Emergency Management Planning: A Value Based Approach to Preparing Coastal Communities for Sea Level Rise


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Abstract

There is an increasing amount of evidence that the climate is changing at an unnatural rate on a global scale. Unpredictable extreme weather patterns have become a common occurrence and they take a toll on humans from all perspectives as seen in Hurricane Sandy (2012). The damage was undeniable and questions were raised about the preparedness and response of the communities affected. The need to be proactive in preparing for these events as a means of adapting to climate change is evident. This study seeks to determine what it means for coastal communities vulnerable to severe storms to be prepared. Preparedness is often defined by the resources and plans a community has in place. However, a large part of being prepared also lies in the decision making and deployment process as well as the reliability of the overall system. This study will attempt to evaluate that decision making process at the community level in the event of a storm surge. A value based approach will be used to construct storm simulation mock-up exercises for community responders. The simulation can be prescribed as a method to identify gaps in the strategy where improvements can be made.

Keywords: Value-based design, decision analysis and evaluation, Storm damage, Community preparation and adaptation, Adaptive strategies, Simulation, Storm event mock-ups

Discipline: Operations research, Decision analysis, Simulation modelling
Abbreviations

**ADMS** – Advanced Disaster Management Simulator
**DPI** – Disaster Preparedness Index
**EMBC** – Emergency Management British Columbia
**EMO** – Emergency Management Organization or Emergency Measures Organization
**EMWIN** – Emergency Managers Weather Information Network
**EOC** – Emergency Operations Centre
**FERP** – Federal Emergency Response Plan
**FEMA** – Federal Emergency Management Agency
**GEM Model** – Global Environmental Multiscale Model
**HFA** – Hyogo Framework for Action
**IEMAC** – International Emergency Management Assistance Compact
**IEMG** – International Emergency Management Group
**IEMS** – Integrated Emergency Management System
**IFRC Societies** – International Federation of Red Cross and Red Crescent Societies
**IPCC** – Intergovernmental Panel on Climate Change
**JEOC** – Joint Emergency Operations Centre
**LIDAR** – Laser Imaging Detection and Ranging
**MEOPAR** – Marine Environmental Observation Prediction and Response
**MEOW** – Maximum Envelopes of Water
**MOM** – Maximum of the MEOW
**NOAA** – National Oceanic and Atmospheric Administration
**NWS** – National Weather Service
**SLOSH** – Sea, Lake, and Overland Surges from Hurricanes
**TCL** – Target Capabilities List
**UN/ISDR** – United Nations International Strategy for Disaster Reduction
**UN/OCHA** – United Nations Office for the Coordination of Humanitarian Affairs
**UTL** – Universal Task List
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1 Introduction

Climate change represents one of the great environmental challenges of our time. There is increasing discussion and evidence by the scientific community that the climate is changing at an unprecedented rate on a global scale. Along with climate change, comes an increase in occurrence of severe storms that may have adverse effects on humans if we are not prepared.

This chapter presents the issues of climate change and the importance of developing adaptation methods, primarily in the area of preparing for the effects of sea level rise. Research questions and objectives are found in the latter section of this chapter.

1.1 Background and Motivation

In 2007, the Intergovernmental Panel on Climate Change (IPCC) produced their fourth assessment report showing that there is compelling evidence that points to a warming climate trend (IPCC, 2007a; IPCC, 2007b). The three IPCC working groups issued several key statements found in the synthesis report that further strengthens the connection between human activities and the warming climate system. Greenhouse gas emissions due to human activities have increased at an astonishing 70% between 1970 and 2004. As a result of higher concentrations of greenhouse gases in the atmosphere, the average global temperature has also increased drastically. The average temperatures in the Northern Hemisphere over the last 50 years have been very likely higher than any other 50 year period over the last 500 years (IPCC, 2007c).

Climate change is a trending issue. At the same time, the global population is growing and the resource consumption rate has never been higher. It can be seen that under the most optimistic conditions the Earth has committed to some degree of warming for the near future and the need for humans to adapt is imperative (Etkin, Medalye, & Higuchi, 2012; World Bank, 2012). This raises the question of what climate change brings in terms of a new environment and how communities can anticipate and prepare for it.

As the average temperature rises, evaporation rates also increase, adding more moisture into the atmosphere. Naturally the result of an increase in atmospheric vapour is an increase in more drastic and unpredictable weather occurrence. Rising sea level is also consistent with
warming temperatures due to thermal expansions, melting glaciers, ice caps and ice sheets. Global average sea level has risen at an average rate of 3.1 mm/yr since 1993, which far exceeds any model projections (IPCC, 2007c). Changes in precipitation patterns and rising sea levels put coastal communities the first in line to witness the effects of climate change. The consequences of sea level rise is an increase in storm surge occurrences as well as much more severe weather phenomena as seen in Hurricane Katrina (August 2005) and Hurricane Sandy (October 2012).

The notion of preparedness for natural disasters is a contentious topic of discussion for policy makers. It garners less attention in the scope of policy making, where problems at hand attain greater priority (Jackson, 2008). This is particularly prevalent in less fortunate communities where the list of community problems is extensive. Investing in preparedness for a situation that may or may not happen may seem trivial but with the recent issues and impacts surrounding climate change one may wish to think otherwise. Decision and policy makers are proactive in taking recourse actions after the storm has occurred. Learning from one’s mistakes based on real life situations is important but with the tools and technology available in our day and age, decision makers should be proactive in advance. They require better methods to assess preparedness from the resources, strategies, as well as system reliability standpoint. Not only will such a method of assessment aid decision and policy makers, it will also allow the public to set reasonable expectations of their government at all levels and invoke a sense of confidence and comfort in the general population (Jackson, 2008).

The C-Change project aims at developing resources for coastal communities to increase their capacity to adapt to and anticipate environmental change. The coastal communities selected for research are spread out across Canada and selected communities in the Caribbean region. Their selection is based on the seriousness and immediate threats to infrastructure if an environmental disaster was to occur (C-Change, 2010). The C-Change project aspires to enhance community capacities and to better prepare for possible environmental disasters. There are other numerous ongoing campaigns to raise awareness about this issue. At the same time adaptive response plans should be in place and well designed to prepare for climate change.
This proposed research examines the state of preparedness for coastal communities within the C-Change Project. The following research questions and objectives are proposed.

### 1.2 Research Questions and Objectives

Sea level rise leads to a common occurrence of storm surges in coastal communities. This calls for adaptive response strategies to mitigate the effects of the threatening storm surge. The challenge to designing adaptive response strategies lies in balancing between being cost efficient and being sufficiently prepared. This notion of being prepared is evidently dependent of the magnitude of the storm; therefore another challenge lies in dealing with the uncertainty and varying magnitude of the storm. It is commonly seen that preparedness takes a retrospective approach in planning. Gaps in response strategies are identified and patched post storm. This research project aims at developing a framework to define preparedness for storm surges in coastal communities and develop methods to evaluate response strategies pre-storm.

The following research questions were proposed for this study:

1. What does it mean for communities to be prepared for emergency situations?
2. How can this concept of preparedness be applied to coastal communities vulnerable to sea level rise and more frequent severe storms?
3. How effective is the emergency response system in practice?
4. What prescriptions are required to improve preparedness and response reliability?

The objective of this study is to develop a framework for coastal communities to assess their level of preparedness in the event of a storm surge. Several steps will be taken to achieve this objective and to provide a means of answering the research questions. These steps will consist of:

1. Examining literature to determine what it means to be prepared for emergency situations.
2. Developing hierarchical indicators of preparedness for applying concepts of preparedness to coastal communities vulnerable to the effects of sea level rise.
3. Constructing a model designed to evaluate the decision making and reliability of the emergency response system for communities.

4. Analyzing the results of the simulation storm mock-up to identify gaps for preparedness improvement for communities.

Given recent events, e.g. Hurricane Sandy, the Great Earthquake and Tsunami of the Sea of Japan, many efforts have been made to assess preparedness overall and create a baseline standard that defines preparedness. However, many of these standards tackle the layout and framework for emergency planning. They typically do not include a method of evaluation for deployment and effectiveness of the system in practice. A quantitative modelling approach to determine preparedness provides the missing link in the adoption of community-based storm surge adaptation strategies. Communities would be able to utilize the storm mock-up model to identify gaps in their adaptive response strategy and improve on them.

1.3 Thesis Proposal Outline

An outline of the key components presented in each chapter is as follows

Chapter 1 – Introduction: The current section provides the background information to climate change as well as the motivation for this study. Several key issues stemming from climate change were discussed and the need for adaptation was shown. The latter section of Chapter 1 presented the challenges in designing adaptive response strategies. This leads to the research questions proposed and the objectives of the study.

Chapter 2 – Literature Review: A literature review of the concepts examined in this study will be presented in this section. Areas of interest include terminologies, approaches to preparedness, preparedness measures and indicators, and evaluation and preparedness modelling. Chapter 2 also presents applications of the study and a summary of the literature reviewed.

Chapter 3 – Methodology: The methodology section of the proposal will examine the tools and potential methods required to develop the framework mentioned as part of the objectives. Preparedness will be redefined within the context of coastal communities
vulnerable to the effects of severe storms. A process for the storm mock-up exercise is laid out and suggested as means for identifying gaps in response plans.

Chapter 4 – Expected Analysis and Results: An overview of the expected analysis method and modelling approach will be shown in this section. The case of the causeway way in Petite Anse Isle Madame will be used as an example to show the expected results.

Chapter 5 – Expected Outcomes and Recommendations: The expected outcome as well as expected recommendations for adaptive response strategy designing will be discussed in this chapter.

Chapter 6 – Timeline of proposed Study: A brief timeline for the proposed study can be found in the last chapter.
2 Literature Review

The unnatural weather patterns of late have forced many communities to review their emergency preparedness strategies in addition to the resources they have to overcome the storm. The strategy reviews often times put policy makers from all ends of the spectrum in a position to determine at what point one can say that they have achieved preparedness. Often seen in media is that a community was not prepared, however they fail to define what preparedness is and how they measure it to come to such a conclusion. In Chapter 2 we wish to frame the issues behind preparedness for emergency situations in communities. Several key concepts found in literature will be examined along with the different methods in use to define preparedness.

To set the stage for the literature review, common terminologies used in the field are presented in Section 2.1. The terminologies are followed by approaches to preparedness as defined by different levels of disaster management organizations in Section 2.2. Numerous attempts have been made to quantify preparedness in the form of a measure or index. These are discussed in Section 2.3. Methods to model storm surge effects and response efforts are shown in Section 2.4. An overview of the applications for this research and a profile of Charlottetown and Isle Madame, which will be used as case studies, are shown in Section 2.5.

2.1 Terminology

Community preparedness is a vast topic of study and the terminologies used are often ambiguous or interchangeable due to the immense range of community based programs that exist. The following section identifies key terms and discusses and defines the issues of these terms that are fundamental to this research.

The term adaptation that is used in the climate change field has its roots in the field of natural science and specifically evolutionary biology (Smit & Wandel, 2006). Classically, adaptation refers to the evolutionary process involving a genetic or behavioural change in which a population or individual becomes fitted to its prevailing environment (Campbell, et al., 2008). The later part of this definition still hold true in the context of this study, but humans
have evolved to a point where genetic makeup can be masked by advancements in technology. Adaptation to a prevailing environment for humans is now dependent on how a population prepares themselves for environmental forces as opposed to an elimination of futile genes. The C-Change project describes adaptation as the capacity of natural and human systems to adjust to global and local environmental change and to reduce adverse effects (C-Change, 2010). The use of the word adaptation in this study will refer to the C-Change definition.

The term disaster is commonly used in emergency management. It may refer to a wide variety of disaster types, including cyber-attacks, terrorist attacks, and pandemic disease outbreaks (FEMA, 2007b). The Intergovernmental Panel on Climate Change defines disasters as severe alterations in the normal function of a community due to hazardous physical events, leading to widespread adverse human, material, economic, or environmental effects requiring immediate emergency response (IPCC, 2007c). Within the context of this study, disasters are of the form caused by sea level rise. Rising sea levels lead to hurricanes, storm surges, and floods.

The approaches to preparedness that will be examined in the following section present their method as guidelines, frameworks, or plans to preparedness. Each approach presents a different perspective and method for defining preparedness. In this section terms like capabilities, indicators, goals, priorities, and targets arise. For this study the term indicators will take on the meaning of a quantitative or qualitative identifier to monitor the state of preparedness.

Please refer to the glossary for definitions of commonly used terms that are fundamental to this study.

2.2 Approaches to Preparedness

Organizations worldwide have taken a proactive approach to developing definitions of preparedness. They range from local community based programs (provincial or territorial Emergency Measures Organization) to international efforts (Hyogo Framework for Action). Local community based programs focus on resources specific to the community at risk while international efforts aim at introducing a holistic approach to defining preparedness worldwide.
An overview of the different scopes of preparedness as defined by those in the field would provide a better understanding of what it means to be prepared. In the following section, 5 different approaches to preparedness are examined; National Weather Service’s StormReady Program, Federal Emergency Management Agency’s Target Capabilities List, UN Office for Disaster Risk Reduction’s Hyogo Framework for Action, Public Safety Canada’s Emergency Measures Organization and the International Emergency Management Group’s International Emergency Management Assistance Compact. They have the similar objectives but differ in their approach as well as terminologies. The terminology used in each section is within the context presented by that specific organization’s approach.

2.2.1 National Weather Service – StormReady Program

The StormReady program introduced by the National Weather Service (NWS) in 1999 has certified 2056 communities in the United States as of March 31st 2013 to be “StormReady” (NOAA, 2013). The National weather Service is a branch of the National Oceanic and Atmospheric Administration (NOAA). The program increases the level of preparedness in the community through a checklist approach that aims at improving the communication and safety skills needed to mitigate storm effects, before and during a storm. The program was created with the intentions of the following as described by NWS (NOAA, 2004):

1. Improve timeliness and effectiveness of weather warnings
2. Provide clear and detailed recommendations to the community
3. Helps community leaders justify budget allocations for emergency preparedness
4. Reward communities that have exemplified what it means to be “StormReady”
5. Provide an image incentive for the community
6. Encourage surrounding communities to take part as well

Aside from improving community response, the designation also increases property value for the community. From a public relations standpoint, this provides an incentive that encourages all citizens to participate.

A set of guidelines were developed to encourage communities to take a proactive approach and improve their response operations. The guidelines touch on the different aspects
or dimensions of being prepared as defined by the NWS. They are communication, information reception, hydrometeorological monitoring, warning dissemination, community preparedness and administration (NOAA, 2013). Table 2-1 shows an overview of the population based guidelines developed for the StormReady program. Guidelines that have boxes containing an (X) are required at the given population, while empty boxes mean that the guidelines are not required for a population of that size. In cases where the guidelines require a quantitative count, they are presented in the table as a numerical value.

Community budgets are typically dependent of the community size, therefore the guidelines were designed to accommodate budgets and resources available based on the population size (NOAA, 2004).

To meet the communication guideline as set out by the StormReady program, a warning point that can relay NWS information must be established as well as an Emergency Operations Centre (EOC) in communities with a population larger than 2,500 (NOAA, 2004). This communication point can be established at law enforcement or fire department dispatching points. In the case where a community has neither of these, the use of a county agency is also acceptable. The office must operate 24 hours a day with warning reception capabilities and authority to activate local warning systems. In larger communities, an EOC is required and must be staffed during hazardous weather. Aside from the duties of a warning point, the EOC must also be able to communicate with adjacent communities and act as the messenger between the NWS and community decision makers (NOAA, 2004).

The second guideline to meet for the StormReady program is the number of ways in which the warning point or EOC can receive NWS warnings. The storm may damage communication means, therefore it is important to have several different means of communication with the NWS. These information receivers range from something as technologically advance as Emergency Managers Weather Information Network (EMWIN) receivers with satellite feed to something as basic as a radio or pager system (NOAA, 2004).
### Table 2-1 StormReady population-based guidelines overview. Source: NOAA (2013)

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 2,500</td>
</tr>
<tr>
<td>1. Communication</td>
<td></td>
</tr>
<tr>
<td>Established 24 hr Warning Point</td>
<td>X</td>
</tr>
<tr>
<td>Establish Emergency Operations Centre</td>
<td></td>
</tr>
<tr>
<td>2. NWS Information Reception</td>
<td></td>
</tr>
<tr>
<td>Number of ways for EOC/WP to receive NWS warning, etc.</td>
<td>3</td>
</tr>
<tr>
<td>3. Hydrometeorological Monitoring</td>
<td></td>
</tr>
<tr>
<td>Number of ways to monitor hydrometeorological data</td>
<td>1</td>
</tr>
<tr>
<td>4. Local Warning Dissemination</td>
<td></td>
</tr>
<tr>
<td>Number of ways for EOC/WP to disseminate warnings</td>
<td>1</td>
</tr>
<tr>
<td>NWR - SAME receivers in public facilities</td>
<td>X</td>
</tr>
<tr>
<td>5. Community Preparedness</td>
<td></td>
</tr>
<tr>
<td>Number of annual weather safety talks</td>
<td>1</td>
</tr>
<tr>
<td>Train spotters and dispatchers biennially</td>
<td>X</td>
</tr>
<tr>
<td>Host/co-host annual NWS spotter training</td>
<td></td>
</tr>
<tr>
<td>6. Administrative</td>
<td></td>
</tr>
<tr>
<td>Formal hazardous weather operations plan</td>
<td>X</td>
</tr>
<tr>
<td>Biennial visits by emergency manager to NWS</td>
<td>X</td>
</tr>
<tr>
<td>Annual visits by NWS official to community</td>
<td>X</td>
</tr>
</tbody>
</table>

Aside from communication and emergency operations centres, communities must also be able to monitor hydrometeorological (weather) information in their surrounding area (NOAA, 2004). StormReady suggests the following means of gathering supplementary weather information: access to radar information via internet, instruments to measure local hydrological conditions, or locally owned and operated weather radars (NOAA, 2004).
Communication with the NWS and surrounding communities is important, but the EOC and warning points are simply the middle connection in the communication chain. The ultimate goal lies in relaying the information to decision makers and the public. For this reason warning dissemination methods should be placed to alert the citizens and keep them informed. The StormReady program proposes several public propagation means such as television audio/video overrides, outdoor warning sirens and the NOAA Weather Radio All-hazards receivers (NOAA, 2004).

From a different perspective, the last two guidelines are aimed at pre-storm preparation practices. Public education is vital in preparing citizens to respond effectively to weather threats. A more educated community is more likely to take proactive steps to receive warnings and recognize potential threatening weather conditions (NOAA, 2004). The three subcomponents of the community preparedness guideline for the StormReady checklist are: to conduct safety talks for schools, hospitals and industries, facilitate weather related safety campaigns, and send EOC staff to NWS storm spotter training (NOAA, 2004).

Lastly, no program will be successful without proper and proactive administration for support. Consequently, StormReady established the last guideline with this concept in mind. The administrative team has to be well organized and be able to effectively communicate with NWS (NOAA, 2004).

The StormReady program was proven to be effective in the case of Dickinson County Iowa on July 17th 2010. Dickinson County encountered a severe windstorm that caused widespread damage across most of the Great Lakes area of Dickinson County in Northwest Iowa (NOAA, 2010). Wind gusts of 100 mph damaged trees, boats, farm buildings and storage sheds. Numerous residents reported hearing the warnings and took shelter before the storm hit and credited the National Weather Service in issuing the life-saving warnings (NOAA, 2010).

2.2.2 Federal Emergency Management Agency – Target Capabilities List

In an effort to be better prepared for emergency situations in the United States, the Department of Homeland Security’s Federal Emergency Management Agency (FEMA) set out to establish a national policy to prevent, protect, respond, and recover from terrorist attacks,
major disasters, and other emergencies. The National Preparedness Guidelines were created in 2007 to define what it means for a nation to be prepared by providing a vision for preparedness, establishing priorities and identifying target capabilities (FEMA, 2007a). The vision for the guidelines was coined as the following;

“A nation prepared with coordinated capabilities to prevent, protect against, respond to, and recover from all-hazards in a way that balances risk with resources and need.” (FEMA, 2007a, p. 1)

The planning process as outlined by the National Preparedness Guidelines is supported by three planning tools; the National Planning Scenarios, Target Capabilities List (TCL), and Universal Task List (UTL) (FEMA, 2007a).

The National Planning Scenarios portray a diverse set of 15 high-threat scenarios that cover a range of possible situations, including terrorist attacks and natural disasters (FEMA, 2007a). Collectively they were designed to focus on contingency planning at all levels from governments to the private sector and the public. The scenarios were used for identifying tasks required to facilitate efforts in preparing for emergency situations as well as the capabilities required to perform the tasks. A catalogue of these tasks can be found in the UTL (FEMA, 2007c), while a listing of capabilities is found in the TCL (FEMA, 2007b).

The TCL contains 37 capabilities that are shown in Table 2-2. They address the four homeland security mission areas of prevent, protect, respond, and recover. The TCL document also acts as a basis for assessing preparedness in local communities, an important tool in designing action plans. The approach to defining these capabilities rest on three fundamental questions (FEMA, 2007b);

- How prepared do we need to be?
- How prepared are we?
- How do we prioritize efforts to close the difference?

To answer these questions, a threat analysis was conducted using the 15 National Planning Scenarios. Tasks required to overcome these scenarios were identified and capabilities necessary to perform the tasks were compiled as the TCL (FEMA, 2007b).
Table 2-2 FEMA’s Target Capabilities List overview. Source: FEMA (2007b)

<table>
<thead>
<tr>
<th>Common Capabilities</th>
<th>17. Volunteer Management and Donations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning</td>
<td>18. Responder Safety and Health</td>
</tr>
<tr>
<td>2. Communications</td>
<td>19. Emergency Public Safety and Security</td>
</tr>
<tr>
<td>5. Intelligence and Information Sharing and Dissemination</td>
<td>22. Explosive Device Response Operations</td>
</tr>
<tr>
<td><strong>Prevent Mission Capabilities</strong></td>
<td>23. Fire Incident Response Support</td>
</tr>
<tr>
<td>7. Intelligence Analysis and Production</td>
<td>25. Citizen Evacuation and Shelter-in-Place</td>
</tr>
<tr>
<td>8. Counter-Terror Investigation and Law Enforcement</td>
<td>26. Isolation and Quarantine</td>
</tr>
<tr>
<td>9. CBRNE Detection</td>
<td>27. Search and Rescue (Land-Based)</td>
</tr>
<tr>
<td><strong>Protect Mission Capabilities</strong></td>
<td>28. Emergency Public Information and Warning</td>
</tr>
<tr>
<td>10. Critical Infrastructure Protection</td>
<td>29. Emergency Triage and Pre-Hospital Treatment</td>
</tr>
<tr>
<td>11. Food and Agriculture Safety and Defence</td>
<td>30. Medical Surge</td>
</tr>
<tr>
<td>12. Epidemiological Surveillance and Investigation</td>
<td>31. Medical Supplies Management and Distribution</td>
</tr>
<tr>
<td>13. Laboratory Testing</td>
<td>32. Mass Prophylaxis</td>
</tr>
<tr>
<td><strong>Respond Mission Capabilities</strong></td>
<td>33. Mass Care (Sheltering, Feeding and Related Services)</td>
</tr>
<tr>
<td>14. On-Site Incident Management</td>
<td>34. Fatality Management</td>
</tr>
<tr>
<td>15. Emergency Operations Centre Management</td>
<td><strong>Recover Mission capabilities</strong></td>
</tr>
<tr>
<td></td>
<td>36. Restoration of Lifelines</td>
</tr>
<tr>
<td></td>
<td>37. Economic and Community Recovery</td>
</tr>
</tbody>
</table>

Each capability summary in the TCL document contains the capability definition and is followed by an outcome statement that describes the expected results to be achieved. The summary includes an identification of the relationship between the capability and the emergency support function. Each summary also contains a description of major activities performed and the critical tasks and measures associated with the each activity. As a method to determine if a community has achieved the target capability, the summary provides metrics.
associated with the performance measures of that capability (FEMA, 2007b). Performance measures are quantitative or qualitative levels against which achievements of a task or capability can be assessed. It should be noted that they are not normalized, nor are they standards. They are simply a guide for planning and training.

The communication capability will be used as an example of the information provided by the TCL document. The capability definition is given as follows:

“Communications is the fundamental capability within disciplines and jurisdictions that practitioners need to perform the most routine and basic elements of their job functions. Agencies must be operable, meaning they must have sufficient wireless communications to meet their everyday internal and emergency communication requirements before they place value on being interoperable, i.e., able to work with other agencies.” (FEMA, 2007b, p. 29)

An example of critical tasks required to meet this capability are (FEMA, 2007b, p. 34):

- “Implement incident communications interoperability plans and protocols”
- “Implement procedures to protect information facility and communication network systems”

Measures and metrics to determine accomplishment of these tasks are given as the following (FEMA, 2007b, p. 34):

- “Percent of communications sent and received that are completely understood without ambiguity by the sender or the intended receiver - 90%”
- “Frequency with which communications back-up is provided during emergencies when the conventional mode of communication fails or become overloaded - Continuous”

**2.2.3 UN Office for Disaster Risk Reduction – Hyogo Framework for Action**

Shortly after the Asian tsunami in 2005, the Hyogo Framework for Action (HFA) 2005-2015 was developed at the World Conference on Disaster Reduction in Kobe Japan (UN/ISDR, 2005). The conference provided an opportunity to promote a strategic and systematic approach
to reducing vulnerabilities and risks to hazards. The need to identify ways to build communities with better resilience to disasters was evident. As a result, the United Nations International Strategy for Disaster Reduction (UN/ISDR) office in collaboration with United Nations Office for the Coordination of Humanitarian Affairs (UN/OCHA) put forth three strategic goals as part of the Hyogo Framework for Action (UN/ISDR and UN/OCHA, 2008).

1. To integrate risk reduction into sustainable development and planning
2. To develop and strengthen institutions, mechanisms and capacities to build resilience to hazards
3. To systematically incorporate risk reduction approaches into the implementation of emergency preparedness, response and recovery programs

To achieve the goal set out as part of the framework, the conference also outlined five specific priorities (UN/ISDR and UN/OCHA, 2008).

1. Making disaster risk reduction a national and local priority
2. Improving risk information and enhance early warning
3. Building a culture of safety and resilience through education and innovation
4. Reducing the risks in key sectors
5. Strengthening preparedness for effective response

As part of the fifth priority, strengthening preparedness for effective response, a guidance and indicator package for implementing the framework was created. In the package, the Hyogo Framework highlighted the essential role that disaster preparedness can play in saving lives when integrated into an overall disaster risk reduction approach. Preparedness for hazardous events is mainly concerned with two objectives, increasing capacity to predict, monitor and be prepared to reduce damage and strengthening preparedness to respond in an emergency and help those involved (UN/ISDR and UN/OCHA, 2008).

The essentials required for developing disaster preparedness capabilities is discussed as part of the framework. It outlines the importance of contingency planning and capacity analysis in strengthening disaster preparedness. Each section includes a suggested outcome and a set of indicators to help measure levels of preparedness and progress made. The indicators have various forms for measuring outputs and processes. Ideally, indicators developed during the
preparedness phase can be used as a baseline for measuring change over time and across different contexts. In some instances the indicators serve as a checklist for ensuring preparedness activities are being undertaken. The indicators cover the following components of preparedness (UN/ISDR and UN/OCHA, 2008).

- Holistic Approaches and Preparedness
- National institutional and Legislative Framework
- Coordination at the Local, National, Regional, and International Level
- Contingency Planning
- Capacity Analysis and Capacity-Building
- Hazard Monitoring, Forecasting and Early Warning
- Information Management and Communication
- Emergency Services and Stand-by Arrangements
- Incorporating Early Recovery into Preparedness Planning
- Resource Allocation and Funding

Each component has a set of indicators developed specifically for each level of society; government, civil society, regional organizations and international actors (UN/ISDR and UN/OCHA, 2008).

The Red Cross and Red Crescent Implementation of the Hyogo Framework

Since the Hyogo Framework’s conception in 2005, 168 governments and organizations have pledged to implement it (UN/ISDR and UN/OCHA, 2008). One of the more prominent supporters of the Hyogo Framework is the International Federation of Red Cross and Red Crescent Societies (IFRC). As seen in the International Federation’s global agenda in 2008, the IFRC committed to four goals. They are the following: (1) reduce the deaths, injuries and impacts of natural disasters, (2) reduce the deaths, injuries and impacts of diseases and public health emergencies, (3) increase capacity to address urgent situations of vulnerability, and (4) promote respect for diversity and human dignity (IFRC, 2008).
With the first goal in mind, the IFRC societies have been working with communities to strengthen their coping capabilities and resilience to natural disasters using the HFA. By integrating the HFA and lessons learned through experience, the International Federation and National Societies were able to develop their own framework entitled Framework for Community Safety and Resilience (IFRC, 2008).

“The aim (of the Framework) is to support National Societies in the promotion and implementation of a holistic, integrated approach developed with and for communities in response to the multiple hazards they face (including those worsened by climate change) and incorporating health, environmental risks, and economic and social issues. The framework consolidates work undertaken to date to reduce underlying vulnerabilities to disasters as part of the Red Cross Red Crescent’s commitments under the HFA.” (IFRC, 2008, p. 1)

By contributing to the goals and priorities of the HFA, the IFRC societies have given themselves an advantage in disaster preparedness. They are now part of a global network that shares the same goals and priorities when it comes to disaster risk reduction. The advantage enables them to participate in large scale disaster relief operations in parallel with other organizations that have implemented the HFA.

2.2.4 Public Safety Canada – Emergency Measures Organizations

Emergencies stemming from natural disasters are localized events for most cases. Coastal and landlocked communities are vulnerable to different threats and therefore have different measures in place. A village in Saskatchewan would most likely not have emergency response plans to deal with storm surges. For this reason emergencies are managed at the community or provincial/territorial level. However, in some cases natural disasters can transcend jurisdictional boundaries and the scope of the emergency becomes much larger than the jurisdiction can handle. The Federal Emergency Response Plan (FERP) is the Government of Canada’s all-hazard response plan. The FERP is designed to complement response efforts from the provincial and territorial government. It does not override the provincial plans (Government of Canada, 2011).
The provincial approach to preparedness is managed by their respective Emergency Management Organization or Emergency Measures Organization (EMO). Whether they go by emergency management or measures, they provide the same service to their inhabitants and collectively fall under Public Safety Canada. The EMO’s activities include planning, training, and responding to disaster situations. They are also responsible for research and the administration and delivery of financial assistance to their province. By establishing provincial or territorial organizations, EMOs can address natural hazards and risks for their respective region. The following segment provides an overview of the EMOs for the four provinces and territories in which there are Canadian C-Change communities.

**Prince Edward Island Emergency Measures Organization**

The Prince Edward Island Office of Public Safety overlooks emergency services in the province. These services include the 911 Administration office, the Fire Marshal's office and Emergency Measures Organization. The emergency measures organization is responsible for the development and coordination of the provinces emergency management program in relation to emergencies and disasters in the province (Prince Edward Island EMO, 2010).

In an effort to prepare communities in PEI for emergency situations, a comprehensive response program was introduced. As part of the response plan two key documents can be found on the PEI EMOs website, the Municipal Emergency Management Guide (Prince Edward Island EMO, 2010) and the Municipal Emergency Measures Plan Template (Prince Edward Island EMO, 2012). The management guide outlines key components and steps to develop plans, create exercises and ensure resources have been identified before an emergency occurs. The document guides communities through the process of developing a municipal emergency program, writing the contingency and evacuation plan, and setting up the emergency operation centre (Prince Edward Island EMO, 2010). The Municipal Emergency Measures Plan Template provides municipalities with a starting point in developing an emergency measure plan. This all-hazards emergency plan template guides the emergency management actions of the community and describes activities and arrangements to deal with any emergency situation (Prince Edward Island EMO, 2012).
Municipalities in PEI are responsible for (Prince Edward Island EMO, 2010):

- Analyzing risks and hazards within their municipality and developing emergency plans for those in the community.
- Preparing and implementing emergency programs using the resources available to them.
- Guiding all emergency operations where the magnitude of the emergency is within their capabilities.
- Requesting assistance from other municipalities or higher government levels when needed.

The documents by the PEI EMO are all-hazard emergency response oriented, however they provide breakdowns and case studies that may prove to be very helpful for this research. In the Municipal Emergency Management Guide, a sample table top exercise called “Exercise October” was shown. This will be discussed in further detail in Section 2.4.2. The table top exercise can be found in Appendix A.

**Emergency Management British Columbia**

British Columbia is the third most populated province in Canada. With over 4.6 million people (BC Stats, 2013). It boasts a wide variety of services and resources as seen in their emergency planning resources. The provincial emergency program, Emergency Management British Columbia (EMBC) is the coordinating agency for all emergencies in the province. EMBC has the mission to enhance public safety through leadership and collaboration with all levels of the government, public and stakeholders involved (EMBC, 2012a).

Similar to Prince Edward Island, British Columbia has an all-hazard emergency response plan. The All-Hazard Plan outlines the response framework for emergencies and disasters at scales that requires the involvement of EMBC. The framework involves a provincial all-hazards methodology, description of responsibility for key players at all levels, and an outline of the collaborative intergovernmental relationship and integration for emergency planning (EMBC, 2012a).
In British Columbia the Emergency Program Act and the Local Authority Emergency Management Regulation states that local municipalities are responsible for developing emergency plans based on the hazards and vulnerabilities of their communities (Government of British Columbia, 2013). Often times, these plans will closely reflect the All-Hazard Plan for maximum interoperability within the system. It should be noted that the provincial All-Hazard Plan does not override the local authority plans. Instead, the provincial All-Hazard Plan will guide EMBC activities when the local municipality has declared a provincial state of emergency (EMBC, 2012a).

Aside from the provincial All-Hazard Plan, EMBC has a flood response plan that is specific to dealing with rising water levels and storm surges. The British Columbia Flood Response Plan of 2012 describes the methodology to be taken by the government in the event of a flood. The plan focuses on readiness and response activities for floods at the regional or provincial level (EMBC, 2012b).

Water level advisory is provided by the River Forecast Centre in three advisory levels (EMBC, 2012b):

1. High stream flow advisory: river levels are rising rapidly, but no major flooding is expected. Minor flooding in low-lying areas is possible.
2. Flood watch: river levels are rising and may exceed bankfull. Flooding of areas adjacent to affected rivers may occur.
3. Flood warning: river levels have exceeded bankfull. Flooding of areas adjacent to the rivers affected will result.

In the event of a high stream flow advisory resources are pre-positioned and the media is contacted to alert the public. Public flood impact mitigation techniques are relayed through the media. Local authority will assign observers and monitor the water level closely. If a flood watch advisory is issued by the river forecast centre, local authorities will actively patrol river banks to monitor the situation. Dikes, dams and other water control infrastructure are constantly monitored and spillways are kept clear. These measures are conducted on top of the high stream flow advisory measures. Flood warnings advisories indicate a high probability of a flood.
that will lead to damage. Provincial response will depend on the severity of the event and the areas affected (EMBC, 2012b).

**Nova Scotia Emergency Management Office**

Emergency preparedness in Nova Scotia is outlined in the Nova Scotia Emergency Response Plan and the Emergency Management Act of 2009. The all-hazard approach document outlines methodologies for an effective, efficient and coordinated emergency response plan. The document was designed to guide actions and decisions at the provincial level, whether it involves a response from a single department on a contained site or a fully coordinated joint response across multiple departments and jurisdictions (Nova Scotia EMO, 2012).

The response effort as outlined in the Nova Scotia Emergency Response Plan is coordinated through the Joint Emergency Operations Centre (JEOC). The centre has the mission to facilitate and maintain an efficient system for planning, managing and executing response and recovery operations with the help of technology. The planning process at the JEOC follows the incident command system’s P-model as shown in Figure 2-1 once an event has occurred (Nova Scotia EMO, 2012). The P-model is commonly seen in incident command systems management and the following section is based on the P-model as presented by FEMA in their Incident Action Planning Guide (FEMA, 2012). The Nova Scotia Emergency Response Plan did not explain the stages of the P-model. It should also be noted the Nova Scotia Emergency Response Plan focuses on the action and decision making process of responding. Not as much emphasis has been placed on the resources required to be prepared.

The P-model describes the decision making process that occurs at the JEOC once an incident or event has occurred. The figure depicts the stages of the incident action planning process. The leg of the “P” includes the initial steps to gain awareness of the situation and establish the organization for incident management. Once incident management is completed the process shifts into a cycle of planning and operation (FEMA, 2012).
Phase 1 of the P-model focuses on gaining an understanding of the situation and establishing initial priorities based on community values. The activities carried out to acquire more information about the situation include gathering, analyzing and displaying information regarding the scale, scope, complexity and impacts of the event at hand. Examples of the information required are the boundaries and scope of the incident, number of displaced survivors, infrastructure damage, resources on hand, and health related concerns. A comprehensive understanding of the situation is essential to properly develop and implement an incident action plan. The final step of the phase is to assemble an incident management assistance team. Once completed the process moves in an operation cycle (FEMA, 2012).

![Figure 2-1 The incident command system’s P-model. Source: FEMA (2012)](image)

The operation cycle commences with phase 2, establish incident objectives. A unified coordination group develops or updates the incident objectives that drive the response operation. Incident objectives are based on realistic expectations that can be accomplished
when all available resources are effectively deployed. In the initial stages following an incident, objectives are general and simple. As the operation loop progresses and the situational awareness and status has improved, then objectives can become more specific. An example of a general objective is to restore electrical service in the county. Once the situation has improved, then a time component can be added to the objective. For instance, restore power to more vulnerable areas first within a given time frame (FEMA, 2012).

Phase 3 of the P-model calls for developing strategies to achieve the incident objectives previously set out and to create tactics to accomplish the strategies. Strategies, as defined by FEMA, describe actions and resources required to achieve specific objectives. They are distinct from tactics, which address the conduct of specific operations. Properly developed strategies are (FEMA, 2012):

- Feasible and are likely to achieve a desired outcome
- Meet safety standards
- Cost effective
- Conscious of the environment
- Considers the political situation
- Address the capabilities

As part of the strategy developing process, work assignments and responsibilities for the response are allocated at this stage as well. Organizations are to assign responsibilities based on their internal hierarchical structure, and this may vary from organization to organization (FEMA, 2012).

In phase 4, prepare and disseminate the plan, the incident action is approved by the unified command group. As part of policy, this phase requires key supporting documents and paperwork to be completed. The supporting documents will depend on the event or incident to be addressed. In most instances they include: Incident Radio Communications Plan, Incident Map, Assignment List, Air Operations Summary and Medical Plans (FEMA, 2012).
Once all plans and strategies have been approved, phase 5 calls for execution, evaluation and revision of the plan. Phase 5 begins with the operations briefing and continues as the incident action plan is executed, followed by the evaluation (FEMA, 2012).

Incident action plans are useful for emergency responders in the sense that it:

- Shows clear objectives of the decision makers for the response operation
- Shows how individuals fit in the overall plan and that their individual effort affects the success of the operation
- Identifies work assignments
- Provides a schedule of key events during operation
- Provides information about safety, important contacts, and graphical representation of the incident area

The Nova Scotia Emergency Management Office Incorporates the P-model into their decision making process as well (Nova Scotia EMO, 2012).

**Nunavut Emergency Management**

Nunavut Emergency Management is part of the Community and Government Services Department of Nunavut. They are responsible for developing emergency response plans and coordinating emergency response operations in the territory. Training for emergency responders and education for public awareness and preparedness is coordinated through the Nunavut Emergency Management also (Government of Nunavut, 2010). The City of Iqaluit has a Climate Change Adaptation Action Plan developed in 2010 that mentioned the need to improve emergency response plans to adapt to a changing climate (Lewis & Miller, 2010).

**2.2.5 International Emergency Management Group – International Emergency Management Assistance Compact**

The International Emergency Management Assistance Compact (IEMAC), adopted in 1998 by the International Emergency Management Group (IEMG) following the ice storm, provides a structure for inter-jurisdictional and international mutual aid (IEMG, 2009). It establishes the procedures whereby a disaster impacted jurisdiction can request the aid of another quickly and
efficiently. The plan resolves two key issues, liability and reimbursement. The requesting jurisdiction assumes all liability for the out-of-jurisdiction aid and agrees to reimburse the aid provider with all deployment related costs (IEMG, 2009). The members of IEMAC are shown in Table 2-3.

If a jurisdiction is in a state of emergency and requires the assistance of another, there are two approaches that can be taken to initiate IEMAC and request assistance as shown in Figure 2-2. The activation process starts with the requesting jurisdiction in box 1. The authorized representative of this jurisdiction may contact another jurisdiction if they feel the emergency can be handled with the aid of another jurisdiction. If the emergency is of a larger scale, the authorized representative may choose to contact a member of the IEMG, where a call for aid can be sent out to all participating jurisdictions. The aiding jurisdiction would check its capacity to respond the emergency before responding. If the aiding jurisdiction agrees then an information request form is filled out and both parties must agree on the conditions as laid out by the IEMAC (IEMG, 2009).

Table 2-3 Jurisdictions participating in the IEMAC. Source: IEMG (2009)

<table>
<thead>
<tr>
<th>United States Jurisdictions</th>
<th>Canadian Jurisdictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>New Brunswick</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Newfoundland and Labrador</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>Nova Scotia</td>
</tr>
<tr>
<td>Vermont</td>
<td>Prince Edward Island</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Quebec</td>
</tr>
<tr>
<td>Rhode Island</td>
<td></td>
</tr>
</tbody>
</table>

The IEMAC has proven to be a valuable tool for responding to emergencies as seen in November 2004 when Nova Scotia was hit with a snow storm that brought over 60 cm of snow to some regions in the span of 2 days. The storm hit hardest in the Annapolis Valley, the Halifax region and North-Eastern Nova Scotia between Truro and the Canso Causeway. Residents in rural areas were left in the dark without running water for upwards of a week. The utility companies received more than 250 000 calls in the 12 hours after the storm. With the
unexpected demand, emergency crews from New Brunswick and Maine were called in to assist in restoring power to those in need. Two hundred emergency crews, including 55 from New Brunswick and Maine, worked around the clock to restore power and running water (Environment Canada, 2004).

2.3 Preparedness Measures

Given the persistent concerns about preparedness, many have tackled the issue from a quantitative point of view. Peter Drucker, an Austrian born American management author, once said “what gets measured gets managed”. This can be argued as a valid statement in various communities, where managing emergency response is not a priority (McConnell & Drennan, 2006; Petak, 1985). For this reason, valuating and quantifying the components of
preparedness to develop preparedness measures, checklists and indices have been pursued by many.

2.3.1 Preparedness Indicator Checklists

The checklist approach focuses on developing a list of items (guidelines) or set of indicators that a community requires in order to be prepared for a storm. In general, these guidelines or list of indicators are based on ingredients of preparedness that are readily countable (Jackson, 2008). They do not take into account the dynamics of the system, the operations aspect. To be successful a community needs plans in place to respond, needs equipment that the plans call for as well as personnel to implement the plan. This approach is most easy to follow for decision makers and allows the common public to visualize areas that need improvement (O'Leary, 2004). Shortages in preparedness ingredients can easily be identified from the list of indicators and appropriate actions can be taken. In a sense, it is the most user friendly approach and lays out the requirements clearly (Jackson, 2008).

Checklist style approaches often utilize the terms guidelines, indicators, and/or capabilities to identify the components of the checklist. The NWS StormReady Program, FEMA Target Capabilities List and the Hyogo Framework for Action all take this approach to defining preparedness.

2.3.2 Preparedness Indices

A different approach to defining preparedness is through the use of an aggregated measure or index of preparedness. The creation and use of an index has been a popular methodology for evaluating relative levels of some state, whether economic, health, quality of life or another state of being (O'Leary, 2004; Simpson, 2008). In some cases, there have been indices that attempt to capture levels of social vulnerability to natural hazards (Adger, 1999). Preparedness indices consist of a set of indicators, and through the application of a mathematical method the indicators are assigned scores and an index value is derived to measure relative preparedness.
A number of issues arise when attempting to construct disaster-preparedness measures and indices. Potential problems include subjectivity, bias, weighting, mathematical combinations, and selection of indicators. The following discussion examines several major indices and provides a breakdown of their structure and approach.

In 1987, Gillespie and Streeter proposed a method of conceptualizing and measuring disaster preparedness of an organization through the use of seven items that contributed to an overall measure of the preparedness. The summative measure of preparedness was scored upon how the organizations responded to the seven questions. The questions covered past training experience for the organization, future training opportunities, planning, and Integrated Emergency Management System (IEMS) Concepts. The IEMS concept was coined in the 1980s by FEMA as an all-hazard approach to the coordination, direction and control of disasters independent of their type, origin, size, and complexity. The responses were scored based on their type. For example, a yes or no response from the question of “Does your organization have a specific emergency response plan to guide its operation in a disaster?” would yield a score of 1 for yes and 0 for no. Questions that yield a quantitative responses such as “During the past three years, how many different times has a representative of your organization participated in simulated disaster exercises?” will have a scoring system of 0, 1, 2 or 3 for 3 or more times. The scores from the seven items were normalized onto a single dimension with the help of z-distributions. The average between the scores became preparedness measure (Gillespie & Streeter, 1987).

In 2006, Simpson and Katirai from the Centre for Hazard Research and Policy Development at the University of Louisville proposed an integrative framework for disaster preparedness index (DPI). Various models have been created in the past to evaluate community exposure and risks to a disaster but not so much for preparedness. They proposed a disaster resiliency index that is a function of vulnerability and preparedness (Simpson & Katirai, 2006).

\[
\text{Disaster Resiliency Index (DRI)} = \frac{\text{Preparedness Index (Pi)}}{\text{Vulnerability (V)}} \tag{2-1}
\]
Where DRi > 1 means that the community is more resilient, and DRi < 1, the community is less resilient.

The disaster resiliency index can be considered to be a function of a community’s preparedness in a ratio relative to its exposure and a set of hazards. Resiliency and community preparedness are directly proportional (Simpson & Katirai, 2006).

The key variables, measures and metrics for such a model are developed using a collaborative and consensus based process among literature in the field. The individual measures used will be determined and weighted from a list of indicators used in previous literature. The indicators will be identified as either a functional measure of preparedness (FM) or a vulnerability measure (VM). Once these measures have been identified and selected from previous literature, they can scaled and normalized to fill the following equations (Simpson & Katirai, 2006).

The first equation derives the preparedness index for the given community.

\[
P_i_x = \sum (w_1FM_1 + w_2FM_2 + \ldots + w_nFM_n)
\]  

Where:

\(Pi\) = community preparedness \((P)\) index  
\(x\) = location of community  
\(wn\) = weight for a given measure  
\(FMn\) = functional measure/indicator  
\(n\) = number of measures

The second equation derives the vulnerability score for the given community

\[
V_x = \sum [H_ap_af_a + H_bp bf_b + \ldots + H_np fn_n] \times \sum (w_1VM_1 + w_2VM_2 + \ldots + w_nVM_n)
\]  

Where:

\(V\) = Community vulnerability  
\(X\) = Location of community  
\(Ha, b, c\ldots\) = Hazard agent (earthquake, hurricane ....)  
\(f\) = Frequency of hazard
By plugging vulnerability \((V)\) and preparedness index \((Pi)\) into the disaster resiliency index equation mentioned previously, one can derive a score that is directly proportional to the community’s preparedness level (Simpson & Katirai, 2006).

Figure 2-3 summarizes how the disaster preparedness index is formulated. The measurement indicators will be determined from a listing of indicators used in other models.

Figure 2-3 Disaster indexing measurement model diagram. Source: Simpson and Katirai (2006)
2.3.3 Response Reliability

As seen from the checklists and indices, attempts to assess preparedness have focused on quantifying resources or measures that are easiest to quantify and identify. It is evident that having the right quantity of equipment or personnel is essential for a community to be prepared. Without the right tools the operation would not be able to succeed. Other efforts have gone beyond inventorying resources to developing preparedness standards to assess less tangible components of preparedness. These efforts generally produce an action plan or framework for response. They can be viewed as the instruction manuals providing guidance on how to proceed in the case of an emergency. At this stage, the tools and instructions are both evident as modules of preparedness. With an excess of resources and an optimal response plan, communities still lack a response to the fundamental question of: How certain can we be that the systems we have put in place to respond to storm surges will be able to deliver when called upon? The answer to this question lies in evaluating the effectiveness or reliability of the system once it is in practice. Confidence that response plans will be able to execute effectively depends on the reliability of the system that is executing these plans (Jackson, 2008; Jackson, Sullivan, Willis, & Goulka, 2009).

Emergency preparedness plans can be deceiving in many cases. In theory, access to aid supplies and a plan to deliver them to areas in need is a great preparedness strategy. However, if these areas of need are only accessible by a single road that can easily wash out in the event of a storm then the plan is no longer as relevant to the overall preparedness state.

The RAND Corporation has brought light to this issue by proposing that response reliability should be evaluated as part of preparedness measurement efforts. Such assessments should be based on the nature of the system of organizations, governments and public and the factors that contribute to how well they respond as a whole. The RAND Corporation suggested mapping the system and identifying the elements that shape the performance of a given task. In other words, the capabilities are mapped with factors that may interrupt the process. Reliability measures can be tabulated by estimating the likelihood of breakdowns and identifying their impact on performance of the system (Jackson, 2008; Jackson, Sullivan, Willis, & Goulka, 2009).
Figure 2-4 is an example of a fault analysis for identifying risks to evacuation reliability using buses.

Figure 2-4 Example fault tree for the analysis for identifying risks to evacuation reliability. 
Source: Jackson (2008)

This example is seen in areas prone to flooding and the population needs to evacuate. The response operation is shown in the white boxes, while the shaded boxes show possible disruption to the evacuation operation. The events are not exhaustive but they do illustrate factors that vary the reliability of such a plan. Simply having a system in place is not merely enough. Preparedness is heavily dictated by the reliability of the system in place (Jackson, 2008; Jackson, Sullivan, Willis, & Goulka, 2009).
2.4 Evaluation and Preparedness Modelling

The application of modelling techniques to preparedness has proven to be a valuable tool. Modelling and simulation studies have been conducted to predict vulnerable areas to storms, and train responders. Simulation studies can also be done as a role playing table top exercise, commonly referred to as a “mock-up” exercise.

Section 2.4.1 reviews modelling and simulation approaches for emergency situations while Section 2.4.2 examines emergency mock-up exercises.

2.4.1 Emergency Situation Modelling

The section reviews emergency situation models. Four models supported by large organizations, such as the US National Weather Service and the Canadian Meteorological Centre of Environment Canada, provide modelling information for describing and predicting weather related impacts. The later sections review simulation approaches applied to public education and professional training through the use simulation gaming.

Sea, Lake, Overland Surges from Hurricanes (SLOSH)

In the days leading up to arrival of Hurricane Sandy in 2012, emergency responders were tasked with deciding on which regions of the Eastern Seaboard had to be evacuated due to imminent floods. The National Weather Service of the United States developed a tool called the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model to provide guidance when a hurricane is threatening by providing the predicted surge height in a specific region. In most cases the model is used as a hazard analysis study for hurricane evacuation and training by FEMA, the U.S. Army Corps of Engineers and local state or municipal responders. It has been applied to 38 specific coastal areas in the United States, called basins that run along the eastern coast down into the Gulf of Mexico coast (Glahn, Taylor, Kurkowski, & Shaffer, 2009; NOAA, 2003).

The SLOSH model is run by the National Hurricane Centre to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create...
a model of the wind field which drives the storm surge. The model is constructed on a set of physics equations which are applied to the local topological and bathymetrical data. It also incorporates physical barriers such as roads, bridges, trees, and levees (NOAA, 2003).

Currently, there are three approaches that the SLOSH model can take on, deterministic, probabilistic, and composite modelling. The deterministic approach is based on the assumption of a perfect forecast. For a realistic simulation using the deterministic approach, the model must have accurate meteorological inputs. These inputs have the form of pressure, radius of maximum winds, location, direction, and forward speed. The deterministic approach proves to be a great tool for simulation and training exercises where the storm is required to be generated. The probabilistic approach incorporates statistics of past forecast performances to generate an ensemble of SLOSH runs based on distributions of tracks, intensity, and size errors. The composite SLOSH model predicts surge levels and location by running SLOSH several thousand times with hypothetical hurricane conditions. The outputs generated from the composite model are the Maximum Envelopes of Water (MEOW) and Maximum of the MEOWs.
(MOM). This is determined to be the best method of analysis for surge vulnerability since it takes into account forecasting uncertainty. A screenshot of the SLOSH program output is shown in Figure 2-5 for the basin of Galveston Bay, Texas during Hurricane Ike. The colours represent surge heights for their respective quadrant (NOAA, 2011).

The advantage found in using the SLOSH model is its efficiency in generating results in real time. This makes it an ideal tool for operational use. The model can resolve the flow dynamics of the surge as it passes through barriers. The disadvantage of the SLOSH model is that it lacks the ability to account for waves on top of the surge level. It also does not account for normal river flow and rain, nor does it model the tide level. In most cases the tide level can be inputted as an initial water level before the simulation run (NOAA, 2003; NOAA, 2011).

**Global Environmental Multiscale Model (GEM)**

The Global Environmental Multiscale (GEM) model was developed by the Canadian Meteorological Centre of Environment Canada. The GEM model presents an integrated forecasting and data assimilation system to meet the foreseeable weather forecasting needs of Canada. The motivation behind creating a global model is to forecast the weather, address climate issues such as global change, and examine air quality issues such as smog, and ozone depletion. The model is often used to predict short range forecasts and is often integrate with the Global Forecast System model as designed by the Nation Weather Services of the United States to North American Ensemble Forecast System (Environment Canada, n.d.).

**National Oceanic and Atmospheric Administration – Sea Level Rise and Flooding Impacts Viewer**

The National Oceanic and Atmospheric Administration developed a tool to enable users to visualize sea level rise and how it may affect their community. The Sea Level Rise and Flooding Impacts Viewer is a screening level tool that enables the user to adjust the increase in sea levels and explore their community through different visualization. It is interesting to note that the viewer also enables users to compare socioeconomic vulnerability with flood risks (NOAA, 2012).
Marine Environmental Observation Prediction and Response (MEOPAR)

Formed in 2012, the Marine Environmental Observation Prediction and Response Network (MEOPAR) brought together leading Canadian researchers in the fields of marine environment research and hazard management. Through research, MEOPAR seeks to reduce Canada’s vulnerabilities and exposure to marine emergencies. This goal is to be carried out by developing disaster risk reduction tools and proposing positive adaptation measures for impacts of the ocean (MEOPAR, 2012).

MEOPAR is currently developing several weather prediction tools. Of interest to this study are the Building a Network of Fixed Coastal Observing and Forecast Systems and the Climate Change and Extreme Events in The Marine Environment projects. The first project will build observation and prediction systems in the Halifax Harbour and the Southern Strait of Georgia. The data acquired from these systems will help forecast sea levels, waves, currents, and biogeochemical properties on a real-time basis for a multiple users like port authorities, municipalities, and the oil and gas sector. The second project will translate scientific weather prediction data into tools to increase preparedness and mitigate the impact of extreme weather events in coastal regions (MEOPAR, 2012).

UN/ISDR Stop Disaster Simulation

Simulation as tool is not only used for professional training, but is often used in public education as well. The United Nation’s International Strategy for Disaster Reduction as implemented by the Office for Disaster Risk Reduction took the simulation gamming approach to educate the public about preparing for threats from natural disasters. The game simulates threats from tsunamis, floods, wildfires, hurricanes and earthquakes (UN/ISDR, 2007).

The on-line game aims at teaching the public how to build safer communities for preparation against natural disasters. The lessons imparted in the simulation game include how location and construction materials of houses can make a difference when disasters strike. Early warning systems, evacuation plans and education all contribute to being prepared (UN/ISDR, 2007).
Figure 2-6 UN-ISDR Stop Disasters simulation game screenshot Source: UN/ISDR (2007)

Figure 2-6 is a screenshot of the Stop Disasters game. The game gives the player several disaster scenarios to choose from and a budget to work with. The player is tasked with upgrading existing infrastructures, building new ones and educating the public about responding to the imposing threats. The player must finish the required tasks before the disaster strikes. Once the disaster event has occurred a report is given in with suggestions and recommendations for how to prepare in the future if the player failed at preparing the simulated community (UN/ISDR, 2007).

Environmental Tectonics Corporation - Advanced Disaster Management Simulator

Technology is often used to simulate for a more realistic scenario during responders training. The Advanced Disaster Management Simulator (ADMS) produced by the Environmental Tectonics Corporation incorporates the use of CAD and produced 3D models and
environments for the purpose of professional training. ADMS is aimed at training incident commanders, command post staff, and emergency vehicle operators at all levels. The program offers training for individuals or as teams for a more realistic scenario where communication amongst team members is vital (Environmental Tectonics Corporation, 2012).

The advantage that the ADMS program provides is a fully customizable environment. The scenarios and spatial elements can be constructed from scratch based on community needs and requirements. ADMS provides a comprehensive toolset for community simulation instructors to control, assess and debrief after incident command exercises. From the instructor’s point of view, they have a bird’s eye view of the operation environment. This allows for better management during the exercise and areas that require improvement can be identified much easier (Environmental Tectonics Corporation, 2012).

ADMS is widely used for emergency responder training in large scale operations. There notable consumer are New York City’s Office of Emergency Management and the Ottawa International Airport (Environmental Tectonics Corporation, 2012).

2.4.2 Emergency Mock-up Exercises

A mock-up exercise is a simulated emergency in which key players and actors can carry out actions, functions, and responsibilities that would be expected of them in a real emergency. Exercises are often used to validate plans and procedures that will lead to increasing preparedness. These mock-up exercises are the most effective means of testing and validating plans, policies, procedures, training, equipment, and interagency agreements for rare or hazardous situations. If the unfortunate event of a natural disaster occurred more often, then communities would have more experience in dealing with them. This is not a situation that one would wish upon. Therefore a mock-up exercise provides the opportunity to test out the preparedness measures in place. The following are examples of mock-up exercises used in the field of disaster preparedness training.
Emergency Management Ontario

The Guidelines for the Development of an Exercise Program by Emergency Management Ontario will assist governments and communities in developing a full exercise program to be used for training. The Guidelines for the Development of an Exercise Program are a tool that provides a risk based framework with guidance for planning, conducting and evaluating exercises. These guidelines will enable organizations or communities to test elements of their emergency plans, including equipment and functions of personnel. Rather than presenting a predesigned exercise as seen with other approaches, the guidelines provide a standardized process and framework for communities to design their own mock-up (Emergency Management Ontario, 2010).

The document is organized into three sections: Process of Exercise Program Development, Discussion-based Exercises, and Operations-based Exercises. The first section focuses on key concepts in managing exercises and the phases involved in this process. The latter two sections focus on requirements for the conduct of discussions and operations of the exercises. The appendix also contains a mock-up creation template that may prove to be valuable for this study (Emergency Management Ontario, 2010).

FEMA Tabletop Exercises

In 2010, FEMA’s Private Sector Division, Office of External Affairs created a series of tabletop exercises as a tool to help private sector organizations advance their organization’s preparedness. Tabletop exercises are designed to help test a hypothetical situation for a group of responders, such as a natural or man-made disaster, and evaluate the ability of the group to cooperate and work together, as well as test their readiness to respond. The packages contain a PowerPoint presentation for the tabletop activity that includes notes and discussion questions for the exercise facilitator. The exercise packages can be downloaded from the FEMA website for communities to examine the first 72 hours of a response to a catastrophic disaster. The interactive exercise was designed to spur discussion and develop innovative ways to fill gaps in community emergency management plans (FEMA Private Sector Division, 2010).
The first table top exercise of the series entitled Whole Community: Planning for the Unthinkable is designed to simulate an unprecedented catastrophic event, a maximum of maximum approach. The presentation is given as three modules that cover the catastrophic response, crisis communication and search and rescue. Each module is introduced with a mock-up news report video, included in the downloadable package. Another exercise package to be noted is the Hurricane Exercise. The exercise goal in this case is to prepare to respond and recover from a category 5 hurricane (FEMA Private Sector Division, 2010).

**PEI Municipal Emergency Management Guide – Exercise October**

Prince Edward Island’s Municipal Emergency Response Guide includes a table tabletop activity to prepare for emergency situations. Exercise October focuses on the planning committee and organization of the EOC. The exercise can be conducted with little preparation as a tabletop exercise to exchange information from the key players in response to an emergency (Prince Edward Island EMO, 2010).

The following is a quick overview of what Exercise October brings. The scenario presented is a severe winter storm on the hypothetical date of February 24th combined with high winds and freezing rain. The ground is already covered by 30 centimetres of snow to increase the difficulty of the operation. The Municipal Emergency Management Coordinator is apprehensive about the situation and wishes to set up the EOC. What are the questions to consider when setting up the emergency operations centre? As the storm progresses, different situations are presented and a series of questions follow for the key players to discuss and share information as a training exercise (Prince Edward Island EMO, 2010).

It is important to note afterwards, how things can be done differently and how participants felt about the decisions as a whole. The detailed mock-up scenario can be found in Appendix A of this proposal along with the questions for consideration during the walkthrough (Prince Edward Island EMO, 2010).
2.5 Applications

In the case of an emergency, time is of the essence. An effective response means knowing who is in charge and willing to take action. The Emergency Management Act of Canada sets out clear roles and responsibilities for governments across the spectrum of emergency management. The act covers prevention/mitigation, preparedness, response and recovery and critical infrastructure protection. The Act is an integral part of the Government of Canada’s efforts to protect its inhabitants. The Act provides the following (Government of Canada, 2007):

- Gives responsibility to the Minister of Public Safety to provide leadership and sets clear goals for emergency management in Canada
- Establishes clear roles for key players in the emergency management spectrum
- Enhances collaborative practices and information sharing among different levels of government.
- Gives authority to the Minister of Public Safety and Minister of Foreign Affairs to coordinate Canada’s response to an emergency occurring in the United States.

In 2008, the Senate of Canada’s Committee on National Security and Defence produced a report on emergency preparedness in Canada. In summary, the Canadian Government is not moving quickly enough to minimize damage in the event of a hazard. The report also focuses on what the government has done in recent years in preparation for the next large disaster event (Government of Canada, 2008).

The all-hazard document claims that in recent years the government has inched towards improving national coordination for disaster relief, but more is needed for Canadians to be prepared. The committee examined disaster response capacity in areas that include government services in emergency situations, capacity of Canadian forces to offer assistance, funding municipalities, public communication, and many others. The results were attained qualitatively through testimonies from more than 110 witnesses from 2001 to 2008. Two emergency preparedness surveys were also conducted, one in 2003 and the other in 2007 (Government of Canada, 2008). The results identified 12 problems in the Canadian response system that can be improved on. The problems are shown in Table 2-4.
Table 2-4 Twelve problems in the Canadian emergency response system as identified by the Canadian Senate report. Source: Government of Canada (2008)

<table>
<thead>
<tr>
<th>Problem</th>
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<tbody>
<tr>
<td>1. Lack of emergency management</td>
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<td>2. Use of the Canadian Forces for domestic emergencies</td>
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<tr>
<td>3. Hidden emergency caches</td>
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<td>4. Lack of funding for equipment and training</td>
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<td>5. Poor collaboration among governments</td>
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<tr>
<td>6. Lessons learned not remembered and poor leadership on best practices</td>
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<tr>
<td>7. Emergency public communications</td>
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<tr>
<td>8. Lack of first responder interoperability</td>
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<tr>
<td>9. First responders ignored</td>
</tr>
<tr>
<td>10. Poor federal leadership on critical infrastructure protection</td>
</tr>
<tr>
<td>11. Emergency ad hocery</td>
</tr>
<tr>
<td>12. Policing during emergencies</td>
</tr>
</tbody>
</table>

From the problems identified, one can see that disaster preparedness methodologies have applications in Canadian communities.

2.5.1 Coastal Communities – City of Charlottetown, P.E.I.

The City of Charlottetown is the provincial capital of Prince Edward Island, located on the southern shore of the island. The city boasts a rich history that dates back to when it was first incorporated as a town in 1855. Today, with a population of 34,562 residents (2011 census), Charlottetown is the centre of industrial and commercial activity in the province (C-Change, 2011a).

The tourism industry is most prominent in the region and is most strong during the summer months when tourists flock the city for cultural events. Culturally the city is known for its numerous summer festivals that include a Jazz and Blues Festival, Festival of Lights and The International Shellfish Festival. Historically, it was the gathering place for the Charlottetown Conference in 1864 that ultimately lead to the Canadian Confederation (C-Change, 2011a).

Geographically, the city is situated on the Charlottetown harbour forming a rough V-shape pointing south. The harbour opens into the Northumberland Straight and is constrained by the North (Yorke) and the Hillsborough (East) Rivers to the west and east. Aside from being surrounded by waterways, Charlottetown has an impressive amount of green space and parks (approx. 400 acres). They provide residents and tourists with many passive or active
experiences depending on their interests (C-Change, 2011a). A map of the city is shown in Figure 2-7.

Figure 2-7 Map of Charlottetown. Source: Google Maps (2013)

As a coastal community along the eastern seaboard, Charlottetown is directly vulnerable to the effects of sea level rise. In recent years storm surges have taken its toll on the city by means of floods, large waves, and coastal erosions. In some cases, sea ice formations have damaged infrastructures. These are explicitly observable forces. Sea level rise has also caused well contamination in the many communities along the coast.

Hurricane Juan in 2003 was considered to be one of the most damaging hurricanes to have hit the East Coast in recent memory. Juan made landfall onto the shores of Nova Scotia as a category 2 storm in September 2003 with sustained winds of over 1213 km/h. The hurricane moved across Nova Scotia into Prince Edward Island knocking down millions of trees and causing major flooding that damaged homes, businesses and left hundreds of thousands of
residents without power for nearly 2 weeks. The storm was responsible for 8 deaths and $100 – 150 million in damage (Environment Canada, 2012).

In 2012, Hurricane Igor hit the eastern seaboard with winds of 140 km/h and rainfall of more than 200 mm. It caused widespread flooding and power outages in many communities along the coast. Water damaged homes, businesses, and harbours and caused several major roads to close including the Trans-Canada Highway. There was one reported death and damage was pegged at $65 million by the Insurance Bureau of Canada and non-insured costs were estimated to be $120 million (Environment Canada, 2012).

It is evident through literature that climate change has made coastal communities vulnerable to the effects of storm surges. The communities involved in the C-Change project are all at risk. This proposed research uses Charlottetown as a case study but all coastal communities would benefit from further research in adaptation planning for climate change.

2.5.2 Coastal Communities – Community of Isle Madame, N.S.

The island community of Isle Madame is home to 2644 residents as of 2011 (Government of Nova Scotia, 2012) and is located on the South-Eastern side of the larger Cape Breton Island. The community is a part of the Richmond Country in Nova Scotia and is separated from the mainland of Cape Breton by the Lennox Passage. Isle Madame itself is composed of three main communities, Isle Madame, Petit-de-Grat, and Janvrin’s Island (C-Change, 2011b).

Historically, it has been an important port for cod fishing in the region. Today, the fishing industry still remains as a significant employer with a snow crab plant in Petit-de-Grat and the international fisheries operation of Premium Seafoods Ltd. in Arichat. The island was first settled by France and was presumed to be named after Madame de Maintenon, the second wife of King Louis XIV. During the Seven Years’ War many Acadians took refuge in the region. Acadian families were able to established roots in the region and form a large French community. Today, Isle Madame can boast a rich blend of culture and a unique bilingual style (C-Change, 2011b).
As an archipelago community connected by causeways and bridges on the eastern seaboard, Isle Madame is vulnerable to the effects of sea level rise and specifically to storm surges. In August of 2009, Hurricane Bill struck the eastern coast of Nova Scotia causing up to 58 mm of rain and 32,000 Nova Scotians were left without power after 80 km/h winds were recorded (Environment Canada, 2012).

2.6 Summary

There are many methods and approaches to defining preparedness. This section provides a summary of the key issues behind emergency preparedness as examined in the previous sections and identifies what is important for this thesis.

Frameworks for preparedness at different organizational levels were reviewed in section 2.2. At the international level, the Hyogo Framework for Action presented a broad overview of the concepts behind preparedness. The all-hazards all locations approach of the HFA is an indication that emergency preparedness is an international issue and should be incorporated into local response plans to allow for interoperability. A prime example of an interoperable
operation is the IFRC’s implementation of the HFA. At the national level, FEMA’s Target capabilities list is a thorough definition of preparedness given their approach to the problem. FEMA identified 15 national planning scenarios as case studies to develop tasks that must be achieved to overcome the scenarios. From the universal tasks list, they were able to develop target capabilities required to accomplish the tasks. More specific to weather related disasters is the NWS’s StormReady program that can certify communities to be StormReady if they meet the StormReady guidelines. In Canada, emergency management falls under Public Safety Canada’s EMO offices. EMOs are regionally based and operated by the provincial or territorial government to address local threats. Emergency response plans developed by the EMOs for the four provinces and territories in which there are Canadian C-Change communities were presented. In addition to local response frameworks, preparedness can be found through collaboration planning with neighbouring communities. The IEMAC allows for member jurisdictions to request the aid of another member given that all financial costs are reimbursed after the event of need.

Measures of preparedness are generally shown as indicators – a quantitative or qualitative identifier to monitor the state of preparedness. These indicators are referred to as a checklist approach if they are presented as a set of indicators. On the other hand, attempts have been made at weighing and normalizing indicators to create an aggregated measure or index of preparedness. The RAND Corporation presented the concept of a response reliability of the overall response system to measure the preparedness.

Training and evaluation are vital steps towards being prepared. Emergency situation simulation and modelling is often used to forecast weather events and provide responders with risk free training opportunities. The SLOSH and GEM models are weather prediction models commonly used in North America for forecasting. MEOPAR is in the process of developing prediction methods to reduce Canada’s vulnerability and exposure to marine emergencies. A simulation gaming exercise is used by the UN/ISDR for public educational purposes. The Stop Disaster simulation game enables players to construct more resilient communities given a budget and the community is tested against extreme weather forces. Simulation is an important tool for responder training due to the risk free environment it provides. The ADMS
simulation program developed by the Environmental Tectonics Corporation uses 3D-CAD models to place responders in realistic situations training.

In smaller communities, a large scale customized high-tech simulation program is not always a viable option. For this reason, table top mock-up exercises are often used for responders to discuss and validate response plans given a mock scenario. Emergency Management Ontario has published documents instructing communities on how to create these training exercises. FEMA has table top exercise packages that can be presented at the community level that includes mock videos to present the scenarios. Of the C-Change community provinces, PEI has an exercise attached to their Emergency Management guide that should evoke discussion during training.

The need to be prepared for a changing climate is evident internationally and many efforts have been made by all levels of government to address such issues. The Canadian Government’s Emergency Management and Emergency Preparedness Act were established to strengthen emergency preparedness and management in Canada. The Canadian coastal community of Charlottetown and Isle Madame will be used as case studies for this research.
3 Methodology

This study aims at answering what it means for coastal communities to be prepared for severe storms and what prescriptions are required to improve preparedness. In an effort to answer these questions, a methodology is proposed in this chapter to define storm surge preparedness in coastal communities and to evaluate its effectiveness. Several pre-existing tools and literature findings will be integrated with a proposed simulation mock-up exercise to evaluate storm preparedness.

Initially the components of preparedness specific to coastal communities will be defined. Defining is followed by creating a preparedness taxonomy table to systematically classify the characteristics of preparedness and develop a comprehensive list of indicators relevant to coastal communities. The response process and dynamics is presented in Section 3.3 followed by methods for selecting best decisions in Section 3.4. The simulation process is presented in Section 3.5 followed by the methodology for creating a mock-up exercise in 3.6.

3.1 Defining the Components of Preparedness

From the literature reviewed, there exist many different approaches to defining preparedness. Within the context of this study, preparedness for storm surges in coastal communities will be examined.

Organizations from different levels of governance have attempted to define preparedness. They range from the global, as seen in the Hyogo Framework for Action, down to the municipal/community level as seen in the Municipal Emergency Management Guide of Prince Edward Island. The definition of preparedness was also shown from an all-hazard approach for most of these organizations. Before redefining specific to storm surges and coastal communities, one must integrate these components.

Preparedness is often defined by indicators, a quantitative or qualitative identifier to monitor the state of a process. As seen from before, organizations have attempted to develop a baseline count of the resources required to be prepared. This method produces a tangible inventory list of the equipment and supplies required in the time of a disaster. Examples of
quantifiable resources are the number of fire trucks, police officers, water level monitoring sites, and shelters. The other perspective that is often seen in defining preparedness is to develop a response plan. These are often described as guidelines, frameworks, plans or protocols for response.

Without actually deploying the system, one can say that given the correct tools (resources) and the instructions (response plans) one can be prepared for an emergency situation. This study aims to take it one step further and assess the decision making and the reliability of the system. Once an emergency event occurs, decision-makers are tasked with deciding on how to respond and how to apply the resources and response plan. Questions arise in how decision-makers deal with the situation, the stress involved and the time constraints. In the case of an emergency, numerous events may occur at the same time and deplete the supplies and use the available equipment. A state of panic or inexperience may cause the responders to improvise and deviate from the plan. The plan may also ask for decision making and this becomes a crucial part of the outcome. At what point should the community at risk declare a state of emergency, is a prime example of decision making. For the reasons mentioned a third component of preparedness lies in how the decision-makers deploy the resources and plans.

Another factor that can only be examined once the system is in practice is the reliability of the system and how effective it really is. This component of preparedness is often examined in hindsight of the disaster. Events can arise during the response operation that interrupts the process. Examples of these events are seen in ambulances breaking down after flood water gets into the engine, a road leading to a vulnerable site collapses or gets blocked, communication system gets disrupted. These are all events that can occur given optimal resources, plans and decision making. For this reason, system reliability is seen as a fourth component of preparedness.

Figure 3-1 shows the four components of preparedness as identified from reviewing literature. In order to be prepared for emergency situations, communities must be efficient in all 4 aspects of preparedness.
A taxonomy of preparedness will be constructed from the approaches and framework mentioned in Chapter 2. The taxonomy ensures that characteristics used for developing indicators relevant to storm surges in coastal communities are mutually exhaustive and independent. The taxonomy construction involves full understanding of each framework and the intentions or goals of each component. The components will be classified in the taxonomy table shown in Table 3-1 based on the characteristic they aim to address. Overlaps in the preparedness frameworks and unique elements can be easily identified from the table once completed. The aim for this study will be to identify an exhaustive list of characteristics of preparedness from the different framework approaches. A draft of the characteristics is presented as part of the table. Elements may be moved around or added during this study.

The characteristics will serve as the definition to the question of what it means to be prepared specific to coastal communities and storm surges. From the characteristics, indicators can be formulated to portray the dynamic behaviour of the characteristics. The indicators will then form the grounds for creating sub-indicators of preparedness that are community specific. Indicators are a quantitative or qualitative identifier to monitor the state of a process or in this case, preparedness.

Figure 3-1 The components of emergency response preparedness
### Table 3-1 Classification of preparedness characteristics

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Resources</th>
<th>Action Plan</th>
<th>Deployment Logistics</th>
<th>Infrastructure Governance Leadership</th>
<th>Monitoring Training Testing Maintenance</th>
<th>Engagement Participation Education</th>
<th>Communication Collaboration</th>
<th>Social Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NWS – StormReady</strong></td>
<td><strong>Formal hazardous weather operations plan</strong></td>
<td><strong>Visits and consultations with NWS</strong></td>
<td><strong>Hydrometeorological Monitoring</strong></td>
<td><strong>Trainings for spotters and dispatchers</strong></td>
<td><strong>Weather safety talks</strong></td>
<td><strong>Communication</strong></td>
<td><strong>EOC</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FEMA – TCL</strong></td>
<td><strong>Critical Resource Logistics and Distribution</strong></td>
<td><strong>Planning</strong></td>
<td><strong>Risk Management</strong></td>
<td><strong>On-Site Incident Management</strong></td>
<td><strong>Emergency Operations Center Management</strong></td>
<td><strong>Information Gathering and Recognition of Indicators and Warning</strong></td>
<td><strong>Community Preparedness and Participation</strong></td>
<td><strong>Communication Intelligence and information sharing</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Medical Supplies Management and Distribution</strong></td>
<td><strong>Risk Management</strong></td>
<td><strong>On-Site Incident Management</strong></td>
<td><strong>Emergency Operations Center Management</strong></td>
<td><strong>Citizen Evacuation and Shelter-in-Place</strong></td>
<td><strong>Community Preparedness and Participation</strong></td>
<td><strong>Volunteer Management and Donations</strong></td>
<td></td>
</tr>
<tr>
<td>UN – HFA</td>
<td>Emergency Services and Stand-by Arrangements Resource Allocation and Funding</td>
<td>National institutional and Legislative Framework Contingency Planning Incorporating Early Recovery into Preparedness Planning</td>
<td>Holistic Approaches and Preparedness</td>
<td>Coordination at the Local, National, Regional, and International Level</td>
<td>Capacity Analysis and Capacity-Building Hazard Monitoring, Forecasting and Early Warning</td>
<td>Information Management and Communication</td>
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<tr>
<td>PEI EMO</td>
<td>Developing a municipal emergency plan</td>
<td>EOC Management structure and responsibilities</td>
<td>Crisis Communications</td>
<td>Emergency Social Services</td>
<td></td>
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<tr>
<td>IEMG – IEMAC</td>
<td></td>
<td></td>
<td></td>
<td>Collaboration between jurisdictions</td>
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</table>
3.2 Indicators of Preparedness Specific to Coastal Communities

Given the plethora of descriptions of what it means to be prepared for an all-hazard event, one can be selective and reclassify the descriptions based on their characteristics. As part of the process to determine what it means to be prepared for coastal communities, a collectively exhaustive set of characteristics can be formulated from the literature frameworks. Each characteristic will carry with it a set of indicators that enables gauge the state of preparedness. Figure 3-2 shows the hierarchical diagram of preparedness, starting from the characteristics mentioned in Section 3.1 followed by the indicators at the next level down. From the indicators one can formulate sub-indicators of preparedness that are community specific.

![Sample structure of a preparedness taxonomy.](image)

When designing indicators several factors must be taken into account to insure that they are effective in the long run. These factors are the attributes of the indicators and they include (O’Leary, 2004; UN/ISDR and UN/OCHA, 2008):
- Clarity: Ambiguity in defining indicators can result in varied and undesired outcomes.
- Cost-effectiveness: Indicators must be realistic in terms of cost and their outcome can justify their investment.
- Comparability/Measurability: Indicators should be designed with the ability for comparison over time. The measurability allows for easy identification of progress and improvement.
- Relevance: Realistic and sensitive to the system in which the indicators are intended to signify.
- Reliability: The indicator must be reliable to provide a basis for confident decision making.
- Practicality: The information required for the indicator can be obtained in a reasonable amount of time and at a reasonable cost.
- Validity: The indicator must be effective in measuring its target

![Diagram of Time Component of Preparedness Indicators](image)

**Figure 3-3 Time component of preparedness indicators**

The indicators will have a time component attached to them is relative to the storm event as shown in Figure 3-3. Indicators can describe processes occurring before a storm in preparation, during a storm in response or after in the recovery phase. For example, evacuation and shelter capacities are before storm indicators. Emergency response time is a during storm event indicator while water quality may be an after storm indicator.
3.3 Process Definition and Dynamics

As a method to evaluate all four components of preparedness, a decision tree/response process is proposed. The simulation program will walk the responders through a series of events where decisions, storm events, and system reliabilities will dictate the outcome and next stage of the simulation.

The decision tree/response process will commence with the storm event followed by the responder decision. As shown in Figure 3-4, several storm types can be generated and these are given as S1, S2,... S5. The decision tree process presented shows up to 5 different storm types. They can differ based on atmospheric pressure, radius of maximum winds, location, direction and forward speed. Depending on the storm type and impacts it may carry, responder will be required to make an initial decision. Decisions can be facilitated by the emergency response plan, and the dynamically changing inventory of resources available. The indicators will define what the community responders are capable of doing to mitigate the storm effects. The next event presented will commence phase two of the mock-up exercise where the event put forward will depend on the previous decision made, the progression of the simulated storm and the reliability of the system. This process continues until the objective of the response mission is accomplished or the storm has ended.

Once the storm has ended the mock-up exercise will provide an expected value of damage for the storm. These values are for the exercise simulation purpose only and may not reflect reality. They enable the responders to compare between decisions made or not made in the progress.

In an effort to create a general framework for storm surge mock-ups in coastal communities, an inductive approach is proposed. By creating scenarios for specific cases one can gain a generalized concept of the framework after numerous cases have been examined. Through the process of integration, one may develop a simulation process that incorporates a comprehensive list of possible decisions and scenarios. This methodology may prove to be a valuable tool for information sharing in between communities.
Figure 3-4 Sample decision tree for the storm mock-up simulation
3.4 Determinant of Best Decisions

The responders at the table top simulation exercise must work together and navigate through the storm surge simulation by selecting the appropriate branch of the decision tree. Decision making in the time of an emergency can be stressful due to inexperience and time constraints. This exercise allows responders to thoroughly review their decision criteria and test it against a simulated program.

A single best decision route can be charted based on the expected values at the end of the mock-up. However, the best decision route cannot always be selected due to the inherent probabilistic nature of the elements involved. The storm type, reliability probabilities, and dynamically changing resources will force the responders to be creative in navigating the decision tree. This exercise will spur discussion and allow responders to discuss decisions at each stage. For that reason, best decisions are situation dependent and after running the mock-up several times a “best decision” given a situation approach can be recorded. Gaps in emergency response plans can be identified through a tabletop discussion and guidance on situational decision making can be added to the plan.

3.5 Process Simulation

The mock-up exercise will be constructed using Rockwell Arena Simulation software. Arena is a discrete event simulation and automation software developed by Rockwell automation (Kelton, Sadowski, & Swets, 2010). The parameters of the simulation model are shown in Figure 3-5. The initial state of the countable resources and response plans will be the tools that responders have to work with. The spatial inputs will come in the form of the community architecture and the layout of the location. For example the number of roads leading into area requiring assistance is a spatial input. The model outcome will be dependent of human decisions by responders involved, the SLOSH storm simulation and the reliability of certain processes. The reliability probability values will be generated by the mock-up simulation designer based on a risk analysis of the response process.
The storm surge simulation will be generated using the National Weather Services’ SLOSH model as presented in section 2.4.1 of this proposal. The SLOSH model will require laser imaging detection and ranging (LIDAR) information from the community being studied to generate the SLOSH surge simulation.

### 3.6 Mock-up Exercises

The mock-up exercise to evaluate the decision making component of preparedness will be aimed at community level responders for the purpose of this study. In this section, the process of designing, developing, conducting and evaluating the mock-up exercise will be discussed. Given the tools developed from earlier methodologies, the concepts of preparedness and models will be applied to response training exercises.

Emergency Management Ontario suggested 5 phases of building an exercise. The 5 phases are shown in Figure 3-6. Creating a foundation for the exercise in phase 1 includes...
identifying a planning team, scheduling meetings with the community to be studied, establishing project timelines and determining the availability of resources to design and implement the exercise. At this stage it is important to establish needs and requirements of the user (Emergency Management Ontario, 2010).

![Diagram of phases of a mock-up exercise program management]

**Figure 3-6 The phases of a mock-up exercise program management**

In the second phase, design and development, objectives are identified and scenarios are developed. Exercise objectives should define the specific goals of the community, provide a framework for scenario development and provide evaluation methods. Objectives should be limited to enable the design of a reasonable scenario. A multiple hazard approach would not cover the details required for a thoroughly conducted exercise. The inductive approach to mock-up designs should be noted here. A scenario is selected to provide the backdrop to the exercise, however the scenario should not be so challenging that it overwhelms the exercise participants. Scenarios should be hazard specific, realistic, plausible and challenging. Appendix B provides a questionnaire/checklist to develop scenarios as conducted by Emergency Management Ontario (Emergency Management Ontario, 2010).
The third phase the mock-up exercise building is to conduct the exercise and includes setup, briefing, and facilitation. For this study, a table top exercise will be conducted and is therefore isolated from the public. In an exercise of larger scales where the public may be involved, everyone must understand the difference between what is real and what is simply for training. There should be call off signal in the event that responders are required to abandon the exercise and respond to a real situation (Emergency Management Ontario, 2010).

Evaluation is the fourth phase and the corner stone to any mock-up exercise. Evaluation methodology identifies strengths and weaknesses in existing plans and is the first step to improving preparedness. The seven steps of mock-up exercise evaluation as identified by Emergency management Ontario are (Emergency Management Ontario, 2010):

1. Plan and organize the evaluation
2. Observe and collect data
3. Analyze the data
4. Identify improvements and corrections that need to be implemented
5. Develop an After Action Report based on input from participants
6. Conduct a meeting to debrief the After Action Report
7. Finalize the After Action Report

The final phase is improvement planning and requires follow-up activities that include a corrective action plan or an improvement plan. The corrective action plan should identify shortfalls during the exercise and actions required to address these short falls. In this stage, the lessons learned from the exercise are converted to measurable steps that can be prescribed to improve preparedness (Emergency Management Ontario, 2010).
4  Expected Results and Analysis

In this section the expected results and analysis for this study will be discussed. The objective of this study is to develop a framework for coastal communities to assess their level of preparedness in the event of a storm surge. The expected results will be presented in the form of: (1) a comprehensive definition of what it means to be prepared for storm surges using indicators and (2) a framework for constructing tabletop storm mock-up exercises.

The comprehensive definition of what it means to be prepared will be presented with sub-indicators that are relevant to the specific community of study. The framework for constructing tabletop storm mock-ups will be applied to the communities of Charlottetown and Isle Madame. Therefore one can expect to analyze the different scenarios and develop response reliability values to populate the proposed mock-up.

Figure 4-1 Map of Petite Anse Community on Isle Madame. Source: Google Maps (2013)
As an example, the mock-up exercise can be applied to the case of a causeway in the community of Petite-Anse on Isle Madame. The causeway highlighted by the red oval in Figure 4-1 proves to be a vulnerable area during storm surges. Surge waves coming in often washes out the road leaving those living to the south of the causeway trapped.
5 Expected Outcomes and Recommendations

In this section the expected outcomes and recommendations following this study will be presented. Specific to the two coastal communities involved in this project, Charlottetown and Isle Madame, case studies will be conducted and the definitions and mock-up frameworks will be applied to both these communities.

In an attempt to measure and evaluate emergency preparedness for storm surges, the community of Charlottetown can expect the following outcomes and recommendations from this proposed study.

1. A clear definition of what it means for Charlottetown to be prepared for sea level rise and storm surges using indicators of preparedness
2. An evaluation of the Charlottetown’s current emergency response plan with the concept of decisions and systems reliability factored in
3. The construction of a SLOSH basin using LIDAR data for surge height simulation and prediction
4. A series of tabletop mock-up exercises with scenarios specific to Charlottetown and the threats it faces using the generated SLOSH storms to measure

The community of Isle Madame can expect the following outcomes and recommendations from this proposed study.

1. A clear definition of what it means for Isle Madame to be prepared for sea level rise and storm surges using indicators of preparedness
2. An evaluation of the Isle Madame's current emergency response plan with the concept of decisions and systems reliability factored in
3. A series of tabletop mock-up exercises with scenarios specific to Isle Madame conducted
4. An “After Action Report” to follow up on the mock-up exercises identifying gaps in emergency response plans that can be improve upon

There is LIDAR data available for Charlottetown and therefore a SLOSH basin can be created for simulation purposes. The tabletop mock-up exercise will be conducted for the
community of Isle Madame and therefore an “After Action Report” can be developed for Isle Madame.
6  Timeline of Proposed Study

A timeline of the proposed study is shown in Table 6-1. The proposal, set to be completed by April 2013, will focus on framing the research questions and reviewing literature in the relevant field of research. The preparedness taxonomy will be created in May 2013 to identify characteristics and indicators of preparedness. Following the process of identifying all aspects of preparedness, a conceptual model can be developed for the storm surge mock-up starting in June of 2013. The construction of the Charlottetown SLOSH basin will commence in the summer of 2013 as well. The simulation modelling process will start in July 2013 and will phase into the implementation process in October 2013. Analysis and recommendation development will be conducted in late 2013. The dates mentioned are simply projections and may change depending on the nature of activities along the way.

Table 6-1 Timeline of proposed study

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Bibliography


C-Change. (2010). *C-Change Project Overview*. Retrieved February 3, 2013, from C-Change - Canada and the Caribbean Coastal Climate Adaptation Strategies:
http://www.coastalchange.ca/index.php/the-project/description


https://www.rkb.us/contentdetail.cfm?content_id=185590


http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96111_01


Klein, R. J., Nicholls, R. J., & Thomalla, F. (2003). Resilience to Natural Hazards: How Useful is This Concept? *Environmental Hazards, 5*, 35-45.


http://www.planningforclimatechange.ca/wwwroot/Docs/Library/CommAdptPlans/IQALUIT_REPORT_E.


Glossary of Terms

**Action Plan** – A logical sequence of steps or activities developed for a strategy to succeed.

**Adaptation** – The capacity for human and natural systems to adjust to global and local environmental change by reducing vulnerability and increasing resilience to potential adverse impacts (C-Change, 2010).

**Capability** – The power or ability to provide the means to accomplish a mission and achieve desired outcomes by performing critical tasks and achieving desired levels of performance (FEMA, 2007b)

**Disaster** – A serious disruption to the community or societal functionality causing widespread human, economic, and/or environmental losses which exceeds the affected population’s capability to cope (UN/ISDR, 2005).

**Indicators** – A quantitative or qualitative identifier to monitor the state of a process,

**Preparedness** – A combination of capacity and knowledge developed by governments, professionals, community groups and individuals to effectively anticipate and respond to hazardous events or conditions (UN/ISDR, 2005).

**Resilience** – The capacity of a community to be able to absorb stress or destructive forces through resistance or adaptation. Can also be viewed as the ability to manage or maintain functionality during disastrous events and to recover after the event (UN/ISDR, 2005).

**Sea Level Rise** – An increase in the mean water level of the ocean (Richardson G. R., 2010).

**Storm Surge** – Refers to the temporary increase in height of the sea level at a specific location due to extreme meteorological conditions (Richardson G. R., 2010).

**Vulnerability** – The state of susceptibility to impacts of disastrous events from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt (UN/ISDR, 2005).
Appendices


The following is the table top exercise found in the P.E.I. Municipal Emergency Management Guide. It provides an example of a basic exercise that provides responders with the opportunity to discuss and evaluate their response efforts. It is important to note the questions raised between each stage of the exercise for discussion, as this proposed study will attempt to borrow these concepts.

Weather reports from the past two days indicate that a severe storm is expected to reach PEI in the early morning of February 24, combined with high winds and freezing rain. Already on the ground 30 centimetres of snow, will increase operational challenges.

The Municipal Emergency Management Coordinator feels apprehensive about the storm and suggests a review of the instructions for setting up the MEOC. He / She should also be prepared to discuss standard operating procedures.

- Will all agency representatives be required to participate during the initial preparations?
- How and when will the EOC be activated to cope with the storm?
- How will arrangements be made for communications within the EOC?

Several hours pass. Environment Canada issues a warning at 5:30 am on February 24 that predicts the storm will affect all of PEI. Areas of the province have been experiencing strong winds and freezing rain; there are increasing reports of damage and power outages. The wind is from the west at 40 km/h but is predicted to increase to 100 km/h.

- How should the public be warned of the storm’s severity? – note the early hour.
- What areas are facing significant risks?
- What can citizens do to protect themselves from the effects of the storm?
By 10:00 am, the next day, all areas in PEI are experiencing the full effects of the storm. Driving is extremely hazardous, and there have been numerous reports of power outages. Three community care facilities and some citizens are requesting auxiliary power.

- What sources of auxiliary power are available for special care homes and other medical institutions?
- What emergency plans do the community care facilities have?
- How long can residents remain in homes without power?

By late afternoon, winds have finally decreased and the snowfall has reduced to just flurries, all primary and secondary roads are passable, power has yet to be restored in the area. Maritime Electric has just issued a press release stating that power could remain out for up to 48 hours. The increased requests for emergency power have increased considerably at the MEOC. Private homes, financial institutions, farms, poultry operations, service stations and greenhouses are requesting auxiliary power units. A seven-year-old boy, at home suffering from cystic fibrosis, needs a “mist tent,” which requires auxiliary power.

- What can be done to provide assistance to these people?
- What operating information may be required?

It has been decided to evacuate approximately 200 people living in areas from North Street to West Street. Consider and discuss the evacuation from the following points of view:

- What information and discussion led to the decision to evacuate and why?
- How will people be informed of the evacuation?
- Who will warn them?
- What kind of warning should they receive?
- Where will evacuees be told to go?
- How will they get there considering the blizzard conditions?
- Who is responsible for care at the evacuation centre?
- Who is responsible for transportation to and from the evacuation centre?
- Who is responsible for security of the evacuation centre and evacuated homes?
- How will special needs residents be transported to the evacuation centre?
B. Emergency Management Ontario Guidelines for Development of an Exercise Program

The following are questionnaires for needs assessment and scope defining used by Emergency Management Ontario when developing an exercise program.

Needs Assessment

HAZARDS: List by priority any problems in the past, and which ones need to be exercised.

GEOGRAPHIC AREA: Look for areas that are vulnerable to hazards.

EMERGENCY FUNCTIONS: Determine what function needs to be exercised.

- Individual/Family Assistance
- Alert Notification
- Communications
- Public Safety
- Coordination
- Public Works
- Emergency Public Information
- Resource Management
- Damage Assessment
- Warning
- Health and Medical
- Other

ORGANIZATIONS AND PERSONNEL: Determine who would be involved and who needs the training. Have policies or staff changed?

- Police
- Hospital
- Fire
- EMS
- Business and Industry
- Public Transportation
- Public Works
- School District
- Airport
- Surrounding Jurisdictions
- EMO
- Volunteer Organizations
- Red Cross
- Others
**EXERCISE TYPE:** Determine which exercise to conduct. At what level is the exercise experience to be...a tabletop, a seminar, or a functional exercise? How much time can be allocated for development? Is a certain type required to fulfill compliance?

- Seminar
- Drill
- Game
- Tabletop
- Functional
- Full-scale

**Defining the Scope**

1. **Type of Emergency:** (Select one or at most two that are high priority, have not been exercised recently, or best support functions to be tested)
2. **Geographic Location:** (Be specific; make sure it is logical for the hazard choice)
3. **Functions:** (Choose the most important to be tested; three to five are usually sufficient)
4. **Personnel and Organizations:** (Select those that would benefit most and match the functions to be tested)
5. **Exercise Type:** (Consider the exercise experience of personnel involved and the desired degree of stress and complexity)

- Orientation Seminar
- Drill
- Table Top Exercise
- Functional Exercise
- Full Scale Exercise