government of Grenada
8: CDERA, ECHO, Government of Grenada, Government of St. Vincent
9: CDERA, FCIB, Government of Grenada
10: CDERA, Government of Grenada, Government of Saint Lucia
11: CDERA, Government of Grenada, Government of Trinidad and Tobago
12: CDERA, Government of Grenada, HMS_Richland (British Navy)
13: CDERA, Government of Grenada, LIAT Airlines
14: CDERA, Government of Grenada, PAHO
15: CDERA, Government of Grenada, International Red Cross, RSS-CDRU
16: CDERA, Government of Grenada, Trinidad's NEMA
17: CDERA, Government of Grenada, UN_OCHA
18: CDERA, Government of Grenada, USAID_OFDA
19: Caribbean Development Corporation (CDC), CDERA, Government of Barbados
20: CDERA, Caribbean Tourism Organization (CTO), LIAT Airlines
21: CDERA, Government of Dominica, Grenada Prime Minister
22: CARILEC, CDERA, Grenada's NERO
23: CDERA, Grenada's NERO, Grenada's Prime Minister
24: CDERA, Grenada's NERO, Pan American Health Organization (PAHO)
25: CARICOM, CDERA, Grenada's Prime Minister
Cliques with national focal point
26: Government of the British Virgin Islands, Government of Grenada, Grenada's Health Dept.
27: Government of Grenada, Government of St. Lucia, Grenada's Health Dept.
28: Government of Grenada, Grenada's Health Dept., OXFAM
29: Government of Grenada, Grenada's Health Dept., PAHO
30: Government of Grenada, Government of St. Vincent, OAS
31: Government of Grenada, Regional Security System (RSS), RSS-CDRU
32: Government of Grenada, RSS-CDRU, Prime Minister of St. Lucia

Notably, there were no recorded cliques at the national level which included the Department of Planning or Physical Planning. This suggests that Physical Planning is not directly connected to the short term recovery process and thus the mechanism for integrating mitigation into disaster recovery must acknowledge this deficiency. The absence of the Physical Planning Agency suggests that NERO or the designated emergency management agency must have more advanced in-house capability for geocollaboration and housing rehabilitation, if mitigation is to be integrated into the recovery process.

6.4 INTEGRATION OF MITIGATION INTO DISASTER RECOVERY

From the discussions and analysis of the recovery networks, it is clear that disaster management organizations must play a central role in mitigation, not just physical planning agencies. Sadly, the Department of Planning was not prominent in any of the interactions with the major actors during the response or transitional disaster recovery phase in Grenada. The major actors assumed the role of physical planning and negotiated several policies, contracts and funding arrangements for reconstruction and rehabilitation. It is clear that pre-disaster communication for effective physical planning is critical for effective mitigation because the main actors in disaster recovery may not, in practice, be the organization or agency typically responsible for development control. Clearly, a framework must exist to integrate key mitigation activities as in development control into the dynamic disaster recovery system through the main actors of the disaster recovery environment. This information must be readily available for negotiations and collaboration with those donating resources and technical assistance as well as those collaborating on the distribution of resources for recovery purposes.

It is also clear (from chapter 5) that during the immediate aftermath of a disaster, there is an impetus to rebuild better and stronger than before. This must be not only be informed by past practices and building codes, but recent assessment of damages and the stability of the structures.

This system relies on dynamic information and knowledge flows, which can both be enhanced and impeded by the available technology. There is also the need to capture networks at the community level to improve the mitigation mechanism.

In chapter 7, I will discuss the geoinformatics approach to improving mitigation integration with the knowledge of networks discussed in this chapter. I will also develop a synchronization tool that can help to improve information sharing and decision-making.

6.5 SUMMARY

The findings in this chapter indicate that the Eastern Caribbean is progressing towards an auto adaptive system of disaster recovery. It also demonstrates that there is significant need to integrate intergovernmental coordination and public participation. While the adaptive capacity at the regional level is very high, some islands require more socio-technical components to improve their ability to self-organize in the recovery process. This self-organization is critical to the integration of mitigation into disaster recovery. The recovery networks are still fragmented to some degree, and their increased structure and compactness may enhance mitigation and disaster recovery in the future. Information is not severely impacted by the fragmented network because of the size of the island and the short geodesic distances between the key actors. However, improvement in the structure for collaboration and communication may enhance the speed and validity of information flow. It requires the collaboration among the various actors at all levels of the disaster recovery system. At the core of this collaboration are the national agencies and the community organizations with which they interact. More structured and organized local level involvement can greatly enhance the adaptive capacity of the disaster recovery system.

7.0 DISASTER MITIGATION INTEGRATION TOOLS: GIS AND THE DYNAMIC HAZARD RECOVERY AND MITIGATION SYNCHRONIZATION (DHARMS) TOOL

(DHaRMS) – *(also refers to **D**jibrila-**H**uggins **R**ecovery and **M**itigation **S**ynchronization tool as per tool developers)*

This chapter discusses the role of geoinformatics in disaster mitigation and comprehensive disaster management. It also discusses geoinformatics as a vehicle for engaging planning rehabilitation agents. From the analyses and findings in chapters 4, 5 and 6, the disaster recovery environment in the Eastern Caribbean can be characterized as a semi-adaptive or operative adaptive system with some structure for mitigation. Yet, the analyses show that while geospatial data exists and medium levels of inter-organizational communication and coordination are in place, these characteristics do not amount to a sustainable strategy to facilitate mitigation in disaster recovery. The existing process is largely time-delayed and too macro in focus to transform into community and household level mitigation on a regular, sustained basis. What is lacking is a complete, reliable technical infrastructure with an efficient mechanism to manage and synchronize mitigation with rehabilitation and recovery activities. Based on the findings from the review of surveys, interviews and documents, I have developed, with my colleague Aliyassoun Tairou Djibrila, a geoinformatics tool to integrate mitigation into the disaster recovery process in particular, and improve comprehensive disaster management and development overall.

The technical infrastructure is a critical component for information sharing for well-informed decision-making within self organizing and auto-adaptive systems in disaster management (Comfort, 2005). Part one of this chapter discusses the technical infrastructure and the role of GIS in disaster mitigation and comprehensive disaster management in the Eastern Caribbean over four subsections. Subsection 7.7.1 discusses the structure and infrastructure for geospatial support in decision-making by the national disaster management agencies. Subsection 7.1.2 highlights the mechanism for geospatial support in disaster mitigation while subsection 7.1.3 explains the availability of equipment, resources and training to enhance geospatial capacity for disaster mitigation on the islands. In subsection 7.1.4, I identify data management issues that the islands have addressed or may face.

The findings in part one were derived from an Email-based survey[34] that was completed by the head of each national disaster management agency, written documents as well as from structured interviews conducted with the national disaster management agency (DMO) coordinator and rehabilitation agencies. In the survey, DMO coordinators were asked to determine what level of implementation each parameter has achieved. Each parameter could either be (i) fully in place and functional (score =3); (ii) not fully in place, but currently being established (score=2); (iii) exist in writing, but not implemented (score = 1); or (iv) does not exist at all or don't do (score = 0). Open-ended and semi-structured questions were asked in the interviews to further validate the survey information.

Part two of this chapter (section 7.2) outlines the algorithm that I developed to generate zip codes for the islands to enhance the georeferencing capability as well as the means to conduct geospatial comparisons between different areas. Part three (section 7.3) outlines the structure and

[34] The surveys were adopted from survey instruments in "Successful Response Starts With A Map...," published by the National Research Council 2007, to provide a consistent and validated instrument for comparison of geospatial preparedness.

functionality of the GIS-based prototype, DHaRMS (the Dynamic Hazard Recovery and Mitigation Synchronization) that was developed from findings in this research. DHaRMS is a knowledge based GIS system that promotes the integration of mitigation strategies into disaster recovery activities through an accelerated and well-informed decision-making process. The DHaRMS tool integrates geospatial information at the household level with hazard event and physical planning level activities to transform mitigation strategies into implementation. Because the prototype acknowledges the efficient and viable socio-cultural networks from the findings in this research, it provides information where it's most needed and best valued, whether at the household, agency or system level. It addresses the problem of scale and provides a tool that facilitates mitigation action on the ground as well as mainstreams disaster loss reduction information into the development planning process. The DHaRMS Model was developed from data from two of the islands in the study, namely St. Kitts and Nevis (in the north). It was validated using data from St. Vincent (in the south).

The final part of this chapter (section 7.4) summarizes the socio-geotechnical mechanism for integrating mitigation into disaster recovery as well as explains the future development and application of the DHaRMS tool.

7.1 READINESS FOR GEOSPATIAL SUPPORT FOR EFFICIENT DECISION-MAKING IN DISASTER MANAGEMENT

While the islands of the Eastern Caribbean have made strides in the use of GIS technology in physical and development planning through projects such as the UNDP-UNCHS physical planning projects of the 1990s, GIS use in disaster recovery and rehabilitation at the island level remains underutilized and somewhat incoherent. The focus of GIS use in disaster management on the islands has largely been on hazard mapping and vulnerability assessments for planning purposes. Over the past decade, the Eastern Caribbean has garnered support for geospatial enhancements for disaster management and development planning. Most of the islands, including Grenada, St. Lucia, Antigua, St. Kitts, Nevis and Antigua, have common digital datasets that can be utilized for hazard mapping and vulnerability assessments. Yet the structure for sustainable development and standardized use of geospatial products remains under-developed. According to Liz Riley, CDERA

> *"…one of the things we recognize is that there is actually no clear model out there that says for hazard mapping and vulnerability assessments, these are the digital datasets that are required; this is the skill required to use them; this is the metadata that should guide them and that type of thing. So even though we initiated that process by looking at the common digital databases, we fully recognize there is a need to standardize that whole hazard mapping - vulnerability assessments data model… And we actually are in discussions about a standardized approach for the whole hazard mapping and vulnerability assessments within a GIS environment."*

I have highlighted four areas that the region recognizes are essential to building geospatial support for mitigation in disaster recovery and comprehensive disaster management: (i) structure and infrastructure for geospatial support; (ii) mechanisms to facilitate geospatial support; (iii) capacity building and resource allocation for sustainability of the program; and (iv) systematic data generation, management, protection and distribution with adequate feedback to foster currency of data.

7.1.1 Structure and Infrastructure for Geospatial Support in Disaster Management

The use of geospatial information to support disaster mitigation depends on an established structure and infrastructure. DMO agencies not only require dedicated office space, but they require a designated emergency operations center equipped with the geospatial capability. In the Eastern Caribbean, most of the islands have dedicated emergency operations centers that also serve as the home of DMO. These centers have plans for GIS technology in the EOC but most of them are not fully functional or implemented (figure 7.1). While there is provision for GIS support in the operations of the EOC and disaster management operations, none of the EOC or disaster management agencies have an established GIS team. Generation of geospatial data is done primarily in external departments and agencies such as the Department of Planning and Development, Ministry of Lands and Surveys and the Public Utilities (table 7.1).

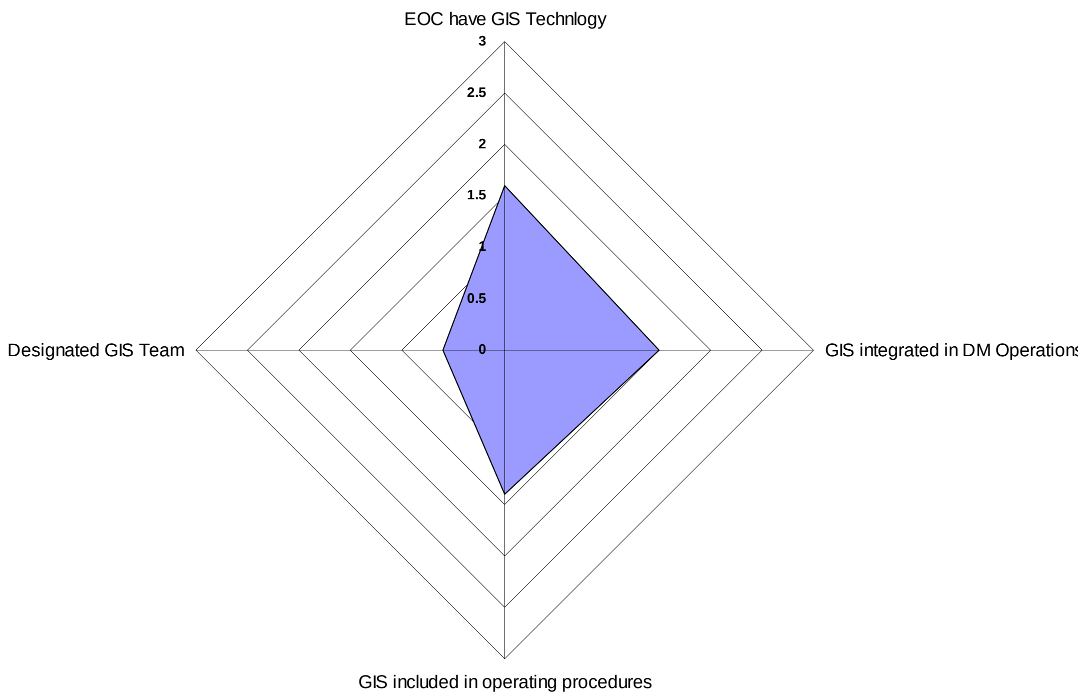

Figure 7.1 Structural Readiness for Geospatial Support

Table 7.1 Structure of GIS System for Disaster Management Organizations

Island	Primarily GIS system	Comment
Antigua	GIS ready computers;	Post Georges Mitigation Project provide impetus for institutional geospatial collaboration
Barbados	GIS active; some staff trained in basic GIS	Utilizes a private contractor GeoCaribe to provide database and mapping;
Dominica	No GIS in-house; Receives digital maps from Planning Department on an ad hoc basis; no trained GIS staff in DMO	
Grenada	GIS ready machines; with limited training GIS training of some staff	
Nevis	GIS-ready computers; Relies on provision of GIS service from Department of Planning; some staff trained in basic GIS/visualization	Post Georges Mitigation Project provide impetus for institutional geospatial collaboration
St. Kitts	No GIS in-house; Receives digital maps from Planning Department on an ad hoc basis; no trained GIS staff in DMO	GIS is hosted at the Department of Planning, but no systematic flow of geospatial information to DMO
St. Vincent	No GIS in-house; Receives digital maps from Planning Department on an ad hoc basis; some staff trained in basic GIS	

7.1.2 Mechanism for Geospatial Support in Disaster Mitigation in the Eastern Caribbean

Despite a high level of familiarity with the national GIS program, its coordinators and access to geospatial data, the disaster management agencies in the Eastern Caribbean lack sustainable mechanisms for geospatial support in disaster management. The "tear-drop" hexagon in Figure 7.2 illustrates that there are virtually no GIS action plans to enhance disaster mitigation, although there are hazard maps and other digital data. Besides the utility agencies (telephone, electricity) and some land management agencies, no plan exists for systematic updating of map data or its transformation to a digital format. Not only are plans missing, but the DMO agencies have no agreement for the systematic sharing of geospatial data. This limits the efficiency of interagency collaboration because exchange is dependent on personal connections or who you know, rather than operating protocols. A sharing agreement reduces boundaries and improves accessibility of data on an ongoing basis.

DMO agencies also do not have any strategy that clearly identifies the role and contribution of GIS professionals on the island. Digital file formats may be similar, but there is no written policy to ensure that such interoperability is promoted or maintained among agencies that produce data. Fortunately, most of the data have been produced by project related initiatives that maintain the same standards throughout the different islands, yet there remain no written strategy to synchronize the various GIS tools for regional compatibility. These findings do not suggest that there is no mechanism, but rather suggests that it is not an organized formal mechanism that promotes continuity, accountability and good governance. Alarmingly, the DMO agents hardly meet with national GIS coordinators to build consensus on GIS updates, policies and initiatives.

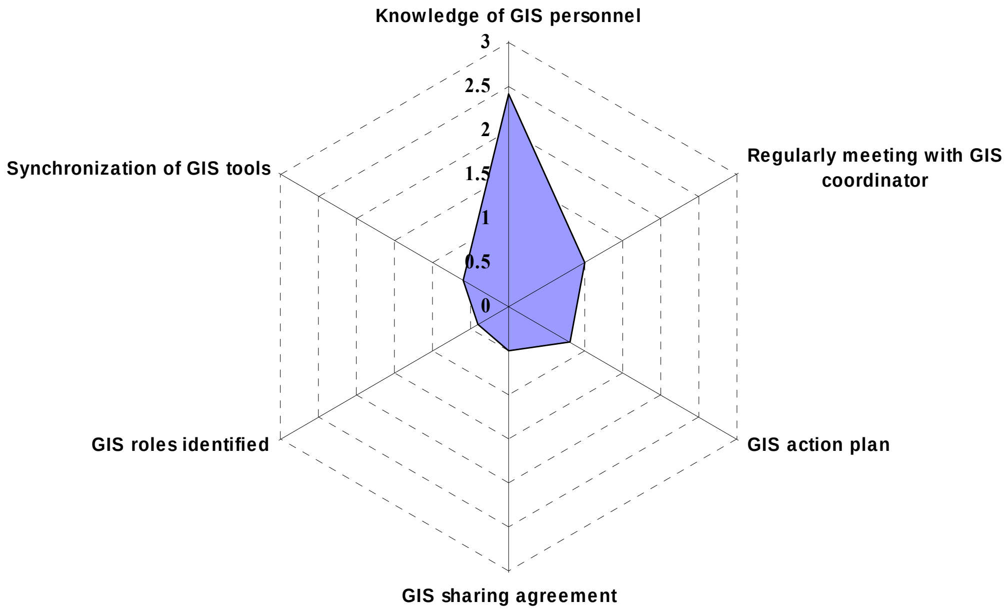

Figure 7.2 Capacity for GIS support in Disaster Mitigation

7.1.3 Geospatial Capabilities and Capacity Building within National Disaster Management Agencies

Auto-adaptive recovery systems rely on rapid access to geospatial information to be effective and efficient. While the islands of the Eastern Caribbean have several geospatial themes and hazard planning data available, the capability for geospatial support is limited by inadequately trained personnel and unreliable equipment, data and tools. The islands utilize vulnerability and hazard maps for development planning and disaster management, but lack rapid access to live or near-live geospatial information and a GIS system with significant individual micro-level data that is essential for effective mitigation and recovery. All the islands lack dynamic models that incorporate real-time geospatial data, but they have the capability to produce hazard and vulnerability maps from existing data as well as provide geospatial information for time-delayed disaster recovery (table 7.2).

Table 7.2 Current Capabilities for Geospatial Support in National Emergency Agencies

Islands	Disaster Mitigation	Disaster Recovery	Gaps related to disaster management
Antigua Barbados Dominica Grenada Nevis St. Kitts St. Vincent	• Digital elevation models (recent models available for St. Kitts, Nevis and Antigua) • Geospatial analysis and environmental impact assessment of projects • Visualization technologies • Vulnerability and hazard maps (may be based on very outdated source maps except in St. Kitts, Nevis and Antigua 2001) • Foundation geospatial data and imagery (though most is not up to date) • Data archives from previous incidents (not readily available in most cases; available after major donor projects)	• Land use classification • Geospatial tools for landuse planning • Social and economic facilities • Shelter management data • Critical infrastructure data (however, may be inadequate as it is often not geo-referenced beyond static map outlines)	• Lacks dynamic models that incorporate real-time geospatial data • Lacks live or near-live data to drive dynamic models (no long-time contracts or agreements) • Lacks simple geocoding capabilities for non-technical field staff and operations • Inadequate correlation of individual data across data sets • No standardized data format across islands, though most use Transverse Mercata (BWI) Projection and shapefiles format • Lacks updated cadastral survey • Lacks skilled personnel to work regularly with the data for benefit of disaster management

Figure 7.3 illustrates that while the islands have become better equipped for geospatial support than in the 1990s, the capacity to geospatial information sharing on a regularly distributed basis remains underdeveloped. None of the islands or DMOs has a secure web-site or geo-portal for secure data sharing (figure 7.3). Most data are either hard copied or sent via electronic mail. In fact, some software and hardware have not been updated since the inception of the GIS programs in some planning departments (particularly in Dominica).

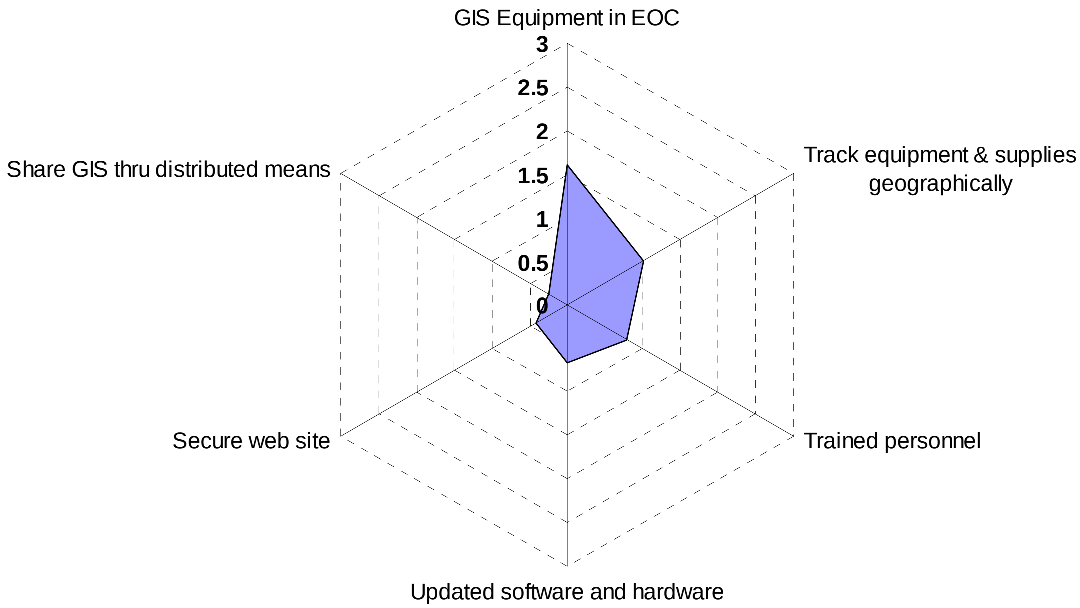

Figure 7.3 Level of equipment for distributed GIS utilization for Disaster Mitigation

The maintenance and capacity building initiatives for geospatial support are critical to the viability and relevance of the system. While the DMOs have made progress in acquiring training for some staff and obtaining GIS data as needed, the system remains susceptible to error due to inefficiencies in backup and retrieval processes, as well as the non-existence of programs to update the GIS data on a regular basis (figure 7.4). The DMOs inability to secure funding for these programs makes the sustainability of the geospatial support system doubtful.

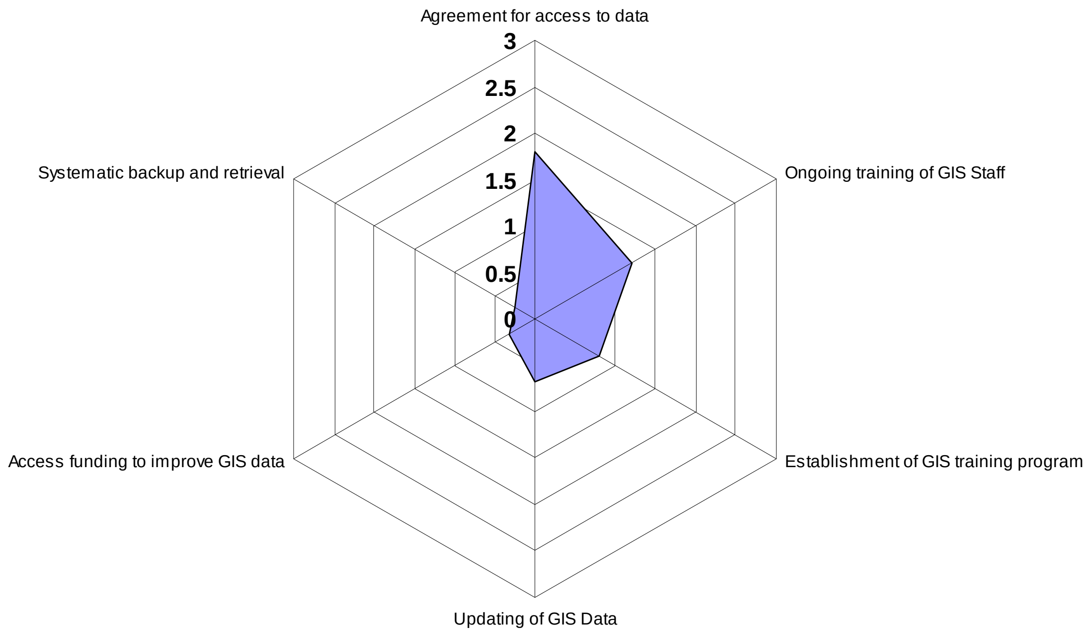

Figure 7.4 Sustainability of geospatial support program for Disaster Mitigation

7.1.4 Geospatial Data Management for Disaster Mitigation

Digital mapping is critical to decision-making and management during the complex disaster recovery stage as well as other stages of the comprehensive disaster management cycle. Beyond compiling databases of disaster relevant map layers, it is important to have adequate backup and data update programs to ensure the relevancy of the data to the situation. Since 2001, the Caribbean Disaster Emergency Response Agency (CDERA) has ascertained financial and technical support from international and regional agencies to commission regional initiatives[35] to reduce vulnerability to natural and technological hazards. Part of these initiatives

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[35] CDERA executed the Caribbean Disaster Management (CADM) Project through support form the Japanese International Cooperation Agency (JICA) and also implemented the Caribbean Hazard Mitigation Capacity Building

included the compilation of hazard maps and vulnerability assessment reports which can be used in the management of disasters. All the islands of the Eastern Caribbean benefited from these initiatives and now have significant amounts of digital mapping to complement hazard mitigation. However, there are several critical issues that affect the relevance of these data sets. There are variations in geo-referencing accuracy that reduce digital map quality as well as the ability to facilitate micro-level decision-making. Finally, the inadequacy of road and address data impacts the quality of other geo-referenced data including housing and land management.

Table 7.3 shows that the Eastern Caribbean islands have a substantial amount of geospatial data that is relevant to disaster recovery and mitigation and development planning as a whole. However, geospatial data on six areas of critical interest either does not exist. Firstly, none of the islands have a thorough street addressing system. Some have partial segments of street address numbering, but more than 90 percent of the islands remain unstructured with the name of resident and street being used as the only reference. This is complicated by the lack of accurate geospatial data on property, both residential and commercial as well as ownership. In emergency situations, poor locating and geo-referencing functions can be the difference between life and death. In this study, I developed a zip code system for location of affected households (See next section, 7.2). Also of note is that little geospatial data exist on religious facilities. In chapter 5, we learned that churches and religious entities play a pivotal role in communication and community assistance and trust during a disaster. Creating access to this resource spatially can therefore enhance mitigation. Finally, some of the more critical data including place of children, emergency equipment and supplies are not well documented to enhance disaster preparedness.

Programme (CHAMP) through assistance form the Canadian International Development Agency (CIDA) and the Caribbean Development Bank's Disaster Mitigation Facility for the Caribbean from 2002 thru 2005.

Table 7.3 Geospatial Data Availability across the Eastern Caribbean region

Geospatial Data	Score
Cellular & communication towers	2.60
Ambulance services	2.50
Detailed road network	2.40
Emergency shelters	2.40
GIS imagery	2.40
Government facilities	2.40
Medical facilities	2.40
Police departments	2.40
Hydrological features	2.33
Bridges and dams	2.25
Educational facilities	2.25
Fire departments	2.25
Flood zone	2.25
Fuel storage sites	2.25
Hotel facilities	2.25
Utilities	2.25
Critical infrastructure	2.00
Military facilities	2.00
Nursing homes	2.00
Property data	1.75
Religious facilities	1.75
Emergency equipment	1.40
Emergency supplies	1.40
Daycare centers	1.00
Address data	0.50

Beyond the GIS data management, the system for geospatial support in disaster management in the Eastern Caribbean is not fully ready for a dynamic GIS system. There are no live data feeds for geospatial data except for weather and there is limited capability to track the distribution of emergency equipment and supplies, geographically (figure 7.5). Rapid delivery of digital GIS data remains a work in progress at best and can affect the efficiency of building mitigation into disaster recovery.

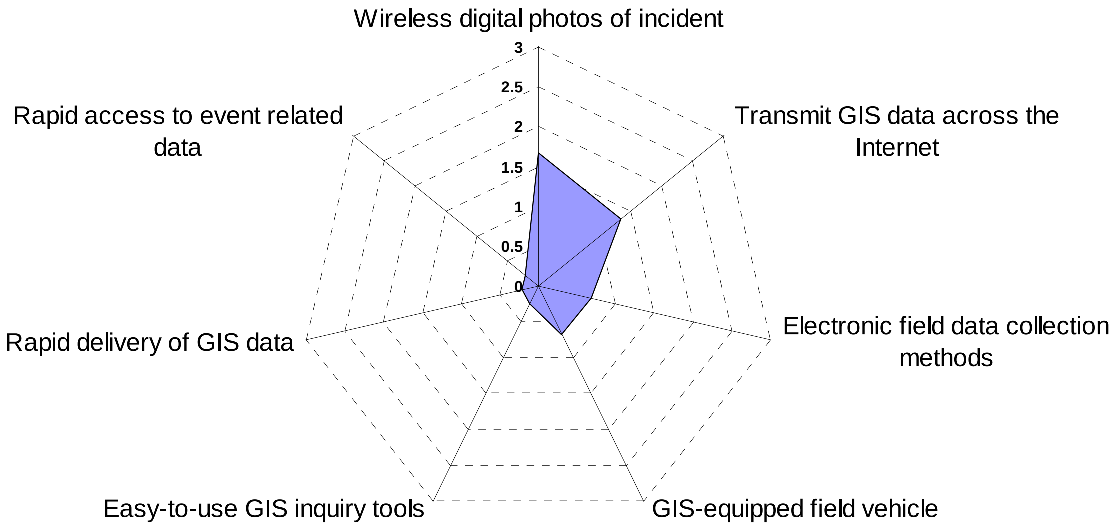


Figure 7.5 Readiness for dynamic GIS system

7.2 GENERATING ZIP CODES FOR GEOREFERENCING IN THE EASTERN CARIBBEAN

The Eastern Caribbean islands do not have a comprehensive addressing system. Street and house numbers are existent in some urban areas, but there is no systematic or established zip code generating system to register each street. The consensus among the national disaster management (DM) coordinators in this study was that a better address matching system is needed. The DM coordinators believed that such a system would not only enhance geographic information and applications, but it would also improve the timeliness and efficiency of emergency response and rehabilitation as a whole. While the standard format for addressing land parcels can be applied to the Eastern Caribbean islands, the islands need to generate zip codes that are relevant to the distribution of the population, geographical features and administrative boundaries on each island. The following algorithm provides the basis for generating zip codes that are easily identified and meaningful (Figure 7.6a and 7.6b). These zip codes were used in the DHaRMS synchronization tool discussed in section 7.3. The process of generating these zip codes was validated through discussions with Ms. Michelle Forbes, Assistant Disaster Management Coordinator in St. Vincent, Mr. Bentley Brown - St. Vincent Ministry of Planning, Mr. Carl Herbert, St. Kitts-Nevis Disaster Management Coordinator and Ms. Lillith Richards - Head of Physical Planning Unit in Nevis.

First, I used a six digit zip code so that I can tie the zip code to the telephone area code, parish and communities within the parishes. The first three digits of the zip code are derived from the telephone area code for the island nation or part of the island nation. For example on St. Kitts-Nevis, the area code is 869. The zip codes for the islands of Nevis and St. Kitts therefore starts with 869. The next two digits of the zip code are assigned by parish. On the islands of St. Kitts and Nevis there are 13 parishes. The main urban parish, St. Georges on St. Kitts is assigned 00 for the parish placeholder on the zip code. So the zip code becomes 86900_. Since there are no more than 10 major communities within the parish, it is not necessary to subdivide the parish into two parish level digits. However, if there were more than 10 such communities, the parish would be divided into contiguous community sets of 10 communities and assigned an incremental parish placeholder in the zip code. Ten was used because the final digit for the zip code identifies the community and since it is a single digit, it becomes exhausted after 10 (that is 0 to 9) when it is no longer a unique identifier. The final digit in the zip code is assigned from the communities in the parish while progressing through clockwise quadrants from the most northern community in the contiguous community set. The next parish in a clockwise sequence from the previous parish receives the next increment of parish digits for its zip code.

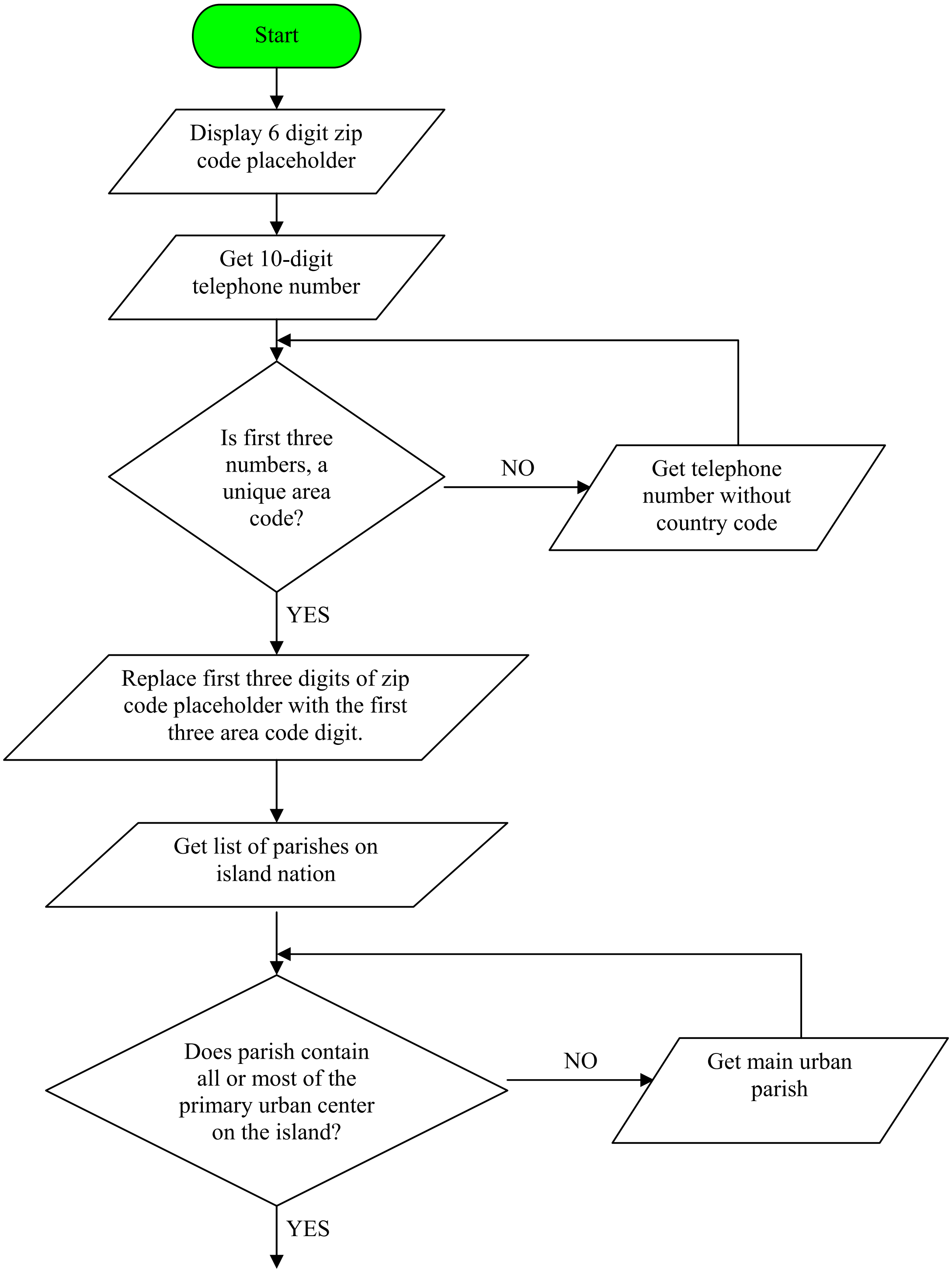


Figure 7.6a Algorithm for generating zip codes (continued in figure 7.6b)

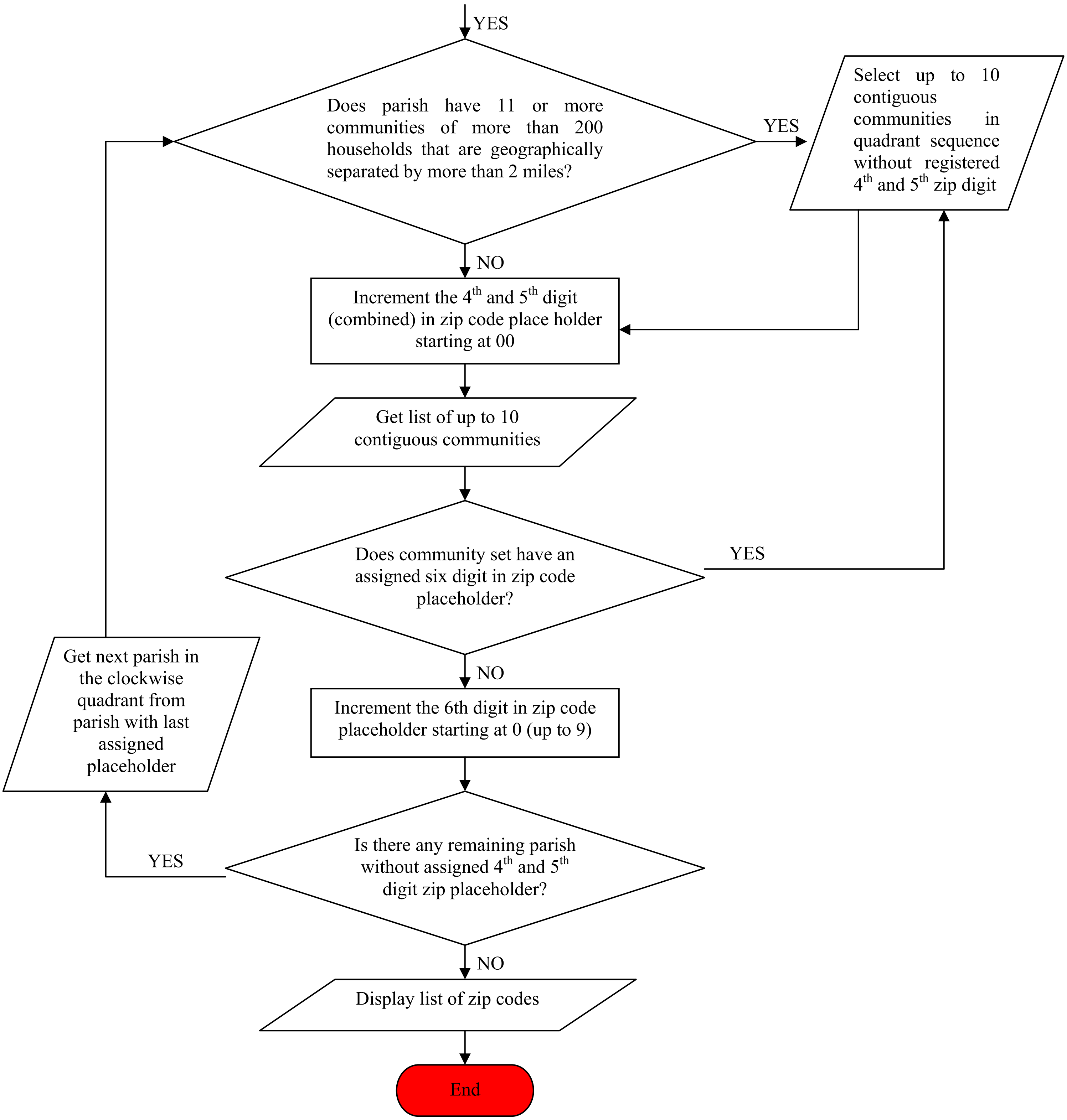


Figure 7.6b Algorithm for generating zip codes (continued from figure 7.6a)

7.3 DHARMS PROTOTYPE FOR EFFICIENT DISASTER MITIGATION

Dynamic Hazard Recovery and Mitigation Synchronization (DHaRMS) –

*(DHARMS may also be referred to as the **D**jibrila-**H**uggins **R**ecovery and **M**itigation **S**ynchronization tool as per tool developers)*

In section 7.1, I highlighted the need to expand the geoinformatics capability of the Eastern Caribbean islands. However, there are several aspects of a geospatial framework in place can be made more cohesive by synchronizing information flow and optimizing the mitigation integration mechanism. While the mitigation integration mechanism depends on the socio-cultural dimensions as discussed in chapter 6, it also requires a viable technical framework to ensure sustainable and relevant information flow at convenient times. The DHaRMS tool enables this synchronization process and makes it convenient for disaster managers to mitigate at all levels and scales.

7.3.1 Purpose, Relevance and Significance of the DHaRMS Tool

DHaRMS Purpose

The purpose of the DHaRMS tool is three-fold. Firstly, it provides a mechanism to engage households, planners, disaster rehabilitation agencies and builders in the mitigation process, which leads ultimately to the integration of mitigation strategies into disaster recovery activities. All stakeholders can access information that can enable them to manage their own risk or regulate mitigation. Secondly, it helps to reduce the shocks from future hazards or disasters; and therefore it serves not only as a mitigation tool, but also as a disaster reduction tool. Thirdly, it is used on a daily basis as a planning tool for through the synchronization of existing information and real-time data.

DHaRMS was developed because disaster management coordinators expressed a need to synchronize physical planning and development activities with disaster management activities. In St. Vincent and St. Kits-Nevis, where I obtained significant geospatial data, coordinators expressed the desire to have a web-based system that can be accessible from any location, including in the field by damage assessment evaluators. A simple database would provide robust data management capabilities, but the coordinators felt that with increased technology, particular telecommunications technology, households can access information directly in the near future and will be more inclined to use such technologies to broaden awareness rather than traditional means. In light of these concerns, I developed a system that can be easily adopted as a standalone database on a local server or an Internet or web-based tool that encourages community participation. The first development of the DHaRMS prototype was reviewed by Michelle Forbes (Disaster Management Office, St. Vincent) and Lillith Richards (Department of Planning, Nevis) as the first steps towards validation of the DHaRMS tool. Further field testing and validation is necessary before the tool can be tailored to each island's requirement or deployed for full use.

Relevance of the DHaRMS Tool and Comparison to Existing Tools

DHaRMS provide essential linkages between damage assessment, actual cost of damage, location of critical damage, under-code structures to identify mitigation priority structures and regions (based on aggregation). Unlike existing similar tools, this scalable system allow for individual household use as well as national agency review. Community participation is essential for efficient mitigation.

DHaRMS is comparable to three key tools that have been used in the Caribbean and North America region: HAZUS_MH; the Economic Commission for Latin America and the Caribbean (ECLAC) Damage Assessment Tool and REDATAM. DHaRMS is similar to HAZUS-MH developed by the US Federal Emergency Management Agency (FEMA). However, it differs from HAZUS-MH in that it provides an estimate of damages based on the actual damage to structures provided through physical damage assessments. It essentially is a plug-in to HAZUS but is significantly more important in developing countries where validated information is needed to affirm figures provided to the aid community. It also incorporates information and standards relevant to the ECLAC community which may be accountable in HAZUS-MH. Unlike HAZUS, it is a distributed system using Internet-based GIS with a higher level of interoperability for multi-users and multi-environments.

DHaRMS serves as an extension to the ECLAC Damage Assessment Model and REDATAM. The ECLAC tool assesses the social, economic and environmental impact of a disaster on a nation. It provides macroeconomic analysis of the impact of a disaster and identifies the most affected sectors, geographic areas and population groups. It does not provide a mitigation synchronization tool for community-based reconstruction, although it allows macro-level decision-makers to prioritize areas for reconstruction based on analysis. REDATAM is a series of tools that determine the geographic distribution of total damages to help identify the worst affected regions of geopolitical entities. It provides information for priority in reconstruction plans, but it does not encourage community involvement or participation in the process and is limited to geo-politically defined areas. DHaRMS addresses the deficiencies outlined above.

7.3.2 Structure of the DHaRMS Tool

What feeds into the tool? Two categories of data feed into DHaRMS model: pre-disaster and post-disaster. Pre-disaster data include hazard mapping, zoning guidelines, vulnerability assessments, existing building vulnerability, building code scores, building costs, as well as pre-existing interagency networks and agreements. The pre-disaster data can be used to generate a retrofitting or pre-disaster mitigation index prior to the disaster. This index can be used to sensitize households on what needs to be done to make their structures disaster resilient and can aid planning for disaster reduction. This existing information feeds into the tool and is integrated with post-disaster data for better decision making during recovery and rehabilitation.

The primary parts of the DHARMS architecture are shown in Figure 7.7. The system is built on the open source database, PostgreSql. PHP Graphic User Interface (PHP GUI) allows the systems manager to manipulate and manage the database as well as set up connections from the database to the main user interface, DHARMS Web GUI. This is the interface that allows for household level participation in the process. Households are provided secure access to their household information and can report damages directly into the system. The damage is validated by the damage assessor or evaluator before it is formally adopted. However, it provides a detailed, baseline fast estimate of damages after an event. This interface also holds the map view that allows all users to see the distribution of damage, hazard zoning, mitigation score, etc. It is connected to the Mapserver that publishes the geoinformation to the web from the database and from the open source GIS, Quantum GIS. Quantum GIS is incorporated because of its geocapabilities and its easy manipulation at the agency level to generate more output. Also, the PostgreSql database can be directly updated from the Quantum GIS.

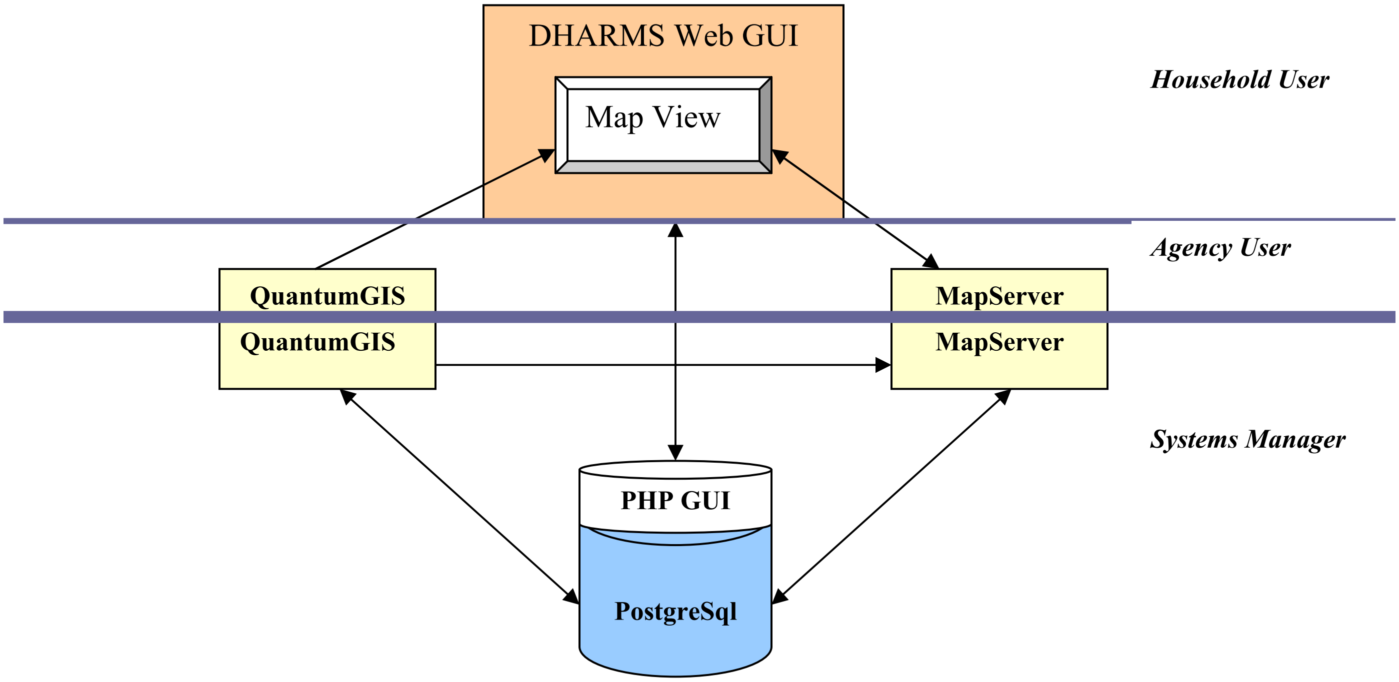


Figure 7.7 Layout of DHaRMS Mitigation Synchronization Tool

The post-disaster data category includes damage assessment and updates on post-disaster self-organizing networks. Making the everyday (pre-disaster) data management thicker than the post-disaster data collection stage provides for several advantages:

1. No new data need to be collected in the post-disaster stage.
2. Less time is spent on data collection and synchronization.
3. The front end provides for avenues for heightened interagency cooperation and coordination because of information sharing requirements.
4. The front-end increases the utility of the software by providing a useful integration of data for planning regardless of whether a disaster occurs or not

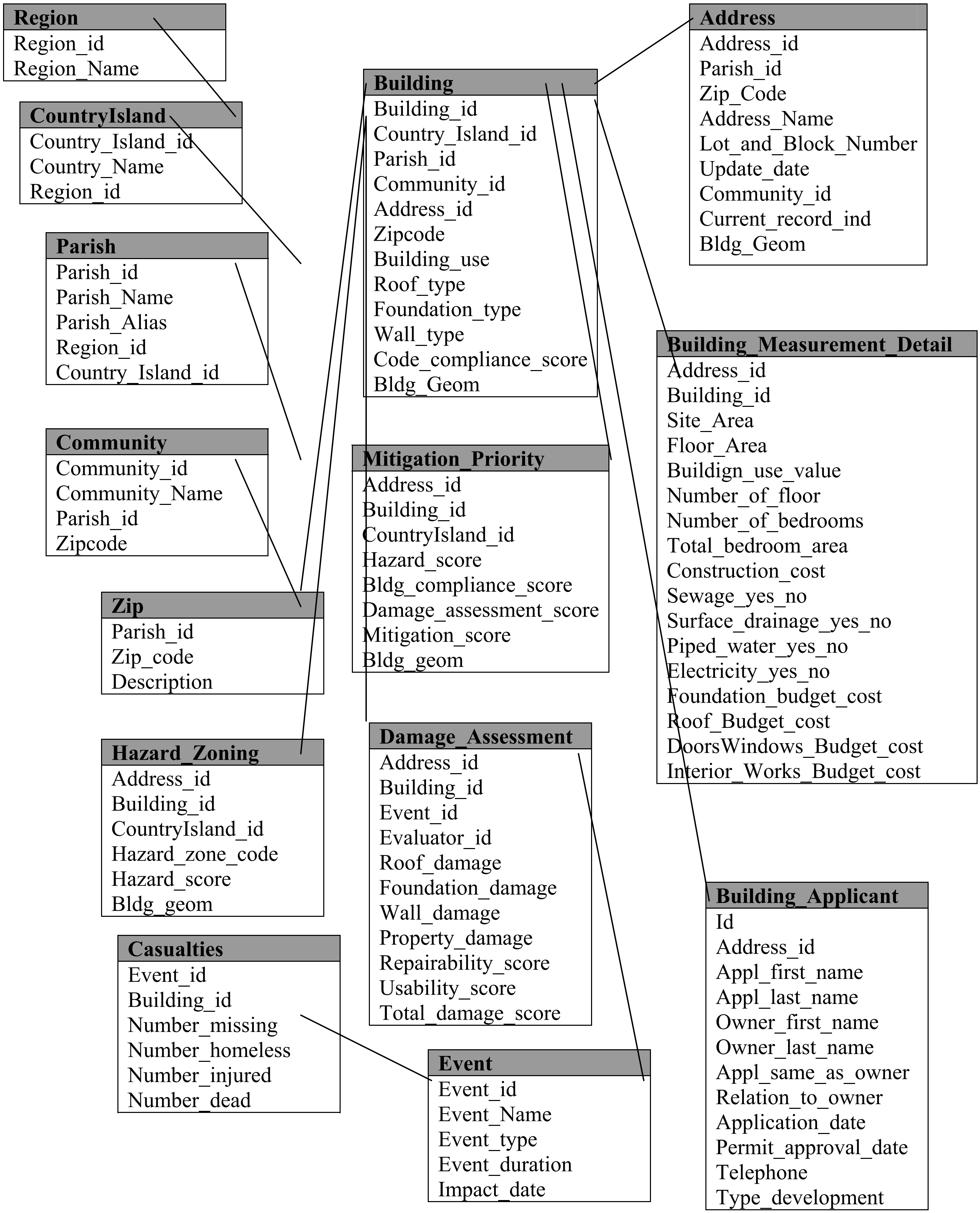


Figure 7.8 Database Relational Schema for DHaRMS Mitigation Synchronization Tool

In order to provide visual alertness to the requirements for mitigation following a disaster event, I developed a 160 point – 5 color scheme (table 7.4) that transforms into a 5-color mitigation priority action scheme (table 7.5). The five color scale is synonymous with that developed by the US Department of Homeland Security (USDHS, 2001). The mitigation priority action scheme is used for viewing on a dynamic map and provides rehabilitation agencies and households with a quick reference tool on what needs to be done during the recovery phase. Three key areas are used to calculate the mitigation priority score through the 160 point – 4 color scheme. They include pre-existing building code compliance, hazard and zoning priority and damage assessment. Damage assessment is weighted more heavily than the other two categories because repairs must be conducted if a structure is damaged regardless of the previous scores under the other two categories. By default, every structure is given a damage assessment score of 80. The map is triggered to be dynamic once a disaster event is registered by an authorized agency user. It then adjusts dynamically as damage assessment reports are entered by evaluators.

Table 7.4 Weighting for Mitigation Priority Score based on pre-existing code compliance and damage assessment report

Building Code Inspection Compliance Status	Zoning Priority	Damage Assessment *
Foundation (10)	Setbacks (10)	Foundation (20)
Roof (10)	Location (10)	Roof (20)
Walls (10)	Elevation (10)	Walls (20)
Interior (10)	Hazard Vulnerability (10)	Interior (20)
*Damage assessment is weighted heavier because if building is impacted, repairs must be done regardless of prior status.		

This visualization allows decision-makers to identify priority areas for mitigation as well as assistance. It also allows for deployment of satellite building permitting services in areas with highest mitigation priority. This representation can also be used for critical infrastructure management, shelter management and re-evacuation strategies.

Table 7.5 Key to mitigation action at agency and household levels

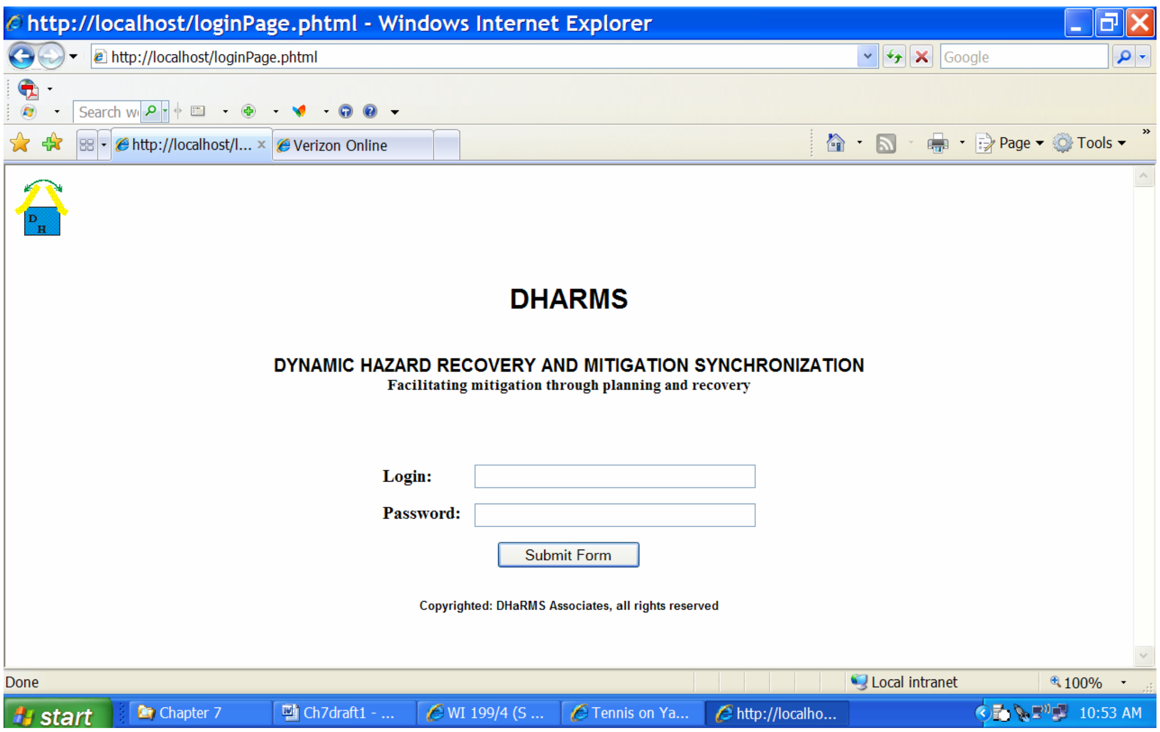
Mitigation Priority Score *(Refer to Table 7.4 for sub-scores)*	Mitigation Action Needed at Agency Level	Mitigation Action needed at Household Level
150 -160	None – no permit required	Minimal
120 – 149	Require retrofitting mitigation guide	Retrofit to code
80 – 119	Require occupancy permit	Retrofit to code
70 – 79	Require hazard vulnerability compliance	Rebuild to code; reduce hazard vulnerabilities
40 - 69	Require all permits to rebuild	Relocate and rebuild in zoning-compliant area

Table 7.6 Sample Mitigation Recovery Scoring (based on 16 point scale)

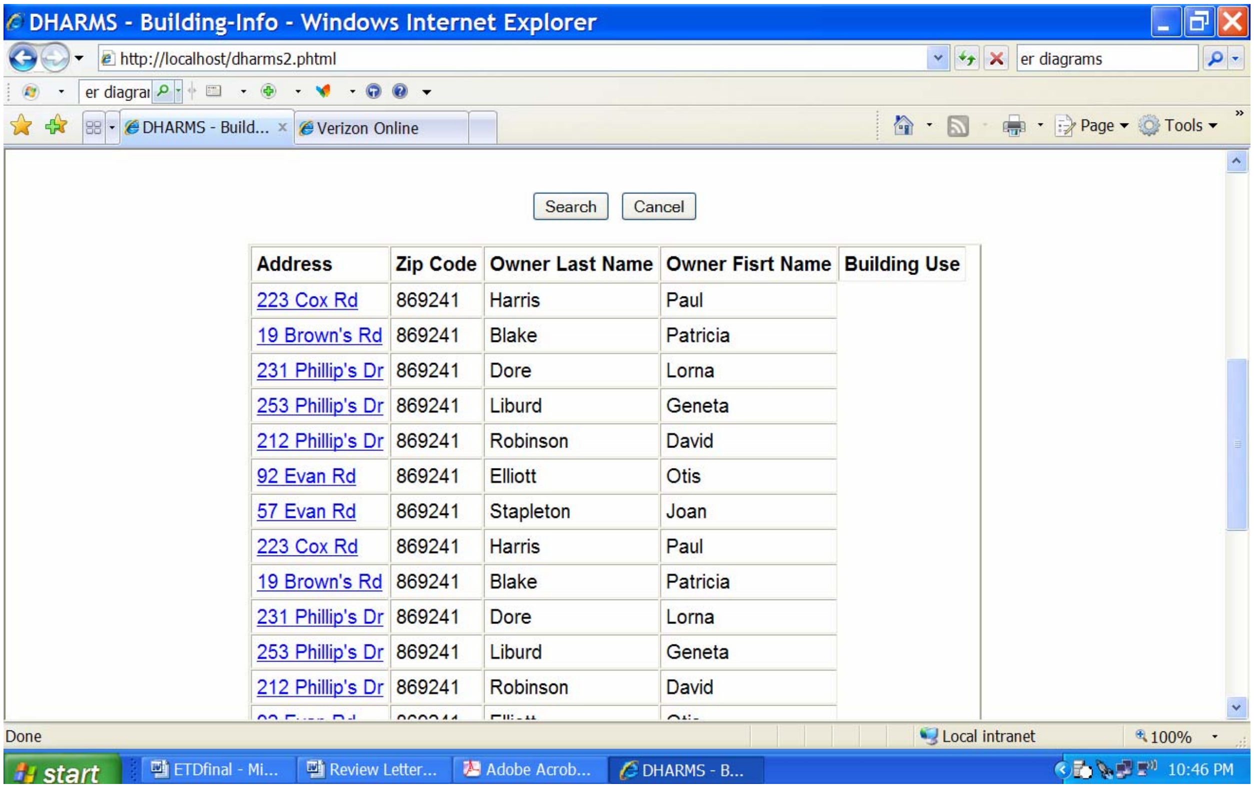
Pre-Existing Building Code Compliance	Hazard Vulnerability & Zoning Priority	Damage Assessment	Mitigation Priority	Recovery & Rehabilitation Mitigation Strategy
Green	Green	Green	Blue	None required (160 pts)
Green	Yellow	Green	Blue	Minimal repairs (150 pts)
Green	Green	Yellow	Green	Retrofit to Code (140 pts)
Orange	Green	Green	Green	Retrofit to Code (140 pts)
Green	Green	Orange	Green	Retrofit to Code (120 pts)
Yellow	Yellow	Orange	Yellow	Mitigate -Retrofit to Code (100 pts)
Green	Green	Red	Yellow	Mitigate -Retrofit to Code (100 pts)
Green	Yellow	Yellow	Yellow	Mitigate -Retrofit to Code (80 pts)
Green	Orange	Red	Orange	Mitigate – major work for hazard vulnerability compliance (70 pts)
Orange	Red	Orange	Orange	Mitigate – major work for hazard vulnerability compliance (70 pts)
Orange	Orange	Red	Red	Relocate and rebuild to Code – all building permits required (60 pts)
Red	Orange	Red	Red	Relocate and rebuild to Code – all building permits required (50 pts)
Red	Red	Red	Red	Relocate and rebuild to Code – all building permits required (40 pts)
Red = 10 Orange = 20 Yellow = 30 Green = 40	Red = 10 Orange = 20 Yellow = 30 Green = 40	Red = 20 Orange = 40 Yellow = 60 Green = 80	*See table 7.4 for color code*	

DHaRMS Interface

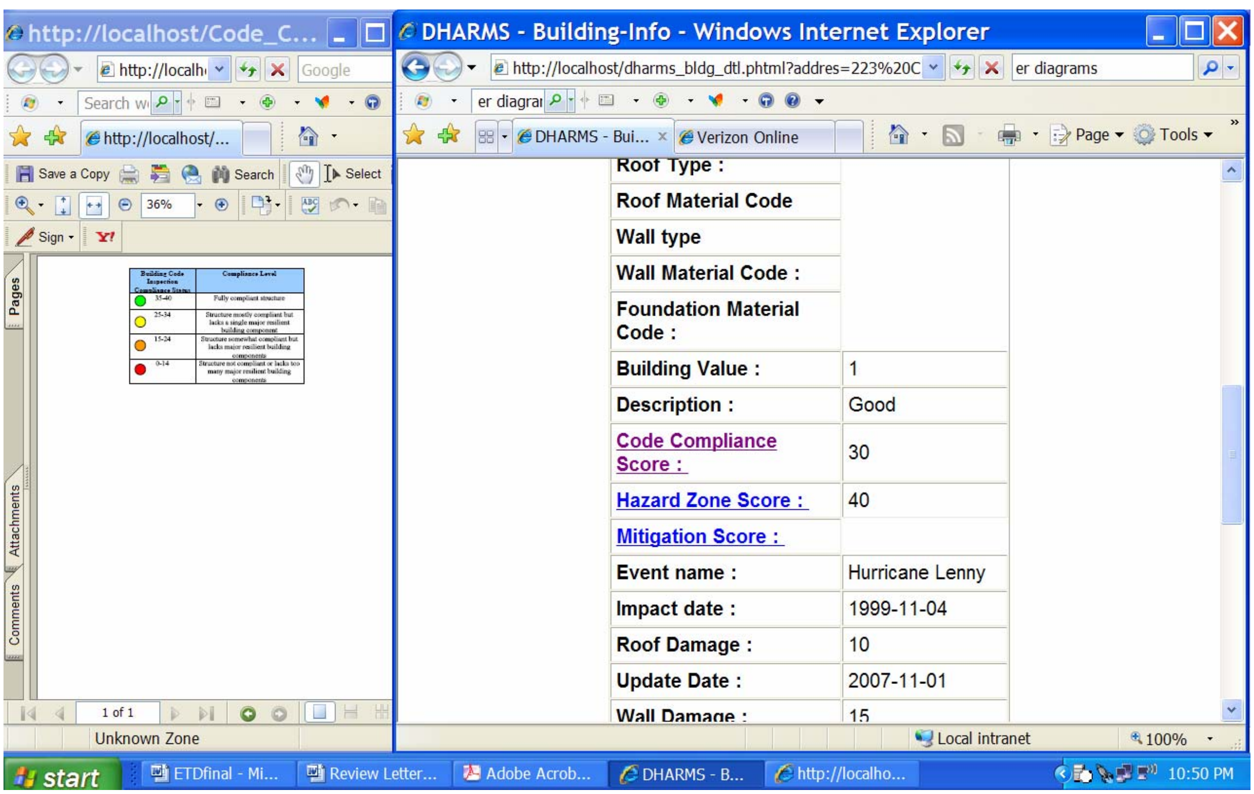
The DHaRMS interface is user-friendly. It has different logins for various users. Administrators and damage assessment evaluators have an additional login to the actual database to enter information (figure 7.7). Community level users can log into the system once they have approved login information.



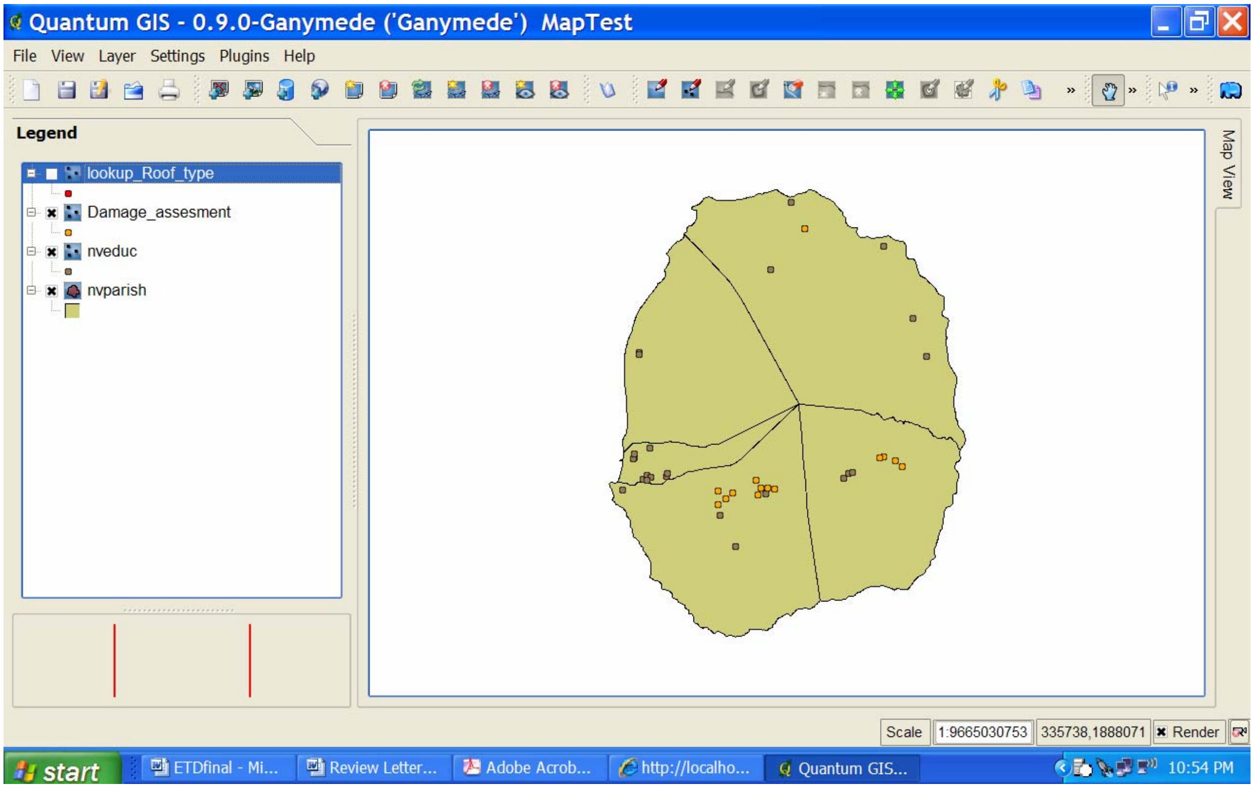
Login security requirement



Query of buildings by zip code



Code compliance query for building



Damaged buildings on the Island of Nevis after Hurricane Lenny

Figure 7.9 Screen shots from DHaRMS Tool (Web GUI)

7.4 SUMMARY OF TECHNICAL INFRASTRUCTURE FOR DISASTER MITIGATION

Geoinformatics plays a pivotal role in disaster mitigation and disaster recovery. While the islands of the Eastern Caribbean have several geospatial themes and hazard planning data available, they lack the institutional structure to ensure the sustainability of a geospatial support program for all aspects of disaster management. The islands utilize vulnerability and hazard maps for development planning and disaster management, but lack rapid access to live or near-live geospatial information and a granular level GIS system that is essential for effective mitigation and recovery. The challenge remains to develop a transparent system for geospatial support; one that provides relevant data, tools and information on a timely basis. Then the system will become more capability of auto-adaptation and lend itself to more efficient collaboration, information sharing and decision-making. Effective disaster mitigation requires the utilization of geospatial information. Based on findings in this study, DHaRMS tool can build on the existing infrastructure for geospatial support in disaster management on the island by providing a tool that allows for community participation and empowerment while at the same time enabling development planning and disaster management authority to regulate.

8.0 SUMMARY AND IMPLICATIONS FOR INTEGRATING MITIGATION INTO DISASTER RECOVERY IN THE EASTERN CARIBBEAN

The analysis and findings presented in this study demonstrate that a significant need exist for a geo-collaborative framework to integrate mitigation into disaster recovery. This framework relies on collaboration between rehabilitation agencies and households. It also relies on timely information flow and information sharing at all levels of the system with multiple users at varying scales. Not only does this framework improve efficient and timely communication for informed decision-making in complex disaster environments, but it also transitions the recovery system into an auto-adaptive, higher level self-organizing system. This is the most desirable system for operations in the dynamic and complex disaster environment because it allows for a systematic and informed approach to operations, but also one that is flexible, dependable and participatory (Comfort, 2005). In this chapter, I summarize the major findings and outline recommendations for action and future research.

8.1 RESEARCH QUESTIONS

The three research questions addressed by this research, as stated Chapters 1 and 3 (pages 11 and 60), are as follows:

1. To what extent do regional agencies, national governments, local builders, planners and households in the islands plan to integrate mitigation into recovery from hurricane-related disasters?
2. To what extent is an understanding of social networks and key actors in disaster recovery and mitigation important to, and utilized in, comprehensive disaster management?
3. To what extent does the use of geoinformation shape the solution to the recurring failure of communities to mitigate following hurricane-related disasters?

The findings to these questions are discussed in chapters 4 through 7.

8.1.1 Research Question 1: Extent to which households and organizations plan to integrate mitigation into disaster recovery

The analysis reported in this dissertation shows that the level of planning for mitigation integration among households is dependent on the perception of risk (Section 5.1, page 128). In fact, households that experience more disasters have a higher tendency to implement measures to safeguard property and minimize risks than those who have less exposure to disasters (Chapter 5, table 5.2). This culture of mitigation integration is evident with 51% of households in the south using hazard resistant building guidelines compared to 75% in North (more exposure). However, this research showed that households are not very likely to use insurance to secure risks as a more progressive means towards mitigation integration.

At the level of rehabilitation agencies, builders and designers demonstrated a high degree of mitigation integration through compliance with disaster-resistant building codes, retrofitting and redesigning damaged structures with more resistant material and communicating building code requirements with clients on a regular basis (Section 5.2, page 141). However, mitigation integration is hampered by the informal building and designing sectors that undercut requirements to minimize costs and attract clients. The majority of building and designers plan for mitigation in disaster rehabilitation because it is required or important (Chapter 5, table 5.9), which suggests that organization and formalization of the designer and building processes would further enhance mitigation integration. Disaster management organizations are moderately equipped to meet the demands to provide mitigation advice to affected households. They have access to hazard maps (80%) and have developed national recovery plan (90%) that include emergency housing and safe rebuilding practices. However, they experience difficulty in collaboration and effective dissemination of this information to meet the needs of all households.

As discussed in chapter 5, the Caribbean Disaster Emergency Response Agency has a well developed plan to integrate mitigation into disaster recovery. Its model mitigation plan and policy informs national governments on how to plan for disaster recovery (Chapter 5). CDERA also have an establish mechanism to attract resources (with 90% mitigation effectiveness) and rapidly deploys assistance to member islands for rehabilitation and safe reconstruction.

8.1.2 Research Question 2: Extent of using an understanding of social networks in disaster

The analysis reported in chapter 6 underscores the importance of an understanding of social networks in disaster recovery. Five of the seven islands in this study were characterized as operative adaptive systems, with progress towards auto-adaptive disaster recovery systems (Table 6.1, page 168). However, the disaster recovery system on two islands was still at the emergent –adaptive stage which suggests that a professional knowledge base, communication and geocollaboration is not sufficiently developed to effectively promote mitigation integration. As discussed in chapter 6, the post-Ivan network is a small world, scale-free network, which indicates the ability of the network to undertake regional as well as local level tasks. This degree centrality of the network is 65%, which indicates that the disaster recovery is fairly well-organized to accommodate mitigation integration (page 171). The most responsive organizations in the network are government entities, which indicate that government agencies play a pivotal role in mitigation integration.

8.1.3 Research Question 3: Extent to which use of geoinformation shapes solution to mitigation problem

The analyses in chapter 7 indicate that the Eastern Caribbean islands utilize geoinformation. However, they do not have real-time geospatial data that can inform recovery decisions, so mitigation is confined to pre-disaster assessments or delayed post-disaster assessments. The geospatial capability to support mitigation is limited by the lack of adequate tools for synchronization of planning and disaster management activities. The islands do not have comprehensive addressing systems that can improve emergency response and mitigation planning. As discussed in chapter7, the DHaRMS prototype provides a synchronization tool to improve information sharing in the complex disaster recovery environment.

Information and data sharing among rehabilitation agencies allow for timely and well-informed decision making. The DHaRMS tool supports not only timely information, but it provides access for community participation in planning and improved governance. The islands have either developed or are in the process of developing common digital geodatabases for hazard mapping and vulnerability. Despite these advances however, the structure and potential for geospatial support in disaster mitigation respectively remain fragmented and largely untapped. In addition, knowledge of networks is not well integrated into the system of management and therefore leads to inefficiencies in communication and collaboration, which in turn hurt the mitigation process.

8.2 HOUSEHOLD MITIGATION

This research shows that the failure to implement mitigation activities in disaster recovery continues to exist because disaster recovery is largely unregulated. It is important to embrace the mitigation culture in an unregulated complex environment through community involvement in planning and mitigation for disasters. I recommend that the dynamism of the mitigation culture needs to be leveraged through models that combine awareness with experience and trends in disasters to better detail mechanism for mitigations implementation on a community level.

This research also indicates that households face a daunting task of knowing what steps to take to incorporate mitigation strategies into household recovery activities unless relevant information is communicated on timely and ongoing basis. An expansion of existing mechanisms to include geoinformatics and household involvement will advance the opportunity for collaboration, communication and awareness for every household. This strategy, as illustrated through DHaRMS, allows households to access specific mitigation information regarding their properties on an ongoing basis and also immediately after the disaster. Damage assessment data is fed back into the systems immediately to guide not only households but also rehabilitation agencies in mitigation implementation. This mechanism is made more viable by the increasingly competent levels of high communication technologies (cellular phones, Internet, and other wireless communication devices) that populate the Eastern Caribbean landscape. With a viable infrastructure in place to facilitate access to information on an ongoing basis even after a disastrous event, phase two of DHaRMS can make information available even to cellular phone users.

8.3 INSTITUTIONAL MITIGATION

This research indicates that several mitigation policies and strategies exist in the Eastern Caribbean, which directly affects households. Yet, any mechanism for households must also engage rehabilitation agencies. Rehabilitation agencies are a key channel for information sharing and knowledge generation. This research showed that designers and builders need to become more organized into professional associations if mitigation is to be consistently emphasized at the grassroots level. Grenada initiated its contractors' association based on the shortcomings experienced in the reconstruction process after Hurricane Ivan. Similar associations will help to ensure the transfer of information to clients on a regulated basis. To be effective in mitigation these organizations must have the ability to learn, coordinate and adapt.

8.4 MITIGATION MECHANISM

From the analyses in chapters 5 through 7, I have further identified five areas where disaster recovery systems in the Eastern Caribbean can move towards auto-adaptive systems and thus better integrate mitigation and improve comprehensive disaster management:

(1) Improve the communication among rehabilitation agencies by formalizing communication strategies;

(2) Advance the professionalism and capacity-building of rehabilitation agencies through training, certification, licensing and on-going client awareness requirement, especially for designers and builders;

(3) Integrate physical planning and disaster management on an ongoing basis, both pre- and post-disaster through interoperable technology, information sharing and a common knowledge base;

(4) Increase public and household participation throughout the physical planning and disaster management processes by providing access to information; housing priority status and direct communication and ready access to housing priority requirements; and

(5) Develop geocollaboration capabilities through digital mapping, geoinformatics technology and geospatial support in a daily-use mode to enhance disaster mitigation and recovery.

It is clear that communication immediately following the disaster event is heightened and somewhat confusing at times. Much of the focus remains on national level programs with large budgets and big representation, but very little written communication between DMOs and the community. In fact, this research showed that not only is the deficiency at an organizational level, but at a functional level of communication and collaboration. The modified bowtie model introduced in chapter one (page 44) provides a standard basis for organizations to relate to each other. The functional approach discussed in chapters 5 through 7 underscores the need to focus on process and functions rather than just organizations. A synchronization tool that integrates both social and technical factors into the mitigation mechanism is likely to be more adaptable at all levels of governance and jurisdiction. The architectural approach discussed in chapter 2 and illustrated again in figure 8.1 below shows how geoinformation can be tied with network knowledge to improve mitigation implementation.

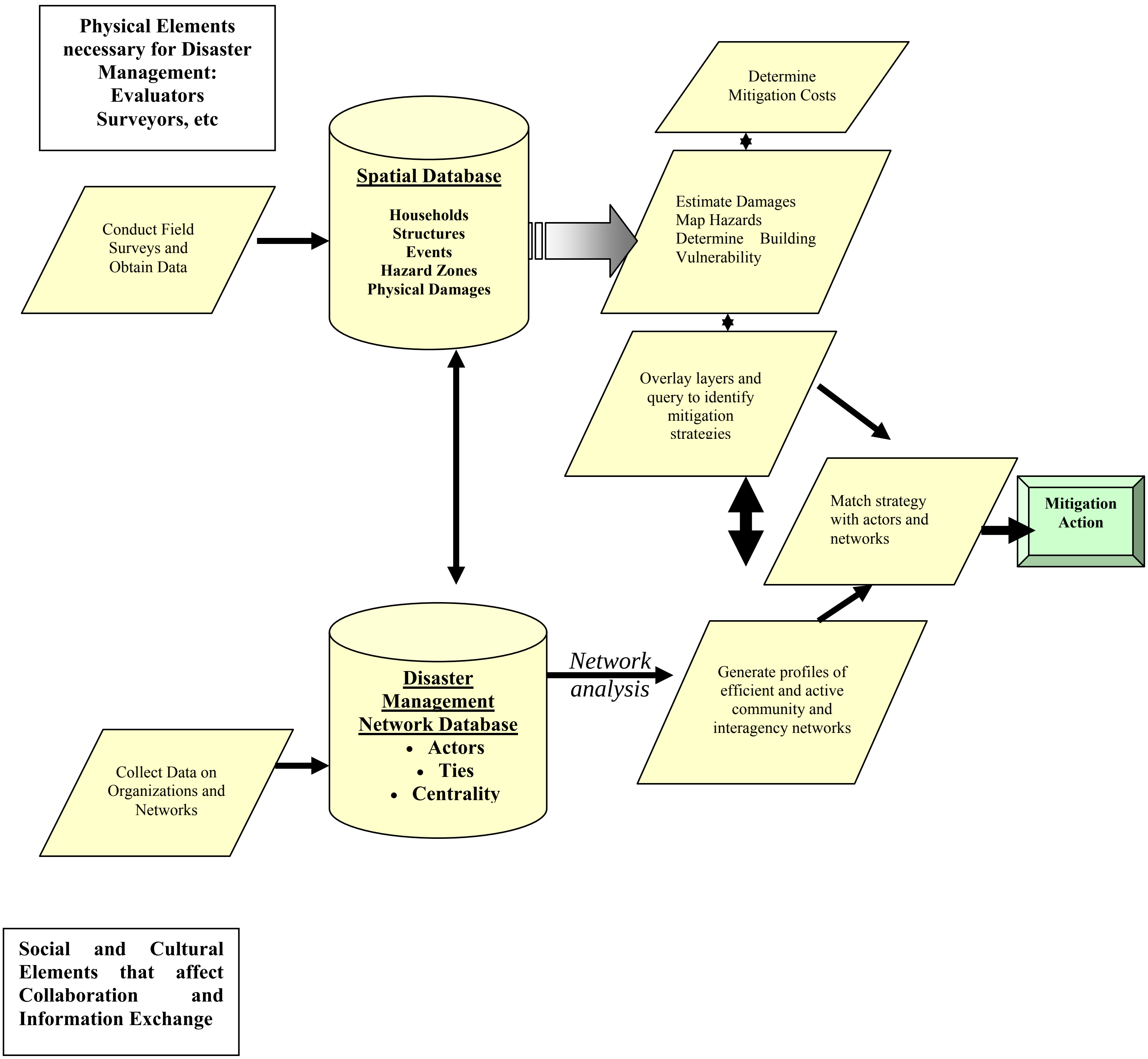


Figure 8.1Architectural approach for mitigation synchronization in disaster recovery

8.4.1 Implementing mitigation in disaster recovery

Analytically, I propose that disaster recovery requires four factors to ensure effective mitigation at the community and national levels: (1) existence and knowledge of safer building codes, guidelines and practices; (2) advanced technology for knowledge transfer and communication; (3) access to rehabilitation resources and (4) a functional quasi-regulated rehabilitation system.

Without knowledge of safer building codes, guidelines and practices, the system for mitigative reconstruction will remain flawed. Not only do builders and designers have to be trained in designing and building more disaster-resistant structures, but households need to be knowledgeable about what needs to be done within their own houses and other properties to make them more disaster-resilient. Awareness at both levels facilitates critically relevant dialogue between households and designers. Dialogue regarding disaster-resistant structures and materials can lead to the more effective retrofitting or the construction of better structures.

Advanced technology enables communication and also provides a means for broader awareness, information sharing and knowledge transfer. More than 65% of households in the Eastern Caribbean have cellular phones, while a rapidly growing percentage has access to both computers and the Internet. This level of technical infrastructure broadens the capacity for community involvement and communication, which is crucial for information sharing. At the rehabilitation agency level, all agencies communicate through web-based programs, cellular phones and some have other wireless communications. National agencies are equipped with geoinformatics capability. These factors indicate that there is a viable infrastructure to tap the advantages of advanced technology and geoinformatics in disaster mitigation and comprehensive disaster management as a whole.

Access to rehabilitation resources is paramount in fostering mitigation. Next to communication and working together, households already contend that materials or money to purchase resources are critical to recovery. The OECS sub-region has two regional warehouses, but up standard concessionary policies and guidelines for disaster relief and commodities for resale following a disaster. Having these guidelines reduces uncertainty in material acquisition after a disaster and facilitates faster recovery.

Islands in the Eastern Caribbean need to establish a functional quasi-regulated rehabilitation system – a registered system of architects, draughtsmen and designers, builders, and contractors approved to conduct rehabilitation work. Already, Grenada has put in place a system for the licensing and registration of contractors. This is direct organizational learning from the experience of Hurricane Ivan that enhances the adaptive capacity of the island. A system to determine what level of work requires rebuilding permission; one that includes a permit system for disaster rehabilitation, a self-guided system to monitor requirements for rehabilitation and policy for rebuilding control (not just emergency housing) need not only be developed but implemented.

While some may argue that this increases bureaucracy during a complex disaster environment, the mechanism for implementing this strategy can be simplified to save time, while at the same time promote awareness and relevant action. From the findings in this study, implementation will be successful if we advance the training of damage assessment evaluators to provide information upon evaluation through the use of technology. In addition, district planning offices should be set up after the disaster to provide more field-based advice and supervised rehabilitation.

8.5 IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE STUDY

This research indicates that socio-technical systems are critical to the effectiveness and efficiency of mitigation in the disaster recovery process and comprehensive disaster management overall. Also, there is anecdotal evidence that mitigation is more desired now than it was a decade ago, and that there has been more progress towards implementing it more consistently. Efficient and effective socio-technical systems are inherently critical to the success of mitigation implementation. Considering this relationship, future research should analyze the implications for such interdependencies. Future research should accurately document the patterns of failure of the socio-technical systems that deal with comprehensive disaster management and the impact of such failure on mitigation during recovery. Clearly identifying these dependencies and the factors that accentuate them will assist in building sustainability into mitigation implementation.

APPENDIX A

HURRICANE SCALE AND COUNTRY DATA

A.1 SAFFIR-SIMPSON HURRICANE SCALE

Type	**Wind Speed** *(Based on U.S. 1-minute average)*	**Storm Surge** (feet above normal)	Typical Damage
Tropical Storm	35 -73 mph	1-3 ft	"No real damage to building structures."
Cat 1 Hurricane	74-95 mph (64-82 knots or 199-153 km/hr)	4-5 ft	"No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage."
Cat 2 Hurricane	96-110 mph (83-95 knots or 154-177 km/hr)	6-8 ft	"Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings."
Cat 3 Hurricane	111-130 mph (96-113 knots or 178-209 km/hr)	9-12 ft	"Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris. Terrain continuously lower than 5 ft above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences with several blocks of the shoreline may be required"
Cat 4 Hurricane	131-155 mph (114-135 knots or 210-249 km/hr)	13-18 ft	"More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shore. Terrain lower than 10 ft above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles (10 km)."
Cat 5 Hurricane	greater than 155 mph (135 knots or 249 km/hr)	> 18ft	"Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles (8-16 km) of the shoreline may be required."
Source: US Weather Service, National Hurricane Center. URL: http://www.nhc.noaa.gov/aboutsshs.shtml			
The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf and the shape of the coastline, in the landfall region. Note that all winds are using the U.S. 1-minute average.			

A.2 GDP BY TOP SEVEN SECTORS, 2005

	OECS		Antigua		Barbados		Dominica		Grenada		St. Kitts-Nevis		St. Vincent	
Sector	**OECS Percent GDP (%)**	**Rank**	**2005 GDP & Percent GDP**	**Rank**	**2005 GDP & Percent GDP**	**Rank**	**2005 GDP & Percent GDP**	**Rank**	**2005 GDP & Percent GDP**	**Ran k**	**2005 GDP & Percent GDP**	**Rank**	**2005 GDP & Percent GDP**	**Rank**
Government Services	842.97 (13.47%)	1	244.5 (14.93%)	1	244.5 (14.93%)	1	88.21 (17.92%)	1	91.29 (11.03%)	4	92.80 (13.56%)	2	111.86 (14.47%)	2
Construction	718.56 (11.49%)	2	235.51 (14.38%)	2	235.51 (14.38%)	2	31.79 (6.46%)	7	133.22 (16.10%)	1	94.81 (13.85%)	1	70.63 (9.14%)	5
Banking & Insurance	667.30 (10.67%)	3	158.34 (9.67%)	**6**	158.34 (9.67%)	**6**	60.96 (12.38%)	**4**	84.71 (10.24%)	**5**	91.58 (13.38%)	**3**	68.21 (8.83%)	**6**
Wholesale & Retail Trade	662.92 (10.60%)	4	125.81 (7.68%)	**7**	125.81 (7.68%)	**7**	65.22 (13.25%)	**3**	83.36 (10.08%)	**6**	73.78 (10.78%)	**5**	135.78 (17.57%)	**1**
Transportation	659.12 (10.54%)	5	172.72 (10.54%)	**4**	172.72 (10.54%)	**4**	42.30 (8.59%)	**5**	124.70 (15.07%)	**2**	62.07 (9.07%)	**7**	99.23 (12.84%)	**3**
Communications	631.00 (10.09%)	6	160.50 (9.80%)	**5**	160.50 (9.80%)	**5**	40.17 (8.16%)	**6**	98.46 (11.90%)	**3**	63.16 (9.23%)	**6**	79.23 (10.34%)	**4**
Hotels & Restaurants	536.84 (8.58%)	7	174.50 (10.65%)	**3**	174.50 (10.65%)	**3**	11.47 (2.33%)	**11**	30.76 (3.72%)	**10**	43.60 (6.37%)	**8**	15.27 (1.98%)	**11**
Agriculture	305.36 (4.88%)	10					75.64 (15.36%)	**2**					64.43 (8.34%)	**7**
Manufacturing	328.93 (5.26%)	9									76.46 (11.17%)	**4**		
Real Estate& Housing	363.17 (5.80%)	8												
Other sectors: Water, Electricity, Mining & Other Services	540.08 (8.63%)	11-13												
Total	6256.25 (100%)													
GDP at 1990 Constant (EC$M)														

APPENDIX B

NATIONAL EMERGENCY MANAGERS

ANTIGUA/BARBUDA
Patricia F. B Julian, Director   Alternative Contact: Philmore Mullin
National Office of Disaster Services
P.O. Box 1399 American Road
St. John's Antigua/Barbuda
Tel: (268) 460-7075 Fax: (268) 462-4742 Email: nods@antigua.gov.ag

BARBADOS
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Email: cero@caribsurf.com http://www.cero.gov.bb

DOMINICA
Cecil Shillingford National Disaster Coordinator
Office of Disaster Management
Post Office Building Bayfront Roseau, Dominica
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Email: j73cs@yahoo.com

GRENADA
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Acting National Disaster Coordinator
National Emergency Relief Organization renamed National Disaster Management Agency (2006)
Fort Frederick, Mt. Wheldale St. Georges, Grenada Tel: (473) 440-0838 Fax: (473) 440-6674
Email: nero@caribsurf.com http://www.spiceisle.com/nero

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Nevis Emergency Management Unit
Charlestown, Nevis
Tel: (869) 469-5521 Fax: (869) 469-5532 Email: nemu@caribsurf.com

SAINT KITTS
Carl Herbert, National Disaster Coordinator
National Emergency Management Agency
Taylors, Basseterre Saint Kitts
Tel: (869) 466-5100 Fax: (869) 466-5310 Email: nemaskb@thecable.net

SAINT VINCENT AND THE GRENADINES
Howie M. Prince Coordinator, Alternative Contact: Michelle Forbes
National Emergency Management Office
Office of the Prime Minister,
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Email: nemosvg@yahoo.com

APPENDIX C

ACRONYMS

CARDIN	Caribbean Disaster Information Network
CARICOM	Caribbean Community
CARILEC	Caribbean Electricity
CBDM	Community Based Disaster Management
CDB	Caribbean Development Bank
CDERA	Caribbean Disaster Emergency Response Agency
CDMP	Caribbean Disaster Mitigation Project
DISMAN	Disaster Management Database
DMFC	Disaster Mitigation Facility for the Caribbean
DRRP	Disaster Reduction and Recovery Programme, UNDP
ECLAC	Economic Commission for Latin America and the Caribbean, United Nations, Santiago, Chile
EM-DAT	Emergency Events Database (CRED, Catholic University of Louvain)
EMS	Environmental Management Systems
FEMA	Federal Emergency Management Agency, Government of USA
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GLIDES	Global identifier number
GNP	Gross National Product
IADB	Inter-American Development Bank. See also: IDB
IBRD	International Bank for Reconstruction and Development, World Bank
ICT	Information and Communication Technologies
IDNDR	International Decade for Natural Disaster Reduction, 1990-1999
JICA	Japan International Cooperation Agency
LDCs	Least Developed Countries
NEMA	National Emergency Management Association
NRDF	National Research and Development Foundation, Saint Lucia
OAS	Organization of American States, Washington, DC, USA
OECD	Organization for Economic Cooperation and Development, France
OECS	Organization of Eastern Caribbean States, Castries, Saint Lucia
OFDA/USAID	Office for Foreign Disaster Assistance/US Agency for International Development
PAHO	Pan American Health Organization, Washington, DC, USA
PERI	Public Entity Risk Institute
PGDM	Post-Georges Disaster Mitigation Project
SIDS	Small Island Developing States

UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-HABITAT	United Nations Human Settlements Programme (formerly UNCHS)
USAID	US Agency for International Development
UWI	University of the West Indies, Jamaica
WB	World Bank

APPENDIX D

LETTERS TO STUDY PARTICIPANTS

D.1 LETTER TO HOUSEHOLD PARTICIPANTS IN SURVEY

Dear,

My name is Leonard Huggins. I am from Nevis and have worked with the Nevis Island Administration and several local and regional organizations including the Nevis Historical and Conservation Society, the OECS-Natural Resources Management Unit, the Caribbean Conservation Association and the UNESCO beach monitoring program to contribute to sustainable development in our region. I am currently a doctoral student at the Graduate School of Public and International Affairs, University of Pittsburgh. I am writing to seek your help and participation in a field research I am conducting for my doctoral dissertation, which I believe will enhance sustainable disaster management activities in our region.

I am in the process of collecting data for my dissertation entitled "Sustainable Disaster Management, Poverty Reduction and Development – An Exploratory Analysis of the Roles of Geo-Information and Geo-Collaboration in Mitigation and Recovery from Hurricane-related Disasters in the Eastern Caribbean". The focus of my dissertation is the processes of data collection and information sharing before and after hurricanes and how individuals and organizations respond to the recovery needs after such hurricanes. The expected outcome of the study is a detailed mapping of the processes of information collection and dissemination and an improved structure for incorporating poverty reduction strategies into disaster planning and management. The study will also identify ways that geographic information can improve decision making during the disaster management periods. Your completion of this survey will enable me to make these deductions and also identify the focal actors in the network and the patterns of their interactions within the disaster management environment. You are being invited to participate in this study because you have experienced a hurricane disaster in the past decade and have first-hand experience of what transpires during and after the disaster.

The data collected is in the form of a survey questionnaire. The questionnaire is made up of three sections. Section one aims at collecting information about your experience and perception of hurricanes. Section two asks you to provide information about your experience and perception of disaster recovery and mitigation. Section three aims at collecting information about the nature of our networks and communication with other disaster-affected households and disaster management agencies. Then finally section four asks you to provide some information about yourself and your household that will enable us to group these results and represent them nationally.

Please take a few minutes to complete the survey. I would like to assure you that all information and data collected will be treated with utmost confidentiality. Reports generated from this study will in no way identify your individual responses or reveal information about your connections without your permission. There is no risk associated with this research. Your participation is vital to the success of this study.

In advance, thank you for your time and participation. If you have any questions or need additional information, please call me at (869) 469-2762 or email me at lenhuggs@hotmail.com.

If you would like to have a summary of the findings of this study, please indicate so at the end of the questionnaire. Once the study is completed, I will be delighted to send you a summary of findings.

Sincerely,

Leonard Huggins

D.2 LETTER TO PARTICIPANTS IN SEMI-STRUCTURED INTERVIEWS

Dear Mr. Drew,

My name is Leonard Huggins. I live in Nevis and have worked with Nevis Island Administration and several local and regional organizations including the Nevis Historical and Conservation Society, the OECS-Natural Resources Management Unit, the Caribbean Conservation Association and the UNESCO beach monitoring program to contribute to sustainable development in our region. I am currently a doctoral student at the Graduate School of Public and International Affairs, University of Pittsburgh. I am writing to seek your help and participation in a field research I am conducting for my doctoral dissertation, which I believe will enhance sustainable disaster management activities in our region.

I am in the process of collecting data for my dissertation entitled "Sustainable Disaster Management, Poverty Reduction and Development – An Exploratory Analysis of the Roles of Geo-Information and Geo-Collaboration in Mitigation and Recovery from Hurricane-related Disasters in the Eastern Caribbean". The focus of my dissertation is the processes of data collection and information sharing before and after hurricanes and how individuals and organizations respond to the recovery needs after such hurricanes. The expected outcome of the study is a detailed mapping of the processes of information collection and dissemination and an improved structure for incorporating poverty reduction strategies into disaster planning and management. The study will also identify ways that geographic information can improve decision making during the disaster management periods. Your completion of this survey will enable me to make these deductions and also identify the focal actors in the network and the patterns of their interactions within the disaster management environment. You are being invited to participate in this study because you have experienced a hurricane disaster in the past decade and have first-hand experience of what transpires during and after the disaster.

The field data for the study will come from two sources: 1) survey questionnaires conducted with the information/communication officers or other individuals within your organization possessing knowledge and insight regarding the disaster management on the islands; and 2) in-depth interviews with the members of a selected number of organizations and government agencies of which your organization is one.

If you agree to participate, please take a few minutes to complete the survey. I would like to assure you that all information and data collected will be treated with utmost confidentiality. Reports generated from this study will in no way identify your individual responses or reveal information about your organization without your permission. There is no risk associated with this research, nor there are any benefits to you. Your participation is important for the success of this study, but feel free to decline answering any question you feel uncomfortable with.

In advance, thank you for your time and participation. If you have any questions or need additional information, please call me at … or email me at lenhuggs@hotmail.com.

If you would like to have a summary of the findings of this study, please state so at the end of the questionnaire. Once the study is completed, I will gladly send you one.

Sincerely,

Leonard Huggins

APPENDIX E

SURVEYS AND INTERVIEW QUESTIONNAIRES

E.1 HOUSEHOLD SURVEY INSTRUMENT

HOUSEHOLD SURVEY QUESTIONNAIRE
Mitigation and Recovery from Hurricane-related Disasters in the Eastern Caribbean: The role of Geo-informatics

Island: _ST. VINCENT_____ Date: ___________ **Urban/Rural Area: _________________**
Head of Household/Assignee: ___________________________ **Number: ____________**
Address: _____________________________ **GPS Order/Code: ________________**

Hello, I'm Leonard Huggins from Nevis and the University of Pittsburgh. Thank you for agreeing to participate in this important study on how we can improve disaster management and recovery in the Eastern Caribbean. I want to take about 25 minutes to find out about your experience with hurricanes.

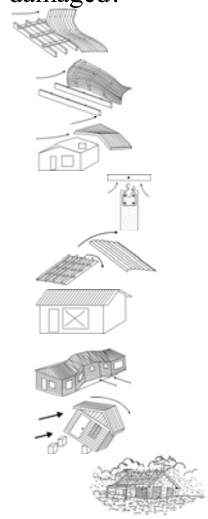
SECTION I. EXPERIENCE & PERCEPTION OF HURRICANES & TROPICAL STORMS

1. How long have you lived on ___________________?
2. How many hurricanes and major tropical storm have you experienced? ___________
3. How did you find out that a storm or hurricane was approaching? *(Check all that apply)*
   - ☐ Family (Word-of-mouth) ☐ Local Radio
   - ☐ Friends (Word-of-mouth) ☐ Local Television
   - ☐ International Television ☐ Other, _________________
4. Can you tell me the last named tropical storm or hurricane that you survived? ____________
5. How did you prepare for this storm/hurricane? *Check all that apply*.
   - ☐ Did not prepare
   - ☐ Listened to forecast often
   - ☐ Stored food, water, medical supplies, etc.
   - ☐ Secured windows and doors
   - ☐ Secured outside property/ assets
   - ☐ Called the emergency management office
   - ☐ Tried to make good repairs to house long before hurricanes.
   - ☐ Other, *please specify,* ____

Let's talk about your most recent experience?

6. What hurricane did you most recently experienced?
   - ☐ Hurricane Ivan ☐ Hurricane Emily ☐ Other, ____________________
7. Did you suffer any damage or loss? ***(Check all that apply)***
   - ☐ Yes, damage to primary house ☐ Yes, damage to other property
   - ☐ Yes, loss of livelihood ☐ Yes, loss of life
   - ☐ Yes, both property damage and loss of life ☐ None **(if none, skip to 10)**

8. **(**If damage to primary house). What parts of your house were damaged?



- ☐ Sheeting comes off
- ☐ Purlins damaged/come off
- ☐ Roof comes off
- ☐ Rafters come out of walls
- ☐ Two sides of roof separate
- ☐ Windows fail
- ☐ Walls blow over
- ☐ Buildings blow off footings
- ☐ Furniture (from rain/flooding)

**Pictures courtesy USAID Guidelines for Builders*

9. Can you tell me why you believe your house got damaged? *(Does the person technically understand what failed – failure mechanism?)*____

10. With whom did you talk with concerning <u>Hurricane (Ivan/Lenny)</u> before it arrived?

☐ Family	☐ Planning Agency
☐ Friends	☐ Community Organization
☐ Emergency Preparedness Office	☐ Other, ___________________

11. What concerns did you have before the hurricane came?

☐ Magnitude of the hurricane	☐ Concerns about insurance
☐ Possible property damage/loss	☐ Concerns about path of hurricane
☐ Concerns about livelihood	☐ Concerns about critical infrastructure
☐ Other, please explain	

12. While the hurricane was going on, did you seek any information from anyone?
☐ Yes ☐ No

13. If so (in 12 above), what information and from whom?

☐ Family	____
☐ Friends	____
☐ Planning Agency	____
☐ Emergency Preparedness Office	____
☐ Public Works	____
☐ Community Organization	____
☐ Other	____

14. Did you evacuate your primary house/home before the hurricane came?
☐ Yes ☐ No

15. If yes (in 14 above), where did you go to?

☐ With Family	☐ At Emergency Shelter
☐ With Friends	☐ Other ____________________

16. Were you displaced from your primary house/home after this hurricane?
☐ Yes ☐ No **(If no, skip to next section)**

17. If yes (in 14 above), where did you stay?

☐ With Family	☐ At Emergency Shelter
☐ With Friends	☐ Other ____________________

18. How long were you displaced from your primary house/home? ________________

19. Did you move back into your primary home after some of the repairs were done or after all the repairs were done?
☐ After SOME of the repairs were done ☐ After ALL the repairs were done

20. Were you able to work while you were displaced from your primary house/home?
☐ Yes ☐ No

21. If not (in 18 above), from whom did you obtain support? ________________________________

SECTION II. EXPERIENCE & PERCEPTION OF DISASTER RECOVERY & MITIGATION

Let's talk about your most recent experience after the hurricane?

Skip to question 8, if no damage from recent hurricane

1. Did you contact any of the following agencies before you rebuilt or repaired your house?
   - ☐ Public Works
   - ☐ Public Utilities
   - ☐ Emergency Preparedness Office
   - ☐ Other ___________________
   - ☐ Planning Agency
   - ☐ Community/ Faith based Organization
   - ☐ Relief Organization

2. Did you obtain any of the following services when you repaired or rebuilt your home? Please specify who or which company.

Service	Yes	No	Who/what company
Draughtsman	☐	☐	
Architect	☐	☐	
Builder	☐	☐	
Contractor	☐	☐	

3. What assistance did you receive for rebuilding or repairing your house?
____

4. Did you obtain a rebuilding permit or repair certification for your house?
☐ Yes ☐ No ☐ Was not required

5. How did you retrofit your house after the hurricane?

☐ Replaced purlins and added purlins where necessary to close the spacing


☐ Raised roof pitch especially when repairing extensive damage


☐ Replaced roof with a hip roof if re-roofing


☐ Boxed eaves, reduced overhangs, edge capped especially at gable ends


☐ Added hurricane straps/clips


☐ Added sheeting nails or screws


☐ Added collar ties, one every 2 rafters


☐ Added hurricane shutters with strong hinges and fasteners


☐ Added bracing to timber walls


☐ Strapped foundations or building masonry footings or strapped wall plates to walls or rafters to wall


☐ None
☐ Don't Know

6. Which building guidelines or codes did you find useful when retrofitting your house?

____

7. How long did it take to fully repair your home? ____________________

Let's talk about previous hurricanes or storms.

8. Did you suffer any damage or loss from any other previous hurricane?
   ☐ Yes ☐ No

9. If yes, which ones?____

10. What types of damage did you suffer?
    ☐ Yes, damage to primary house ☐ Yes, damage to other property
    ☐ Yes, loss of livelihood ☐ Yes, loss of life
    ☐ Yes, both property damage and loss of life ☐ None

11. a. Did you make any modifications to your property to prevent this damage again?
    ☐ Yes ☐ No
    b. If yes, what modifications did you make? ______________________

12. What agency, if any, did you consult regarding the changes you made?

____

13. a. Did the modifications hold up in subsequent disasters?
    ☐ Yes ☐ No
    b. Why or why not?

____

Overall

14. Do you perceive the disaster as a possibility for structural changes or do you prefer to restore what had been?
    ☐ Change ☐ Restore ☐ Don't Know

15. How important do you think the following measures are for making buildings and the overall economy in ________ more resilient against future disasters?

	Very Important	**Important**	**Not Important**	**Enough been done already**	**Don't Know**
Making structural changes in existing houses	☐	☐	☐	☐	☐
Increasing economic diversification	☐	☐	☐	☐	☐
Making more stringent building guidelines	☐	☐	☐	☐	☐
Creating hazard zoning	☐	☐	☐	☐	☐
Providing/using insurance schemes	☐	☐	☐	☐	☐
Updating mapping processes	☐	☐	☐	☐	☐
Increasing public participation in planning for disasters	☐	☐	☐	☐	☐
Improving information technology, exchange and communication	☐	☐	☐	☐	☐
Increasing foreign aid and assistance	☐	☐	☐	☐	☐
Helping the most vulnerable more	☐	☐	☐	☐	☐
Cooperating with other Caribbean islands	☐	☐	☐	☐	☐

SECTION III. INFORMATION, NETWORKS, COMMUNICATION, COLLABORATION, RELATIONSHIPS & PARTICIPATION

The nature of relationship among affected households and mitigation and recovery agencies.

1. Did you seek any information from authorities, agencies or organizations after the hurricane?
   □ Yes □ No
2. If yes, from which agencies, departments or organizations did you seek information?
   ____
3. If yes, what type of information or assistance did you seek?
   - □ Financial
   - □ Information ___________________________
   - □ Structural (Bldg materials) __________________
   - □ Other (pls specify) _____________________

   b. What kind of help did you receive and from what organization or agency?

Help Received	***From this organization***
□ Financial	_______________________
□ Information	___________________________
□ Structural (Bldg materials)	________________
□ Other (pls specify)	_____________________

4. What type of information do you think you will need to deal with future disasters?
   ____
5. Were you aware that you can contribute to the development of your island's disaster management plan? □ Yes □ No
6. How would you contribute now that you are aware?
   ____
7. Do you have access to a computer and the Internet at your primary house/home?
   - □ Yes, Computer but no Internet access
   - □ Yes both computer and Internet access
   - □ No

   If no, do you have access to a computer and the Internet elsewhere?
   - □ Yes, where ___________________________
   - □ No
8. If a technology system was provided for you to report your actual damages or losses and other information about your property to a central agency for disaster management and development planning, would you use the system?

	To which agencies	*What information*
□ Yes	□DM □DP □Central	□Damages □Loss □Other
□ No		

9. Which organization would you prefer to report to?
   - □ Disaster Management Office □ Department of Planning
   - □ A community or faith-based organization
   - □ Other _________________________

Risk, Governance and Effectiveness

10. How can you protect your household against possible risks of a hazard?
    - □ Building guidelines
    - □ Insurance
    - □ Leave island
    - □ Move to less vulnerable part of island

11. Have you already used or will use any of these measures?

☐ I used   I will use   Measure: ____________________

☐ I didn't use   I won't use

12. Has building codes changed overtime? If so, how have they changed?

☐ Yes, more rigorous

☐ Yes, more lenient

☐ No, stayed the same

13. On a scale of 1 to 5 with 1 being poor or very negative impact and 5 being very positive impact, what impact, if any, do you think political decisions have had on recovery from hurricanes?

1 …………… 2 ……………. 3 ……………. 4 …………….. 5

negative impact   positive impact

_____ don't know/ no answer

14. On a scale of 1 to 5 with 1 being very poor and 5 being very good, how would you rate the overall recovery from the most recent hurricane you experienced?

1 …………… 2 ……………. 3 ……………. 4 …………….. 5

very poor   very good

_____ don't know/ no answer

15. How has recovery from hurricanes changed in the last 15-20 years, if any?

____

16. How do you judge the overall recovery efforts and the performance of government agencies from hurricane _______?

	Very Good	Good	Moderate	Poor	Very Poor	Don't Know
Performance of government agencies	☐	☐	☐	☐	☐	☐

17. How do you judge the overall performance of government agencies in the recovery effort from hurricane _______?

	Very Good	Good	Moderate	Poor	Very Poor	Don't Know
Reconstruction of medical facilities	☐	☐	☐	☐	☐	☐
Reconstruction of schools	☐	☐	☐	☐	☐	☐
Providing emergency shelter	☐	☐	☐	☐	☐	☐
Providing water & electricity	☐	☐	☐	☐	☐	☐
Reconnecting roads	☐	☐	☐	☐	☐	☐
Assisting housing recovery	☐	☐	☐	☐	☐	☐
Handling relief aid honestly	☐	☐	☐	☐	☐	☐
Enforcing rebuilding codes	☐	☐	☐	☐	☐	☐
Providing hurricane information	☐	☐	☐	☐	☐	☐
Conducting damage assessment	☐	☐	☐	☐	☐	☐
Performance of government agencies	☐	☐	☐	☐	☐	☐

18. Did you experience any elements of corruption during the recovery process? If so what?

____

19. What do you think is the best way to alleviate such corruption?

____

<u>SECTION IV. DEMOGRAPHIC DATA</u>
<u>Background Information about You and Your Household:</u>
Let's talk about your household. This will help us to group people of similar backgrounds together and see if their experiences with hurricanes and disaster recovery are the same or different.

D1. How many years have you lived at this address?
- ☐ Less than 5 years ☐ 15-25 years
- ☐ 5-10 years ☐ More than 25 years
- ☐ 10-15 years
- ☐ All my life

D2. Are you the head of the household? ☐ Yes ☐ No, ______________

D3. a. How many persons live with you in this household? ________
b. How many are children? _____

D4. Do you have any extended family members living with you?
- ☐ Yes, extended family household
- ☐ No, single family household

D5. Do you rent or own this home?
- ☐ Rented
- ☐ Self-owned
- ☐ Other __________________

Finally, a bit of information about you!
D6. Sex: ☐ Male ☐ Female

D7. Which of the following age groups are you in?
- ☐ Less than 18 ☐ 36-45
- ☐ 18-25 ☐ 46-60
- ☐ 26-35 ☐ Over 60

D8. Are you?
- ☐ Single ☐ Divorced
- ☐ Married ☐ Widowed
- ☐ Unmarried, but live with partner

D9. What is the highest level of formal education you attained?
- ☐ No Formal Education ☐ Tertiary (Sixth Form/Teachers' College)
- ☐ Basic (Primary, Elementary) ☐ University (Associate, Bachelors, Masters, PhD)
- ☐ Secondary (High, Vocational) ☐ Any Other _______________

D10A. What work do you primarily do?
- ☐ Public Authority Worker/Civil Servant ☐ Teacher/Instructor/Daycare
- ☐ Farmer/Fisherman ☐ Construction Worker/Plumber/Tradesman
- ☐ Hotel/Restaurant Worker ☐ Other Tourism Service Worker (Taxi, Etc)
- ☐ Banking/Finance Worker ☐ Health Service Worker
- ☐ Non-Profit Agency Worker ☐ Student (Don't work)
- ☐ Don't Work/Unemployed ☐ Other (pls specify) _______________

10B. Do you work full-time or part-time? ☐ Full-time ☐ Part-time

D11A *(If married or living with* partner). What work does your wife/partner do?
- ☐ Public Authority Worker/Civil Servant ☐ Teacher/Instructor/Daycare
- ☐ Farmer/Fisherman ☐ Construction Worker/Plumber/Tradesman
- ☐ Hotel/Restaurant Worker ☐ Other Tourism Service Worker (Taxi, Etc)
- ☐ Banking/Finance Worker ☐ Health Service Worker
- ☐ Non-Profit Agency Worker ☐ Student (Don't work)
- ☐ Don't Work/Unemployed ☐ Other (pls specify) _______________

D11B. Is this full-time or part-time? ☐ Full-time ☐ Part-time

D12. Which of the following best represents your annual (household) income?

☐ Less than $10,000 ☐ $40,001 - $65,000
☐ $10,000 - $25,000 ☐ $65,001 - $100,000
☐ $25,001 - $40,000 ☐ More than $100,000

Finally, a few questions on how well you know some people and organizations.

How well do you know these persons/organizations? How often do you communicate with them?

	How well do you know this person or organization? **V. Well, Well, Not so well, Don't Know, No answer**					How often do you communicate with this person or organization? **V. Often, Often, No so often, Hardly ever, Don't**				
	VW	**W**	**N/W**	**D/K**	**N/A**	**VO**	**O**	**N/O**	**H/E**	**D**
Immediate Neighbors	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other people in neighborhood who you are not related to	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Extended family living elsewhere on island	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Your builder	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Your designer or architect	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Planning officer/department	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Emergency office or officer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Building Board or its officials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Red Cross	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
CDERA	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Political representative for this area	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other elected officials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

What factors do you think affect recovery from hurricane disasters?
1.
2.
3.

What factors do you think help the poor to be better off after a disaster?
1.
2.
3.

Thank you very much for participating in this survey.

Surveyor's Observations of Physical Structure

Types of Material of the external walls of the home:

- ☐ Permanent ☐ Brick
- ☐ Block
- ☐ Concrete

- ☐ Semi-permanent ☐ Wood/lumbar

- ☐ Non-permanent ☐ Stem
- ☐ Metal sheeting
- ☐ Other

From surveyors external observations, are the following ties in building?

	Yes, Fully	Yes, Partially	No
Roof to Purlins	☐	☐	☐
Purlins to Rafters	☐	☐	☐
Rafters to Ring beam	☐	☐	☐
Ring beam to Walls	☐	☐	☐
Walls to Floor	☐	☐	☐
Floor to Foundation	☐	☐	☐
Foundation to Ground	☐	☐	☐

E.2 BUILDERS' AND DESIGNERS SURVEY INSTRUMENT

BUILDERS' & DESIGNERS' SURVEY QUESTIONNAIRE
Mitigation and Recovery from Hurricane-related Disasters in the Eastern Caribbean: The role of Geo-informatics

Island: ______________ __________ Urban/Rural Base: ________________________

Head of Company/Assignee: _________________________________

Company Name: ____

Address: ______________________ Tel: _______________________

Hello, I'm conducting this survey about your experience with hurricanes, and the designing and building of homes in St. Vincent on behalf of the University of Pittsburgh, and assistance to my friend completing his Ph.D.

SECTION I. EXPERIENCE & PERCEPTION OF HURRICANES & TROPICAL STORMS

1. Have you experienced the hurricanes or major tropical storms that passed through _______ since 1985? If yes how many
   - Yes, all (7-9)
   - Yes, most (4-6)
   - Yes, a few (1-3)
   - No, none

2. What major hurricane did you most recently experienced?
   - Hurricane Ivan
   - Hurricane Lenny
   - Other, _________________

Let's talk about your own property and your most recent hurricane experience.

3. What steps did you take to prepare for this storm/hurricane? *Check all that apply*.
   - Listened to weather forecast often
   - Stored food and water
   - Secured windows and doors
   - Secured outside property/ assets
   - Called the emergency management office
   - Tried to make good repairs to house long before hurricanes.
   - Other, *please specify*, ____
   - Did not prepare as per previous storms/hurricanes
   - Did not prepare at all

4. With whom did you talk concerning the hurricane before the hurricane _____ arrived?
   - Family
   - Friends
   - Emergency Preparedness Office
   - Co-workers
   - Planning Agency
   - Community Organization
   - Other, _________________
   - No one or agency

5. What concerns did you have or talk about as the hurricane approached?
   - Magnitude of the hurricane
   - Possible property damage/loss
   - Concerns about livelihood
   - Other, please explain _______________
   - Concerns about insurance
   - Concerns about path of hurricane
   - Concerns about critical infrastructure
   - No concerns

6. What kind of information did you seek during the hurricane? ______________________________________

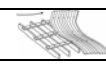
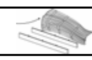
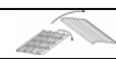
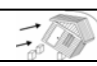
7. From whom did you seek information during the hurricane?

☐ Family	☐ Planning Agency
☐ Friends	☐ Community Organization
☐ Emergency Preparedness Office	☐ Other ___________
☐ Co-workers	☐ No one or no agency

8. Did you suffer any damage or loss from the most recent hurricane you experienced?
   - ☐ Yes, damage to primary house
   - ☐ Yes, damage to other property
   - ☐ Yes, loss of livelihood
   - ☐ Yes, loss of life to family or friends
   - ☐ Yes, both property damage and loss of life
   - ☐ None ***(Skip to question to question 16)***

(If damage to primary house).

9. What parts of your house were damaged?

☐	1	Sheeting comes off	
☐	2	Purlins damaged/come off	
☐	3	Roof comes off	
☐	4	Rafters come out of walls	
☐	5	Two sides of roof separate	
☐	6	Windows fail	
☐	7	Walls blow over	
☐	8	Buildings blow off footings	
☐	**9**	Furniture (from rain/flooding)	

**Pictures courtesy USAID Guidelines for Builders*

10. Can you tell me why you believe your house got damaged?
____

11. Did you restore or repair damaged parts with more resistant structure?
   - ❑ Restored to original work
   - ❑ Repaired with stronger design.
     Please list _______________________________________

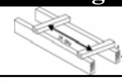
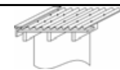
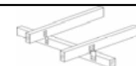
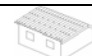
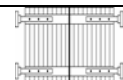
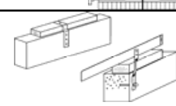
Let's talk about your business experience with the most recent hurricane?

12. What is the main service that your company provides?
   - ☐ Designing (draughtsman/architects)
   - ☐ Building (contractors, builders, etc)
   - ☐ Both

13. How many houses did your company redesign, repair or rebuilt after the most recent hurricane <u>Lenny/Ivan</u>?

Total	Redesign	Repair	Rebuilt
☐ None	☐ None	☐ None	☐ None
☐ 1-2	☐ 1-2 ___	☐ 1-2 ___	☐ 1-2 ___
☐ 3-5	☐ 3-5 ___	☐ 3-5 ___	☐ 3-5 ___
☐ 5-10	☐ 5-10 ___	☐ 5-10 ___	☐ 5-10 ___
☐ 10-20	☐ 10-20___	☐ 10-20___	☐ 10-20___
☐ More than 20	☐ More than 20	☐ More than 20	☐ More than 20

14. How would you rank the following types of repair or redesign you completed in order from 1 to 10 with 1 being the most common and 10 the least common?

Description	Damage	RANK
Replaced purlins and added purlins where necessary to close the spacing		
Raised roof pitch especially when repairing extensive damage		
Replaced roof with a hip roof if re-roofing		
Boxed eaves, reduced overhangs, edge capped especially at gable ends		
Added hurricane straps/clips		
Added sheeting nails or screws		
Added collar ties, one every 2 rafters		
Added bracing to timber walls		
Added hurricane shutters with strong hinges and fasteners		
Strapped foundations or building masonry footings or strapped wall plates to walls or rafters to wall		

**Pictures courtesy USAID Guidelines for Builders*

15. On average, how long did it take to repair a house damaged by hurricane <u>Lenny/Ivan</u>?
- ☐ 0-1 month
- ☐ 2-3 months
- ☐ 3-6 months
- ☐ 6-12 months
- ☐ More than 1 year
- ☐ Don't Know
- ☐ Never had to

16. Does it take the same amount of time, more time or less time to repair houses damaged by the most recent hurricane compared to hurricanes in previous years?
- ☐ Less time
- ☐ Same amount of time
- ☐ More time
- ☐ Don't Know

17. Why do you think this is so? ____

<u>SECTION II. EXPERIENCE & PERCEPTION OF DISASTER RECOVERY & MITIGATION</u>

Let's talk about your most recent experience after the hurricane?

1. Did your company/business consult/contact any of the following agencies before redesigning, rebuilding or repairing damaged houses? If so, how often?
- ☐ Public Works ____________________________
- ☐ Planning Agency ____________________________
- ☐ Public Utilities ____________________________
- ☐ Community Organization ____________________________
- ☐ Emergency Preparedness Office ____________________________
- ☐ Relief Organization ____________________________
- ☐ Other ____________________
- ☐ None
- ☐ Mostly, refer to building codes for information

2. From your observations, what assistance did your clients receive for redesigning, rebuilding or repairing your house after hurricane Lenny?

	All clients	Most clients	Few clients	No clients
Technical assistance	☐	☐	☐	☐
Building materials	☐	☐	☐	☐
Financial assistance	☐	☐	☐	☐
Other	☐	☐	☐	☐

3. Did you obtain a rebuilding permit or repair certification for each house?
   ☐ Yes, all ☐ Yes, most ☐ Yes, a few ☐ No
   ☐ Was not required

4. Did you use the guidelines/codes for building when retrofitting or redesigning damaged houses?
   ☐ Yes ☐ No

5. List the top three code requirements that you have paid greater attention to in designing since 1989.

   ____
   ____
   ____

6. Did this list change before or after the most recent hurricane? If yes, in what did they change?
   ☐ Yes ☐ No
   ____

   Let's talk about previous hurricanes or storms.

7. Did your company provide redesign, rebuilding or repairing services from previous hurricanes in the past 15 years (i.e. since 1989)?
   ☐ Yes, all years
   ☐ Yes, most years
   ☐ Yes, the last few years
   ☐ No, not before most recent hurricane?

8. How well has modifications done by your company hold up in subsequent hurricanes?
   ☐ Very well ☐ Well ☐ Not well ☐ Don't Know

9. Did your company have to repeat or redo any of the designs or repairs from any one hurricane to another for the same property? How many? And for what part of house, mainly?

	How many	***What part of house***
☐ Yes,	__________	__________________________
☐ No, no repeats		
☐ Did not have any designs or repairs to do		

Overall

10. How often do you utilize the building codes in designing new houses?
    ☐ Always ☐ Most times ☐ Sometimes ☐ Rarely ☐ Never

11. Why? ____
    Required.

12. Do you perceive the disaster as a possibility for major structural changes to buildings or do you prefer to restore what had been?
    ☐ Change ☐ Restore ☐ Don't Know

13. How important do you think the following measures are for making buildings and the overall economy in ST. VINCENT more resilient against future disasters?

	Very Important	Important	Not Important	Enough been done already	Don't Know
Making structural changes in existing houses					
Increasing economic diversification					
Making more stringent building guidelines					
Creating hazard zoning					
Providing insurance schemes					
Updating mapping processes					
Increasing public participation in planning for disasters					
Improving information technology, exchange and communication					
Increasing foreign aid and assistance					
Helping the most vulnerable more					
Cooperating with other Caribbean islands					
Having specific house numbers and street address with zip code					

14. What type of information do you think you will need to make building or designing stronger or more resilient to future disasters?

____

15. What factors do you think hinder or help recovery from hurricane disasters?
    Hinder ____
    Help ____

16. What factors do you think hinder or help the poor to be better off after a hurricane disaster?
    Hinder ____
    Help ____

SECTION III. INFORMATION, NETWORKS, COMMUNICATION, COLLABORATION, RELATIONSHIPS & PARTICIPATION

1. Did your business seek any information or help from authorities or agencies after the hurricane?
   ☐ Yes ☐ No

   b. If yes, what kind of help did your business request?
   ☐ Technical ☐ Information on building codes, policy & guidelines
   ☐ Financial ☐ Structural
   ☐ Other (*pls specify*) ____________________

   c. What kind of help did your business receive? ___________________________________

2. How often do you or your business communicate with the following agencies?

	Weekly	Monthly	Quarterly	Once-Twice Per Year	Hardly Ever	Never
Physical Planning/Central Planning						
Ministry of Transportation & Works						
Red Cross						
Disaster Management Office (NEMO)						
Projects Promotions NGO						
Caribbean Disaster Emergency Response Agency						
Past Clients						
Current Clients						
Other designers/ builders						
Your neighbors						

3. Did you comply with the building codes and guidelines when repairing, redesigning or rebuilding damaged structures?

□ Yes, Always □ Yes, Most times □ Yes, Sometimes □ No

4. Do you communicate the building code requirements and guidelines with your clients?

□ Yes, Always □ Yes, Most times □ Yes, Sometimes □ No

5. Do you utilize CAD drawings or geographic information systems (GIS) technology in your work?

□ Yes, Always □ Yes, Most times □ Yes, Sometimes □ No

6. Would you use geographic information systems to report damages or losses and other information about properties that you service to a central agency for disaster management and development planning purposes?

To which agencies *What information?*

□ Yes □ NEMO; □ Other _______ Damages Bldg changes Other

□ No

Risk, Governance and Effectiveness

7. Have building codes changed overtime? If so, in what ways?

□ Yes, more rigorous and disaster resilient

□ Yes, less resilient

□ No, stayed the same, but greater awareness

□ No change.

8. What kind of impact do you think that political decisions have had on recovery from hurricane disasters?

□ No impact

□ Positive impact

□ Negative impact

□ Neutral impact (both positive and negative)

□ Don't Know

□ Other ___________________________

9. How do you judge the overall recovery effort on the island after hurricanes?

	Very Good	Good	Moderate	Poor	Very Poor	Don't Know
Reconstruction of medical facilities						
Reconstruction of schools						
Provision of emergency shelters						
Restoration of water & electricity						
Reconnection of roads						
Government assistance with housing repair						
Honesty in handling relief aid						
Compliance or enforcement of building codes/guidelines						
Performance of government agencies						
Conducting damage assessment						

10. Has the recovery effort improved over time? How?

____

11. Does your business participate in disaster management workshops or disaster planning?
   - ☐ Yes ☐ No

SECTION IV. DEMOGRAPHIC DATA

Background Information about You and Your Company/Business:

This will help us to group businesses of similar backgrounds together and see if their experiences with hurricanes and disaster recovery are the same or different.

D1. How many years have you been a contractor/builder/draughtsman/architect?
- ☐ Less than 5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ 15-25 years
- ☐ More than 25 years
- ☐ All my life

D2. Is this a company, partnership or sole proprietorship?
- ☐ Yes, company ☐ Yes, partnership ☐ Yes, sole proprietorship ☐ None

D3. How many persons do you employ? ________

D4. Do you work on?
- ☐ Houses only
- ☐ Commercial buildings only
- ☐ Both houses and commercial buildings

D5. In which one of the following ranges does your business annual earnings fit?
- ☐ Less than 10,000
- ☐ 10,000 – 20,000
- ☐ 20,000-30,000
- ☐ 30,000 – 50,000
- ☐ More than 50,000

Finally, a bit of information about you!

D6. Sex: ☐ Male ☐ Female

D7. Which of the following age groups are you in?
- ☐ Less than 18
- ☐ 36-45
- ☐ 46-60
- ☐ Over 60

D8. Are you?

- ☐ Single
- ☐ Married
- ☐ Unmarried, but live with partner
- ☐ Divorced
- ☐ Widowed

D9. What is the highest level of formal education you attained?

- ☐ No Formal Education
- ☐ Basic (Primary, Elementary)
- ☐ Secondary (High Sch, Vocational)
- ☐ Tertiary (Sixth Form/Teachers' College)
- ☐ University (Associate, Bachelors, Masters, PhD)
- ☐ Any Other _______________

D10. Are you a?

- ☐ Contractor
- ☐ Draughtsman
- ☐ Other (pls specify) ___________________
- ☐ Builder
- ☐ Architect

D11. Do you work full time or part time in your business?

- ☐ Full time
- ☐ Part time

If part time, do you work else where?

- ☐ Yes, full time
- ☐ Yes, full time
- ☐ No

What work do you do elsewhere?

____

Thank you very much for participating in this survey.

E.3 NATIONAL AGENCIES SURVEY INSTRUMENT

NATIONAL AGENCIES INTERVIEW QUESTIONNAIRE
Mitigation and Recovery from Hurricane-related Disasters in the Eastern Caribbean:
The role of Geo-informatics

Name of Interviewee:		Name of Agency/Organization:
		Position/Title:
Department:	Community/Parish:	Contact Information:
Sex:	Ethnicity:	

Hello, I'm Leonard Huggins from Nevis and the University of Pittsburgh. I am doing a survey of hurricanes and disaster management in the Eastern Caribbean. I would like to ask you some questions about your experience with hurricanes, disaster management, mitigation and recovery. With your permission, I would like to record this interview to better assist me in my data coding and analysis.

SECTION I. BACKGROUND INFORMATION ABOUT AGENCY

1. What is the mission of your department or agency? ____________________________
2. How many people does your department/organization/agency employ? ____________
3. What type of organization would you say your agency is?
   a. National Governmental Agency
   b. National NGO
   c. National Quasi Government Agency
   d. Other, please specify, _______________________
4. What is the primary objective or role of your organization in disaster management, prevention, mitigation and recovery?
   ____
5. What is the estimated annual budget for your agency's programs?
   ____
6. What amount of your budget is dedicated to disaster management and issues involving planning for disaster prevention or recovery?___________________________

SECTION II. LINKING MITIGATION & DISASTER RECOVERY

Planning

1. What role does your organization/agency/department play in disaster planning?
   ____
2. What problems do you encounter in planning for disasters?
   ____

Let's talk specifically about hurricanes.

3. How many hurricanes has your organization experienced since 1985? _____________
4. In what ways has your organization/agency/department provided assistance to any community or organization before, during and after a hurricane/

Assistance to Community	Assistance to Other Organizations
Before hurricane:	
During hurricane:	
After hurricane:	

5. How have you incorporated mitigation against future hurricanes into recovery activities from a current hurricane disaster in the past?
   ____
6. How do you plan to incorporate mitigation against future hurricanes into recovery activities from a current hurricane disaster in the future? Or what approach has your agency taken to build resilience into disaster recovery?
   ____
7. What factors do you think facilitate or hinder recovery from hurricane disasters in ________?
   Facilitate: ____
   ____
   Hinder: ____
   ____
8. What factors do you think facilitate or hinder strategies to make the poor better off after a hurricane disaster? ____
9. What problems do your organization or agency encounter in executing plans prepared before a disaster during the disaster recovery period? ____

Governance

10. Does ___________ have a disaster management plan that you are aware of?
    □ Yes □ No
11. Does ________ have disaster recovery plans? Or does the disaster management plan deal with disaster recovery?
    □ Yes □ No
12. Who administers the disaster recovery plans or parts of the plan?
    ____
13. What community or civic groups help to administer the plan on ___________?
    ____
14. Does the public contribute to the disaster plans? If so, in what ways?
    ____
15. How are recovery programs made accessible to all members of the community?
    ____

SECTION III. INFORMATION, NETWORKS, COMMUNICATION, COLLABORATION, COORDINATION & RELATIONSHIPS

1. Briefly describe how your organization operates? (How are decisions made? In what ways do members participate in setting priorities for action?)

 ____

 Information & Information Exchange

2. Describe how your agency collects, exchanges and distributes information? Who is responsible for checking the validity of information that supports decision making?

 ____

3. How do access to information and its exchange affect communication within your organization and with other organizations?

 ____

4. How do access to information and its exchange affect decision-making for your organization/agency?

 ____

 Geoinformatics

5. How does your organization utilize geographic information systems (GIS) in disaster management throughout the region?

 ____

6. What factors facilitate or hinder collaboration using GIS for disaster management?

 ____

7. What forms of training, if any, do your staff receive regarding the use and management of GIS databases and GIS programs for disaster management?

 ____

Coordination and communication
Information about communication

8. Please rank the following factors that might facilitate or hinder coordination on a scale of 1 to 5, with 5 being the most important and 1 the least important.

Factors facilitating Coordination	Rank	Factors Hindering Coordination	Rank
Formal written agreements		Donors imposing conditions	
Agreed upon structures		Funding cycles	
Personalities of people Involved		Political agendas of host country governments	
Strong Leadership		Costs of Coordination in terms of flexibility and reduced resources	
Frequency of Contact		Competition between Agencies	

9. This question is designed to help the researcher understand the **nature of agreement** between your organization and each of the listed organizations. With which of the listed organizations does your organization have an agreement about the activities performed (particularly relating to disaster management)? Beside each question is a 6 point scale with 0 indicating no relationship exists between your organization and the organizations listed and 5 indicating a legally mandated agreement between your organization and that organization. Please check the box below the number that most accurately reflects the relationship between your organization and each organization listed.

	No relation-ship	Aware-ness but no relation-ship	Casual verbal agree-ment	Explicit verbal agreement	Written formal agree-ment	Legally mandated agreement
Organization:	**0**	**1**	**2**	**3**	**4**	**5**
Development/Physical Planning						
Public Works						
Red Cross						
Disaster Management Office/NEMA						
Chamber of Industry & Commerce						
National Christian Council						
CDERA						
Community-based Organizations such as sports clubs						
The leading national environmental NGO, *please specify*, __EAG						

10. What forms of communication do you typically use to communicate with the following groups, agencies or organizations, if any?

	Radio Message	TV message	News-paper	Newsletter/ Bulletin	Tele-phone or fax	Email/ Internet
Development/Physical Planning						
Public Works						
Red Cross						
Disaster Management Office/NEMA						
Chamber of Industry & Commerce						
National Christian Council						
CDERA						
Community-based organizations such as sports clubs						
Builders & Designers						
The General Public						
The leading national environmental NGO, *please specify*, ____**EAG**____						

11. This question is designed to tell us about the **frequency of contact** between your organization and each of the listed organizations. When you are working with each of the listed organizations, how often are contacts made between your organization and each of these organizations? A 6 point scale is listed beside each organization with 0 indicating no contact between your organization and the listed organization and 5 indicating that your organization is in contact with each listed organization several times per day. Please check the box below the number that most accurately reflects the frequency of contact between your organization and each of the listed organizations.

	No Contact	**Once-Twice Per Year**	**Quarterly**	**Monthly**	**Weekly**	**Daily**
Organization:	**0**	**1**	**2**	**3**	**4**	**5**
Development/Physical Planning						
Public Works						
Red Cross						
Disaster Management Office/NEMA						
Chamber of Industry & Commerce						
National Christian Council						
CDERA						
Community-based Organizations such as sports clubs						
Builders & Designers						
The General Public						
The leading national environmental NGO, *please specify*, ___**EAG**___						

Information about Coordination

This section of the questionnaire concerns coordination activities between your department or organization and each of the listed organizations. The section is comprised of six questions, each addressing a particular element of coordination: (a) strategic planning; (b) division of labor in the field; (c) information management; (d) resource mobilization; (e) negotiating and maintaining a serviceable framework with political authorities; and (f) providing leadership. For Questions (12) and (13): A 6 point scale is listed beside each organization with 0 indicating that your organization does not coordinate efforts with the listed organizations and 5 indicating that your organization coordinates effort to a great extent. Please check the box below the number that most accurately describes the extent of your organization's coordination activities.

12. Strategic planning

To What extent does your organization practice strategic planning (for example in the disaster recovery) with each of the listed organizations?

	Not at all	**Little extent**				**Great Extent**
Organization name	0	1	2	3	4	5
Development/Physical Planning						
Public Works						
Red Cross						
Disaster Management Office/NEMA						
Chamber of Industry & Commerce						
National Christian Council						
CDERA						
Community-based Organizations such as sports clubs						
Builders & Designers						
The leading national environmental NGO, *please specify*, ____**EAG**___________						

13. Division of labor in the field
To what extent does your organization practice division of labor with each of the listed organizations?

	Not at all	**Little extent**				**Great Extent**
Organization name	0	1	2	3	4	5
Development/Physical Planning						
Public Works						
Red Cross						
Disaster Management Office/NEMA						
Chamber of Industry & Commerce						
National Christian Council						
CDERA						
Community-based Organizations such as sports clubs						
Builders & Designers						
The leading national environmental NGO, *please specify*, ___**EAG**____________						

Questions (14) and (15): Each question consists of two parts: (1) the extent to which your organization is a sender of information or resources, and (2) the extent to which your organization is a recipient of information or resources. The same 6 point scale is listed beside each organization. Please circle the number than most accurately reflects the extent to which your organization's exchange of information or resources.

14. Information Management

	1. To What extent does your organization send information to each of the listed organizations?						**2. To What extent does your organization receive information from each of the listed organizations?**					
	None	Little extent				Great extent	None	Little extent				Great extent
Organization name	0	1	2	3	4	5	0	1	2	3	4	5
Development/Physical Planning												
Public Works												
Red Cross												
Disaster Management Office/NEMA												
Chamber of Industry & Commerce												
National Christian Council												
CDERA												
Community-based Organizations such as sports clubs												
Builders & Designers												
The leading national environmental NGO, please specify, __**EAG**_												

15. Resource Mobilization

	1. To What extent does your organization send resources (funds, capacity, logistics) to each of the listed organizations?						2. To What extent does your organization receive resources (funds, capacity, logistics) from each of the listed organizations?					
	None	Little extent				Great extent	None	Little extent				Great extent
Organization name												
Development/Physical Planning												
Public Works												
Red Cross												
Disaster Management Office/NEMA												
Chamber of Industry & Commerce												
National Christian Council												
CDERA												
Community-based Organizations such as sports clubs												
Builders & Designers												
The leading national environmental NGO, please specify, ____**EAG**___												

Questions (16) and (17): Each question consists of two parts: (1) whether your organization provides help and leadership, and (2) whether your organization receives help and leadership. Please provide a yes or no answer for these questions.

16. Negotiating and maintaining a serviceable framework with local political authorities

	1. From which of the listed organizations does your organization ask help in negotiating and maintaining a serviceable framework with political authorities?		2. To which of the listed organizations does your organization provide help in negotiating and maintaining a serviceable framework with political authorities?	
Organization name	Yes	No	Yes	No
Development/Physical Planning				
Public Works				
Red Cross				
Disaster Management Office/NEMA				
Chamber of Industry & Commerce				
National Christian Council				
CDERA				
Community-based Organizations such as sports clubs				
Builders & Designers				
The leading national environmental NGO, please specify, ___**EAG**_____				

17. Providing leadership

	1. In which of the listed organizations does your organization seek leadership?		**2. Which of the listed organizations seek leadership in your organization?**	
Organization name	Yes	No	Yes	No
Development/Physical Planning				
Public Works				
Red Cross				
Disaster Management Office/NEMA				
Chamber of Industry & Commerce				
National Christian Council				
CDERA				
Community-based Organizations such as sports clubs				
Builders & Designers				
The leading national environmental NGO, please specify, _____**EAG**__				

Networks

18. Do you conduct assessments of the social networks that exist during and after the disaster?
    Yes No

19. How do you incorporate this knowledge of networks into your operations?
    ____
    ____
    ____

Overall Recovery

20. How important do you think the following measures are for making buildings and the overall economy in _______ more resilient against future disasters?

	Very Important	**Important**	**Not Important**	**Enough been done already**	**Don't Know**
Making structural changes in existing houses					
Increasing economic diversification					
Making more stringent building guidelines					
Creating hazard zoning					
Providing insurance schemes					
Updating mapping processes					
Increasing public participation in planning for disasters					
Improving information technology, exchange and communication					
Increasing foreign aid and assistance					
Helping the most vulnerable more					
Cooperating with other Caribbean islands					
Having specific house numbers and street address with zip code					

21. How do you judge the overall recovery effort on the island after hurricanes?

	Very Good	Good	Moderate	Poor	Very Poor	Don't Know
Reconstruction of medical facilities						
Reconstruction of schools						
Provision of emergency shelters						
Restoration of water & electricity						
Reconnection of roads						
Government assistance with housing repair						
Honesty in handling relief aid						
Compliance or enforcement of building codes/guidelines						
Performance of government agencies						
Conducting damage assessment						

E.4 GEOSPATIAL SUPPORT SURVEY

GEOSPATIAL SUPPORT SURVEY

(Adopted from "*Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management*", *National Research Council 2007*)

Preparedness for Geospatial Support for Comprehensive Disaster Management

Geospatial (GIS) Integration	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Does your island have an emergency operation center (EOC)?	☐	☐	☐	☐
Does your EOC have geospatial/ Geographic Information Systems (GIS) technology available?	☐	☐	☐	☐
Do you have permanent workspace or office for your geospatial or GIS team?	☐	☐	☐	☐
Is the use of geospatial information integrated into your emergency (or disaster) management operations?	☐	☐	☐	☐
Is geospatial information used in emergencies?	☐	☐	☐	☐
Does your organization have written standard operating procedures for handling emergencies and disasters?	☐	☐	☐	☐
Do your written standard operating procedures include the use of geospatial information in your workflow and decision-making processes?	☐	☐	☐	☐
Do you know the name of your country GIS coordinator?	☐	☐	☐	☐
Do you have contact information for the country GIS coordinator and his or her backup?	☐	☐	☐	☐
Does your country GIS coordinator know who his or her emergency (or disaster) management counterpart is in your organization?	☐	☐	☐	☐
Does the country GIS coordinator have 24-hour contact information for his or her emergency (or disaster) management counterpart and his or her backup?	☐	☐	☐	☐
Do the country GIS coordinator and the country emergency (or disaster) management counterpart hold regular meetings to determine any gaps in their geospatial support for your emergency (or disaster) management operations?	☐	☐	☐	☐
Have action plans been developed to bridge gaps in geospatial (or GIS) support for your emergency (or disaster) management operations?	☐	☐	☐	☐

Geospatial (GIS) Integration	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Have you established agreements with other islands to share geospatial (or GIS) data and products?	☐	☐	☐	☐
Have you established agreements with other islands that determine what geospatial data and tools will be used during an emergency or disaster?	☐	☐	☐	☐
Have you developed agreements between geospatial professional teams at the national and community levels that identify the roles that each level will play and who will produce what in order to avoid duplication of effort during a disaster event?	☐	☐	☐	☐
Have you worked with the country GIS coordinator to develop an inventory with 24-hour contact information for GIS coordinators, their emergency (or disaster) management counterparts and their backups on the island?	☐	☐	☐	☐
Has this information been distributed to the emergency (or disaster) management community and other GIS coordinators on the island?	☐	☐	☐	☐
Have you developed a secure web site with 24-hour contact information for GIS coordinators, their emergency (or disaster) management counterparts and their backups on the island?	☐	☐	☐	☐
Has this information been shared with the emergency management community and GIS coordinators on other islands and CDERA?	☐	☐	☐	☐
Comments???:				

Human Resources for Geospatial Support	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO**, [Exist in writing, but not implemented]	**NO**, [Does not exist at all or don't do]
Do you have a designated geospatial (or GIS) team that is regularly deployed in your EOC (or disaster management office [DMO]) for emergencies and disasters?	☐	☐	☐	☐
Does your geospatial team work full-time?				
Have you developed an organizational structure for your team that defines the roles of team members?	☐	☐	☐	☐
Does your organization have a geospatial team (away team) that can deploy to incident sites to assist in emergency response and disaster recovery?	☐	☐	☐	☐
Does your organization have a geospatial modeling team established, with scientific expertise in developing models for plume analysis, hurricane surges, flooding, etc.?	☐	☐	☐	☐
Have the country GIS coordinators and your emergency management agency worked together to develop a list of additional geospatial professionals (or volunteers) and their expertise on the island?	☐	☐	☐	☐
Have you worked together to develop a secure web site to distribute this information to authorized users?	☐	☐	☐	☐
Comments???:				

Geospatial Training	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO**, [Does not exist at all or don't do]
Is the use of geospatial (GIS) data and tools included as part of your emergency (or disaster) training exercises?	☐	☐	☐	☐
Are these exercises conducted more than once a year?	☐	☐	☐	☐
Do your emergency response professionals understand the capabilities that geospatial data and tools offer to improve their ability to plan for and respond to incidents?	☐	☐	☐	☐
Have you established a training program for your first responders and emergency (or disaster) management decision makers on the use of geospatial data and tools in their workflow and decision making processes?	☐	☐	☐	☐
Are the first responders and emergency (or disaster) management decisions makers trained on geospatial data and tools at least one a year?	☐	☐	☐	☐
Have you established a training program for your geospatial team in the use of geospatial data and tools during a disaster?	☐	☐	☐	☐
Is the geospatial team trained on geospatial data and tools more than once a year?	☐	☐	☐	☐
Does your geospatial team train with pre-developed map templates?	☐	☐	☐	☐
Do you conduct scenario-based training exercises that include geospatial professional and the use of geospatial data and tools in the emergency (or disaster) management work cycle and decision-making process?	☐	☐	☐	☐
Are the geospatial professional team manager and liaison included in the scenario training exercise meetings and briefings to allow them to understand better how geospatial data and tools are being used in the decision-making process?	☐	☐	☐	☐
Do you conduct these exercises on a quarterly basis at a minimum?	☐	☐	☐	☐
Are the results of these exercises posted to a secure web-site so that other authorized responders not involved in the exercise can learn from them?	☐	☐	☐	☐
Have you integrated the use of an on-site geospatial unit (away team) in your training program?	☐	☐	☐	☐
Has your geospatial modeling team been incorporated into your scenario training exercises?	☐	☐	☐	☐
Comments???:				

Geospatial Data Access	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO**, [Does not exist at all or don't do]
Have you developed relationships and agreements with data custodians and your country GIS coordinator to ensure access to and use of the geospatial data you require for planning, training, and emergency response and disaster recovery activities?	☐	☐	☐	☐
Have you developed a methodology to ensure regular updates to those geospatial data?	☐	☐	☐	☐
Are your geospatial data backed up on a regular basis?	☐	☐	☐	☐
Do you have a full copy of the geospatial data?	☐	☐	☐	☐
Do you have copies of the data securely stored in different geographic regions on the island?	☐	☐	☐	☐
Do you have a copy of the data securely stored on a different island in the region?	☐	☐	☐	☐
Have you tested your methodologies for rebuilding your servers or computers using the backed-up data within the past year?	☐	☐	☐	☐
Have you tested the process for accessing data from data-sharing partners during simulations to ensure the viability of your methodology?	☐	☐	☐	☐
Have you established a web-based GIS service to encourage rapid access to and delivery of event-based data?	☐	☐	☐	☐
Have you worked with CDERA to develop links to each island inventories and resources available for sharing of geospatial data?	☐	☐	☐	☐
Comments???:				

Geospatial Data Quality	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Do you have geospatial data on your critical infrastructure?	☐	☐	☐	☐
Do they include the following:				
• Detailed road network	☐	☐	☐	☐
• Bridges and dams	☐	☐	☐	☐
• Utilities (water, electric, sewer)	☐	☐	☐	☐
• Telecommunications lines (including phones, cable)	☐	☐	☐	☐
• Cell and other communication towers	☐	☐	☐	☐
• Transportation systems	☐	☐	☐	☐
• Emergency shelters	☐	☐	☐	☐
• Petroleum storage sites	☐	☐	☐	☐
• Fire departments	☐	☐	☐	☐
• Police departments	☐	☐	☐	☐
• Ambulance services	☐	☐	☐	☐
• EMS (emergency medial service) zones	☐	☐	☐	☐
• Educational facilities	☐	☐	☐	☐
• Medical facilities	☐	☐	☐	☐
• Government facilities	☐	☐	☐	☐
• Religious facilities	☐	☐	☐	☐
• Military facilities	☐	☐	☐	☐
• Hotel facilities	☐	☐	☐	☐
• Nursing homes	☐	☐	☐	☐
• Day care centers	☐	☐	☐	☐
• Animal pounds and care facilities	☐	☐	☐	☐
Do you also have imagery (satellite, aerial photographs, remote sensing, etc.)?	☐	☐	☐	☐
Do you also have address data?	☐	☐	☐	☐
Comments???:				

Geospatial Data Quality	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Do you have geospatial data in electronic format on the following?				
• Elevation data	☐	☐	☐	☐
• Flood zones	☐	☐	☐	☐
• Property data	☐	☐	☐	☐
• Hydrological features	☐	☐	☐	☐
• Location of businesses and industry	☐	☐	☐	☐
• Census data	☐	☐	☐	☐
• Data on agriculture	☐	☐	☐	☐
• Data on tourism	☐	☐	☐	☐
• Data on emergency equipment (pumps, generators, cots, blankets, etc)	☐	☐	☐	☐
• Data on supplies (water, food, etc.) ready for deployment during emergency	☐	☐	☐	☐
Has your geospatial data team determined the quality and usability of the geospatial data gathered to emergency (or disaster) response?	☐	☐	☐	☐
Do the metadata provide an adequate description of data quality, including accuracy and currency?	☐	☐	☐	☐
Comments???:				

Geospatial Data Gathering	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO**, [Exist in writing, but not implemented]	**NO**, [Does not exist at all or don't do]
Have you established a team to identify and gather all geospatial data needed for your emergency response and disaster recovery activities?	☐	☐	☐	☐
Have you worked with your country GIS coordinator to develop an inventory of data that you require for use in emergency response or disaster?	☐	☐	☐	☐
Does this inventory include metadata documenting and describing the geospatial data?	☐	☐	☐	☐
Does your island have contracts in place for emergency aerial imagery?	☐	☐	☐	☐
Do you have agreements in place to acquire digital images via helicopter or airplane of event sites immediately after an event occurs?	☐	☐	☐	☐
Do you have agreements in place and near-live data feeds from utilities detailing the geographic extent of power outages?	☐	☐	☐	☐
Do you have any live or near-live geospatial weather data?	☐	☐	☐	☐
Do you have any live or near-live geospatial data on road conditions and capacities?	☐	☐	☐	☐
Do you have any near-live data feeds from hospitals or medical facilities detailing geospatial data on bed capacity or medication availability?	☐	☐	☐	☐
Do you have the capability to track the distribution of your emergency equipment or supplies geographically?	☐	☐	☐	☐
Have you tested your data-gathering methodologies in training exercise?	☐	☐	☐	☐
Do you have a geospatial web-based service application that provides rapid access to your event-related data?	☐	☐	☐	☐
Comments???:				

Geospatial Data Improvement	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO**, [Exist in writing, but not implemented]	**NO**, [Does not exist at all or don't do]
Has the geospatial data team identified which data require improvements and which data not currently available need development?	☐	☐	☐	☐
Has this team worked with the GIS coordinator to coordinate the required work?	☐	☐	☐	☐
Do you get updates to your data (not including imagery) on an annual basis at a minimum?	☐	☐	☐	☐
Is the imagery for your island less than five years old?	☐	☐	☐	☐
Do you have a system for improving geospatial data to meet your emergency (or disaster) response and recovery requirements?	☐	☐	☐	☐
Have you developed a mechanism to access funding and resources to improve and develop your geospatial data?	☐	☐	☐	☐
Comments???:				

Geospatial Information Delivery	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Has your geospatial team practiced rapid delivery of geospatial information to meet emergency (or disaster) management decision-making requirements?	☐	☐	☐	☐
Can your geospatial team deliver standard geospatial products required by your disaster managers within 12 hours of an event?	☐	☐	☐	☐
Have you developed models depicting the impact of hurricanes or floods on your community?	☐	☐	☐	☐
Do you have an easy-to-use online application that allows disaster managers who are not geospatial professionals to make geospatial inquiries to resolve issues?	☐	☐	☐	☐
Do you have automated geocoding capabilities that will allow staff to convert address locations to latitude and longitude quickly to assist rescuers during disasters?	☐	☐	☐	☐
Are your requests for assistance during a disaster tracked in a database?	☐	☐	☐	☐
Are these requests also tracked via a GIS application to provide visual analysis of patterns, etc.?	☐	☐	☐	☐
Comments???:				

Geospatial Equipment and Infrastructure	**YES,** [Fully in place and functional]	**YES, PARTIALLY** [E.g. Not fully in place, but currently being established]	**NO,** [Exist in writing, but not implemented]	**NO,** [Does not exist at all or don't do]
Do you have up-to-date geospatial software and hardware in your EOC or disaster management office (DMO)?	☐	☐	☐	☐
Do you have electronic field data collection methods (such as Global Positioning system [GPS]) available to determine the extent of a disaster event?	☐	☐	☐	☐
Do you have capabilities of obtaining digital photographs of an incident site and transmitting them wirelessly to the EOC or your DMO?	☐	☐	☐	☐
Does your island have geospatial equipment and data prepared for deployment near an incident site?	☐	☐	☐	☐
Do you have a vehicle that has hardware, GIS software, data and wireless communication systems installed and prepared for field deployment during a disaster or incident?	☐	☐	☐	☐
Do you have the ability to send or obtain geospatial data or web-based services across the Internet?	☐	☐	☐	☐
Do you have backup satellite communications systems to transmit geospatial data when necessary?	☐	☐	☐	☐
Comments???:				

BIBLIOGRAPHY

Argyris, Chris. 1982. *Reasoning, Learning and Action*. San Francisco, CA: Jossey Bass.

Anderson, M.B. and Woodrow, P.J. 1989. *Rising from the Ashes: Development Strategies in Times of Disaster*. Boulder, CO, USA: Westview Press.

Axelrod, Robert and Michael D. Cohen. 1999. *Harnessing Complexity: Organizational Implications of a Scientific Frontier*. New York, NY: The Free Press.

Barabási, Albert-László and Réka Albert. 1999. "Emergence of scaling in random networks", *Science*, 286:509-512, October 15, 1999.

Borgatti, S. P., Everett, M. C., & Freeman, L.C. 2002. *UCINET for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Berke, Philip R. and Timothy Beatley. 1997. *After the Hurricane: Linking Recovery to Sustainable Development in the Caribbean*. Baltimore, MD: John Hopkins University Press.

Bruneau, M., S. Chang, R. Eguchi, G. Lee, T. O'Rourke, A. Reinhorn, M. Shinozuka, K. Tierney, W. Wallace, and D. von Winterfelt. 2003. A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra* 19(4): 733–752.

Caribbean Disaster Response Agency (CDERA). 2003 (a/b). Status of Hazard Maps Vulnerability Assessments and Digital Maps: Antigua and Barbuda Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (s/k). Status of Hazard Maps Vulnerability Assessments and Digital Maps: St. Kitts Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (s/v). Status of Hazard Maps Vulnerability Assessments and Digital Maps: St. Vincent Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (s/l). Status of Hazard Maps Vulnerability Assessments and Digital Maps: St. Lucia Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (g/n). Status of Hazard Maps Vulnerability Assessments and Digital Maps: Grenada Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (b/s). Status of Hazard Maps Vulnerability Assessments and Digital Maps: Barbados Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (d/m). Status of Hazard Maps Vulnerability Assessments and Digital Maps: Dominica Country Report.

Caribbean Disaster Response Agency (CDERA). 2003 (n/v). Status of Hazard Maps Vulnerability Assessments and Digital Maps: Nevis Country Report.

CDERA website. Accessed July 17, 2005. Search results for situation reports and news articles from September 1, 2004 to February 28, 2005. URL: www.cdera.org

Charveriat, Celine. 2000. *Natural Disasters in Latin America and the Caribbean: An Overview of Risk*. Inter-American Development Bank: Working Paper #434.

Carley, Kathleen. Proceedings from CASOS 2004. Carnegie Mellon University.

CARICOM Website. Accessed July 24, 2004. "Agreement Establishing the Caribbean Disaster Emergency Response Agency," 1991.
URL: http://www.caricom.org/archives/agreement-cdera.htm

Central Intelligence Agency (CIA). 2006. World Factbook.
URL: https://www.cia.gov/cia/publications/factbook

Coakes, Elayne, Dianne Willis and Steve Clarke (eds.) 2002. *Knowledge management in the sociotechnical world: the graffiti continues*. London, Great Britain: Springer-Verlag London Limited.

Cohen, Y.A. 1954. The social organization of a selected community in Jamaica. *Social and Economic Studies* 2(4): 104–33.

Comfort, Louise K. and Thomas W. Haase. 2006. Communication, Coherence and Collective Action. *Public Works Management & Policy*, Vol. 11 No. 1, July 2006 1-16. Sage Publications.

Comfort, L. K. 1999. *Shared risk: Complex systems in seismic response*. Oxford, UK, and New York: Pergamon.

Comfort, L. K. 2005. Risk, security and disaster management. *Annual Review of Political Science*, 8, 335-356.

Comfort, Louise K. 2005. "Risk, Security and Disaster Management." In: *Annual Review of Political Science*, 2005: 335-356.

Comfort, Louise K. and Yesim K. Sungu. 2001. "Organizational Learning from Seismic Risk: The 1999 Marmara and Duzce, Turkey Earthquakes." In: Rosenthal, U., R.A. Boin and L.

Comfort (eds.) *Managing Crises: Threats, Dilemmas, and Opportunities***.** Springfield, IL: Charles C. Thomas Publishers, 5-27.

Comfort, Louise K. 1999. *Shared Risk: Complex Systems in Seismic Response.* Oxford, UK: Elsevier Science Ltd.

Comfort, Louise. 1997. "Initiating Change: A Dialogue between Theory and Practice." Journal of Public Administration Research and Theory. 4.3 (1994a): 325.

Comfort, Louise K. ed. 1988. *Managing Disaster: Strategies and Policy Perspectives*. Durham, NC: Duke University Press.

Comfort, L. K., Hauskrecht, M., & Lin, J.S. 2005, September 29-October 1. *Dynamic networks: Modeling change in environments exposed to risk.* Paper presented at the Public Management research Association Conference, Los Angeles, CA.

Dovers, S.R. and J. W. Handover. 1992. "Uncertainty, sustainability and change" In: *Global Environmental Change*, 2 (4):262-276.

Drabek, T.E. 1979. "Review of Burton et al. The Environment as Hazard." *Contemporary Sociology* 8:491-492.

Eastern Caribbean Central Bank (ECCB). 2006. *National Accounts Statistics 2006*: For the year ended 31 December 2005.
URL: http://www.eccb-centralbank.org/PDF/NAC06.pdf

ECLAC 2007. REDATAM Software. Latin America and the Caribbean Demographic Center (CELADE / CEPAL) http://www.eclac.cl/redatam/default.asp?idioma=IN

ECLAC. 2005 Statistical Yearbook for Latin America and the Caribbean. Statistics and Economic Projections Division

Elliott, E. and L.D. Kiel. 1996. Introduction. In: Kiel, L.D. and Elliott, E. (eds.), *Chaos Theory in the Social Sciences: Foundations and Applications.* Ann Arbor, MI: University of Michigan Press.

Freeman, Paul K., Leslie A. Martin, Joanne Linnerooth-Bayer, Reinhard Mechler, Georg Pflug and Koko Warner. 2003. *Disaster risk management: national systems for the comprehensive management of disaster risk and financial strategies for natural disaster reconstruction*. Washington, D.C.: Inter-American Development Bank.

Flin, Rhona. 2001. "Decision Making in Crises: The Piper Alpha Disaster." In: Rosenthal, U., R.A. Boin and L. Comfort (eds.) *Managing Crises: Threats, Dilemmas, Opportunities***.** Springfield, IL: Charles C. Thomas Publishers

Florida Department of Environmental Protection (FDEP). 1999. *Florida Statutes*. Tallahassee, FL: State of Florida.

Geis, Donald E. 1996. *Creating Sustainable and Disaster Resistant Communities*. Aspen, Colorado: The Aspen Global Change Institute.

Green, Reginald, Herbold. 2000. "Rehabilitation: Strategic, Proactive, Flexible, Risky?" *Disasters*, 03613666, Dec2000, Vol. 24, Issue 4

Haas, J. Eugene, Robert W. Kates, and Martyn J. Bowden, eds. 1977. *Reconstruction Following Disaster*. Cambridge, Massachusetts: MIT Press.

Haddow, George D.; Jane A. Bullock. 2004. *Introduction to Emergency Management.* Amsterdam: Butterworth-Heinemann. ISBN 0-7506-7689-2.

Hanneman, 2001. *Introduction to Social Network Methods.* Department of Sociology, University of California, Riverside.

Holland, John. 1995. *Hidden Order*. Reading, MA: Addison-Wesley Publishing Company.

Inter-American Development Bank (IDB). 2000. *Facing the Challenge of Natural Disasters in Latin America and the Caribbean: An IDB Action Plan.* Washington, DC.: IDB Press.

International Labor Organization. 2006. Labor Statistics. URL: http://laborsta.ilo.org/ Accessed December 2006.

Karimi, Hassan. 2000. Lecture notes for Geoinformation Information Systems. Spring 2000. School of Information Sciences, University of Pittsburgh.

Kauffman, Stuart A. 1993. *The Origins of Order: Self-Organization and Selection in Evolution*. Oxford, NY: Oxford University Press.

Kiel, L. D. 1994. *Managing Chaos and Complexity in Government: A New Paradigm for Managing Change and Organizational Renewal.* San Francisco, CA: Jossey Boss Publishers.

Kingdon, J. 1984. *Agendas, Alternatives, and Public Policy*. Boston, MA: Little, Brown and Company.

Laska, S.B. 1990. "Homeowner Adaptation to Flooding: An Application of the General Hazards Coping Theory." *Environment and Behavior* 25:228-249.

Lauden, Kenneth C., and Lauden Jane P. 2000. *Management Information Systems, 6th Edition*. Upper Saddle River, NJ: Prentice Hall Publishing Company.

Lavell, A. 1994. "Prevention and Mitigation of Disasters in Central America: Vulnerability to Disasters at the Local Level." In Varley, A., ed., *Disasters, Development and Environment,* pp. 49-64. Chichester: Wiley.

Lawrence, P. and Lorsch, J. 1967. *Organization and Environment. Managing Differentiation and Integration*. Boston, MA: Harvard University Press.

Lembke, S. and Wilson, M. 1998. Putting the "Team" into Teamwork: Alternative Theoretical Contributions for Contemporary Management Practice. Human Relations **51** (7): 927-944.

Liebenau, J. and Backhouse, J. 1990. *Understanding the Information*. New York, NY: McMillan.

March, James G. 1991, "Exploration and Exploitation in Organizational Learning". *Organization Science,* 2(1), 71-87

Martyn Hammersley and Roger Gomm, *Case Study Method* eds. Roger Gomm et al (London: Sage Publications Ltd, 2000), 3.

Maurer, John G. ed. 1971. *Readings in Organization Theory: Open-System Approaches.* New York: Random House, 1971). pp 4.

Maxwell, Joseph. "Designing a Qualitative Study." In Leonard Bickman and Debra J. Rog (eds.) *Handbook of Applied Social Research Methods*. Thousand Oaks, CA: SAGE Publications, 1998: 87.

McCarthy, Ian and Jane Gillies, 2003. "Organizational Diversity, Configurations and Evolution." In Eve Milton-Kelly (ed.)_*Complex Systems and Evolutionary Perspectives on Organizations: Application of Complexity Theory to Organizations.* Oxford: Elsevier Science Ltd, 2003. 71-98.

Merry, U. 1995. *Coping With Uncertainty: Insights from the New Sciences of Chaos, Self-Organization and Complexity*. Westport, CT: Praeger.

Mileti, Dennis S. 1999. *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Washington, D.C.: Joseph Henry Press

Miller, Delbert C. and Neil J. Salkind. 2002. *Handbook of Research Design and Social Measurement, 6th edition*. Thousand Oaks, CA: Sage Publications, Inc.

Mohr, Lawrence, B. 1982. *Explaining Organizational Behavior*. San Francisco, CA: Jossey Boss.

Moore, D.P., and J.W. Moore. 1996. "Posthurricane Burnout: An Island Township's Experience." *Environment and Behavior* 28:134-155.

National Research Council (NRC) 2007. *Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management***.** Committee on Planning for Catastrophe: A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, National Research Council: The National Academy of Sciences Press.

Neuendorf, Kimberly A. 2002. The Content Analysis Guidebook. Thousand Oaks, CA: Sage Publications, Inc.

Palm RI. 1990. *Natural Hazards: An Integrative Framework for Research and Planning*. London: John Hopkins University Press.

Parker, Jinx. 1994. "Building Codes: The failure of public policy to institutionalize good practice." *Environmental and Urban Issues*, Vol XXI, No. 4. Miami, Florida: Florida Atlantic University/Florida International University.

Ploman, Edward E. 1995. Introduction. *The Science and Praxis of Complexity: Contributions to the Symposium Held at Montpellier, France. 0-11 May 1984*. S. Aida et al. (Tokyo: The United Nations University (UNU), 1985). 7-22; Espejo; Luhmann

Possekel, Anna K. 1998. *Living with the Unexpected: Linking Disaster Recovery to Sustainable Development in Montserrat*. New York: Springer. Hamburg, Univ., Diss. 1998.

Ravid, D. and Sheizaf Rafaeli .2004. "Asynchronous discussion groups as Small World and Scale Free Networks". *First Monday* **9** (9).
URL: http://firstmonday.org/issues/issue9_9/ravid/index.html

Rolfe, Jim and Neil Britton. 1995. "Organisation, Government and Legislation: Who Coordinates Recovery?" *In Wellington After the Quake: The Challenge of Rebuilding Cities.* Wellington, New Zealand: Wellington Earthquake Commission and the Centre for Advanced Engineering.

Rose, Adam. 2004. "Defining and Measuring Economic Resilience to Disasters. In *Disaster Prevention and Management.* Vol 13, No. 4: 307-314. Emerald Group Publishing Ltd.

Rosenthal, Uriel, R. Arjen Boin and Louise K. Comfort. 2001. "The Changing World of Crises and Crisis Management." In: Rosenthal, U, R.A. Boin and L. Comfort (eds.) *Managing Crises: Threats, Dilemmas, Opportunities***.** Springfield, IL: Charles C. Thomas Publishers

Rosenthal, U., Charles, M.T. and P. t'Hart (eds.) 1989. *Coping with crises: The Management of Disaster, Riot and Terrorism*. Springfield, IL: Charles C. Thomas Publishers.

Scott , W. Richard. 1995. *Institutions and Organizations.* Thousand Oaks, CA: Sage.

Scott , W. Richard. 2003. *Organizations: Rational, Natural, and Open Systems, 5th edition.* Saddle River, NJ: Prentice Hall.

Simon, Herbert A. 1981. *The Sciences of the Artificial*. Cambridge, MA: MIT Press.

Sinhua, Saurabh, Michael Lipton and Shahin Yaqub. 2002. "Poverty and Damaging Fluctuations: How do they relate?" In *Journal of Asian and African Studies*, July 2002 v37 i2 p186 (61).

Smith. K.,1996. *Environmental Hazards, Assessing risk & reducing disaster*, II Edition, London & New York: ROUTLEDGE.

Stake, Robert. 2000. “The Case Study Method in Social Inquiry,” In *Case Study Method* eds. Roger Gomm, et al (London: Sage Publications Ltd, 2000), 23.

Tenkasi, R. and Boland, R. Jr. 1996. Exploring Knowledge Diversity in Knowledge Intensive firms: *A New Role for Information Systems. Journal of Organizational Change Management* **9** (1): 79-91.

USAID. 2000. *Housing Recovery Plan for St. Kitts and Nevis*.

USAID, 2001. *Structural Vulnerability Assessment for St. Kitts and Nevis: Post-Georges Disaster Mitigation Project in Antigua & Barbuda and St. Kitts & Nevis*. Organization of American States, Unit for Sustainable Development and Environment for USAID-Jamaica/Caribbean Regional Program. URL: http://www.oas.org/pgdm.

USAID/OAS. 2001. Status of Building Codes in the Caribbean. Edited by Alwyn Wason. USAID/OAS Post-Georges Disaster Mitigation: http://www.oas.org/pgdm

Waldorf, M.M. 1992. *Complexity: the Emerging Science at the Edge of Order and Chaos.* New York, NY: Simon and Schuster.

Wasserman, Stanley, and Katherine Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge, UK: Cambridge University Press.

Watts, Duncan J.; Strogatz, Steven H. (June 1998). "Collective dynamics of 'small-world' networks". *Nature* **393**: 440-442.

Watt, D. J. 1999. Small worlds: The dynamics of networks between order and randomness. Princeton, NJ: Princeton University Press.

Watt, D. J. 2003. Six degrees: The science of a connected age. New York, NY: W.W. Norton & Company, Inc.

Waugh, W.L., Jr. 2000. *Living with hazards, managing disasters*. Armonk, NY: M.E. Sharpe.

Weiss, Thomas G. and Cindy Collins. 1996. *Humanitarian Challenges and Interventions: World Politics and the Dilemmas of Help***.** Boulder: Westview Press.

Weick, K.E. and Roberts, K.H. 1993. Collective Mind in Organizations: Heedful Interrelating on Flight Decks. *Administrative Science Quarterly* **38**: 357-381.

Woodrow, and Anderson. 1989. Rising from the Ashes: Development Strategies in Times of Disaster. Boulder, Co: Westview Press.

The World Bank Website. 2005. Data and Statistics. Accessed July 2005. URL:http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/OECSEXTN/0,,contentMDK:20221180~menuPK:339320~pagePK:1497618~piPK:217854~theSitePK:339287,00.html

Yin, Robert. 1984. *Case Study Research: Design and Methods*. Beverly Hills, CA: Sage.