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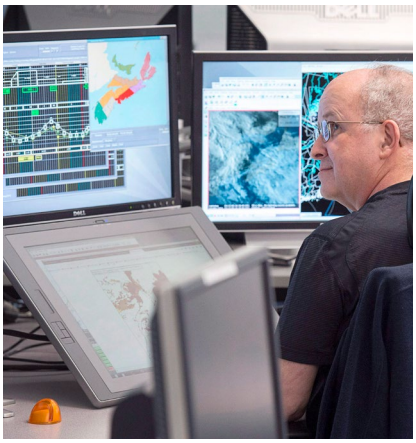
Communicating Hurricane Risk in Eastern Canada: Enhancing the communication lines between the Canadian Hurricane Centre, municipalities and insurers

By Paul Kovacs, Sophie Guilbault and Brian Pentz

August 2017



Communicating Hurricane Risk in Eastern Canada: Enhancing the communication lines between the Canadian Hurricane Centre, municipalities and insurers

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List of abbreviations

CHC: Canadian Hurricane Centre

NSEMO: Nova Scotia Emergency Management Office

NBEMO: New Brunswick Emergency Measures Organization

EMO: Emergency Management Office

NHC: National Hurricane Center

ICLR: Institute for Catastrophic Loss Reduction

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Executive Summary

Hurricanes represent a critical challenge for Emergency Management Organizations (EMOs) in Atlantic Canada. These storms, while possessing similar baseline characteristics and identifying features, invariably possess a degree of distinctiveness and novelty, which translate into unique challenges for emergency managers and their organizations. Effective response to such events requires highly developed institutions that provide the structural basis and support for emergency managers, while having the flexibility and adaptability to ensure personnel are capable of executing optimal decisions in less than optimal situations.

The dynamic nature of systems within their jurisdiction requires EMOs to continually assess and refine their approaches, methods and strategies. The link between climate change, hurricanes, and public and private loss furthers this imperative in the Atlantic region.

This report sets out to strengthen these institutions and heighten their ability to respond to the impacts and consequences of climate change by reviewing the communication strategies employed by EMOs. Although the existing communication systems and strategies are comprehensive, refining them will increasingly allow for EMOs to mitigate impacts and loss associated with severe hurricanes.

The report's six recommendations for communication reform, noted below, are derived from a series of interviews with emergency management professionals in Nova Scotia and New Brunswick and a survey of the Canadian insurance industry. The interviews inform the report's characterization of emergency management communication frameworks in these provinces, and along with the insurance industry survey, reveal potential options for communication refinement in EMOs.

The six recommendations are separated into (four) government-centric and (two) industry-centric recommendations. The government-focused recommendations are: (1) provincial and local governments should consider mandating compulsory training in the CHC's severe hurricane interpretation course; (2) emergency management at the municipal level should be expanded to support all phases of emergency management; (3) EMOs should heighten, develop and expand sources of institutional memory; and (4) the warning structure should be changed from a hazard-based analysis to a risk-based/impact-based analysis. These reform options are designed to accommodate the existing emergency response framework and possessed by the region's EMOs, and represent tangible, measurable and achievable options for tailoring the emergency management and response strategies for both the warning and insurance communities.

Waves crash against rock embankments that protect the Escuminac road against erosion during Tropical storm Arthur in Escuminac, N.B. on Saturday, July 5, 2014.

[THE CANADIAN PRESS/Diane Doiron]

The report's two recommendations focusing on a potentially expanded role for the insurance industry are: (1) establishing a clear and direct communication line between the Canadian insurance industry and the Canadian Hurricane Centre; and (2) focusing on a risk-based analysis when communicating with the insurance industry. Collaborative approaches, which include the participation of key players in the private sector (i.e. the insurance industry), can increase the likelihood that EMOs can effectively manage emergency situations and improve outcomes for their publics.

The report also identifies three areas which could benefit from additional research: (1) jurisdictional complications and their relation to weather forecasting and emergency response; (2) demographic trends in the Atlantic region, and (3) warning fatigue. The breadth and variance of these challenges is analogous to the complexity of emergency management in dynamic environmental and social systems, and are relevant not only to hurricane response, but the broader EMO mandate.

Achieving acceptable outcomes for all stakeholders in dynamic, complex environments is invariably difficult, and can only be achieved by strong, highly-developed, adaptive and forward-looking institutions. Embracing contextual flux, and identifying and executing effective and appropriate reformative approaches is one critical way such institutions can be ensured, with all stakeholders standing to benefit. Refining the communication strategies possessed by EMOs in the Atlantic region represents a tangible and important step forward in the evolution of these institutions, and one that is necessitated by scientific projections.

1.0 Introduction

Hurricanes and tropical storms are major meteorological events that threaten coastal areas in North America each year. Although the majority of these storms impact Caribbean countries and the United States, hurricanes and tropical storms have often had a significant impact in Atlantic Canada, endangering the public and creating substantial private and public loss. Hurricanes and tropical storms have impacted the four provinces in the Atlantic region substantially, with 21 storms causing 21 fatalities and more than $274 million in damage since 1970 (Canadian Disaster Database, 2017).

Hurricane frequency and strength will likely change as a result of climate change (Bender et al., 2010), affecting the potential for impacts to the Atlantic region. Shifting prevalence of these storms places a greater emphasis on the importance of effective hurricane forecasting, emergency management effectiveness, impact mitigation, and communication efficiency.

Hurricane risk management is a key responsibility of Emergency Management Organizations (EMOs) in the region. EMOs have evolved to incorporate contemporary emergency management strategies and institutionalize learning experiences with the wider goal of improving the effectiveness and efficiency of the emergency response. For emergency management to maximize effectiveness in an era characterized by increased hurricane risk, evolution and continual refinement of the communication strategies employed by EMOs is of paramount importance. Hurricane warning systems have significantly reduced hurricane-related fatalities by allowing forecasters to evaluate risks with greater precision thereby improving the response capacity of emergency managers (Lazo et al., 2010). While the meteorology underlying hurricane forecasting has been widely studied, the communication strategies used between the various actors participating in hurricane warnings have not received the same level of attention (Anthony et al., 2014). Two main issues are associated with warning communication between forecasters, emergency managers, and broadcast meteorologists: (1) tensions surrounding accuracy and timeliness of information dissemination, and (2) tensions surrounding information access and attribution (Anthony et al., 2014).

Clear and efficient communication lines are necessary to ensure public safety when responding to the imminent threat of a storm (Lindell et al., 2011). Initial hurricane warning systems, first implemented in the United States, were designed linearly, where information would be transmitted by forecasters to emergency managers, and then forwarded to broadcast meteorologists (Anthony et al., 2014). Owing to the emergence and ubiquitousness of new communication technologies (i.e. smartphones) and platforms (i.e. social media), and the presence of a larger number of stakeholders now involved in public warning systems (Gladwin et al., 2007), emergency communication has evolved dramatically in recent years. This transformation highlights the importance of inter-organizational collaboration. While nonlinear communication has the potential to increase the dissemination of hurricane risk information (via expedited information transmission), the multiplicity of actors and the singularity of their focus in response can affect information flow and therefore the quality of the response (Anthony et al., 2014).

Given the multiplicity of actors and the number of communication channels involved in the hurricane warning process, further research is needed to examine how communication around hurricane risk can be optimized.

The road through Trouty, Newfoundland and Labrador seen on September 24, 2010 was washed away by a raging river flooded by Hurricane Igor. More than two months after hurricane Igor slammed into eastern Newfoundland, the rebuilding effort continued.

[THE CANADIAN PRESS/Andrew Vaughan]

While modern technologies have made it possible to transmit hurricane warnings with greater precision, issuing alerts and response directives remains a highly challenging task under dynamic and threatening meteorological conditions. In these contexts, maximizing the response potential of emergency managers by enhancing the quality and efficiency of communication channels becomes crucial.

This research is conducted with this outcome in mind. This study seeks to enhance communication channels of the regions EMOs by (1) characterizing contemporary emergency management communication strategies, and (2) offer suggestions to refine existing emergency communication strategies in order to maximize their potential capacity to mitigate hurricane (and tropical storm) related threats. The research also (3) investigates the potential for establishing a direct line of communication between the Canadian Hurricane Centre and the Canadian insurance industry, with the intention of identifying potential pathways to optimize communication strategies in order to reduce human loss, (public and private) economic loss, and improve outcomes for the general public. To achieve these research objectives, the study conducts eight interviews with individuals involved in the emergency management process, and surveys the Canadian insurance industry.

Together, the research objectives listed above will identify areas in which the emergency management communication system employed in the Atlantic region can be refined. The outputs of this research will help ensure timely, efficient and effective hurricanes management processes, ultimately improving climate change resiliency in Atlantic Canada.

2.0 Methodological approach

Achieving the three goals of this research requires a mixed-method approach. The information sources, collection methods, and analytical processes used to answer the three discrete, but related, questions at the centre of the research are outlined in this section. The method section also includes an explanation and justification for the geographical scope of the study.

Western University granted ethics approval for this study in March 2016.

2.1 Geographical scope

While all Atlantic Canada provinces have experienced hurricanes or post-tropical storms, this study focuses on provincial and municipal emergency management agencies in Nova Scotia and New Brunswick. The Town of Sackville, the Halifax Regional Municipality, and the Municipality of the District of Guysborough were selected as municipal representatives, as these entities theoretically have contrasting views originated to differences in size, provincial context, resource availability, stakeholder network complexity, and proximity to the Canadian Hurricane Centre.

2.2 Characterizing contemporary communication systems employed by municipal and regional EMOs

Eight semi-structured interviews were conducted with government officials in order to inform the characterization of EMO communication strategies and provide a detailed basis for comments regarding its refinement. The interviews were conducted with representatives from federal (CHC), provincial (NBEMO and NSEMO), and municipal (Town of Sackville, Halifax Regional Municipality, Municipality of the District of Guysborough) levels of government.

2.2.1 Recruitment of participants

Recruitment emails were sent to key informants at the Canadian Hurricane Centre, the New Brunswick Emergency Measures Organization and the Nova Scotia Emergency Management Office, and emergency managers in the Town of Sackville, the Halifax Regional Municipality, and the Municipality of the District of Guysborough. All organizations agreed to participate.

2.2.2 Interviews

Five of the semi-structured interviews were conducted in person, and three of the interviews (MEM4, MEM5, PEM6) were completed by email. Interviews were composed of open-ended questions, and were supplied to participants in advance of the interviews.

The interview with a federal employee, a staff member of the Canadian Hurricane Centre (CHC), is distinct in that this representative's responsibilities include hurricane forecasting, releasing weather bulletins, and forecast interpretation training, but not emergency management per se. However, as forecast communication is an integral component of emergency management, including these perspectives vis-à-vis emergency communication is of critical importance and provides insight into the entirety of the emergency communication chain.

The remaining six interviews were conducted with emergency management officials at the provincial and municipal level whose portfolio of responsibilities include communication and collaboration with internal and external stakeholders. Interview questions sought to examine the participant's perceptions of communicative experiences as warning product end-users, to characterize the type of communication model employed, and to provide a platform for emergency management professionals to offer assessments of the perceived strengths and weaknesses of the communication system.

2.2.3 Data analysis

In-person interviews were recorded and transcribed to facilitate analysis. All interviews (i.e. in-person and email) were coded with Atlas.ti, a qualitative coding software package, to analyse patterns and trends across interviews, identify themes, and identify possible inconsistencies. Interviews were coded inductively, and assigned codes were reviewed twice to ensure accuracy.

2.3 Investigating the potential for a direct line of communication between the CHC and the Canadian insurance industry

To investigate the potential for establishing a direct line of communication between the Canadian Hurricane Centre and the Canadian insurance industry, an online survey was provided to members of the Canadian insurance community. The survey was designed to examine (1) how insurers gather information on upcoming hurricanes and (2) assess the possibility of implementing direct communication lines between the Canadian Hurricane Centre and the insurance community.

2.3.1. Recruitment of participants and survey dissemination

The online survey was shared by leveraging previously established relationships with members of theInstitute for Catastrophic Loss Reduction's (ICLR) Insurance Advisory Committee and the Atlantic Division of the Insurance Bureau of Canada. Representatives from both large and small insurance companies completed the survey and the respondents represented over 58% of the market share for home insurance in Atlantic Canada (MSA, 2016).

A boy carves a piece of wood in Prospect, N.S. on Thursday, Oct. 2, 2003. A fishing boat rests on the shore tossed by the waves and wind during Hurricane Juan. Fishermen along the Nova scotia coast are facing an uncertain future after the storm which devastated the area.

[CP PHOTO/Andrew Vaughan]

2.3.2 Survey design

The survey was composed of both close-ended and open-ended questions. The close-ended questions included both yes/no and multiple-choice questions. The questions were designed to get a better understanding of how hurricane risk information is shared within companies and with policyholders both before and after a severe storm. The questions also aimed to identify the information needs of insurance companies to facilitate their involvement in the response process.

2.3.3 Data analysis

Participant responses are summarized in aggregate and expressed as percentages. Expressing the results in this manner allows for comparison across question and subject types.

3.0 Hurricane warning structure in Atlantic Canada

Hurricane warnings for Atlantic Canada are generated through meteorological data collected by the U.S. National Hurricane Center and the Canadian Hurricane Centre. Warnings are then communicated by the CHC and interpreted through interactions with various stakeholders, including provincial and municipal emergency managers. Although other partners, such as broadcast media, are an important part of the hurricane warning dissemination process, this section will focus on the role and responsibilities of the three levels of government in the hurricane warning process. It also examines how Canadian insurance companies currently communicate with their policyholders to warn them of upcoming storms.

3.1 The U.S. National Hurricane Center

The World Meteorological Organisation (WMO) is the United Nations agency that facilitates the exchange of meteorological information across national borders (WMO, 2016). The WMO is composed of seven regions that have their own regional specialized meteorological centres. The U.S. National Hurricane Center (NHC) is in charge of monitoring tropical meteorology in the Atlantic and Eastern Pacific oceans on a full-time basis. When a hurricane forms in the Atlantic or Eastern Pacific, forecasters at the NHC attribute meteorological characteristics to the storm by analyzing and synchronizing information coming from a variety of sources. This analysis allows them to express the hydrometeorological threat that the storm poses at regional and larger scales (Lindell et al., 2007; Morss and Ralph, 2007; Heinselman et al., 2012; Demuth et al., 2012). As the situation evolves and hurricane risk information becomes more precise, the NHC updates its hurricane warnings, which include information such as the track forecast and wind speed probabilities.

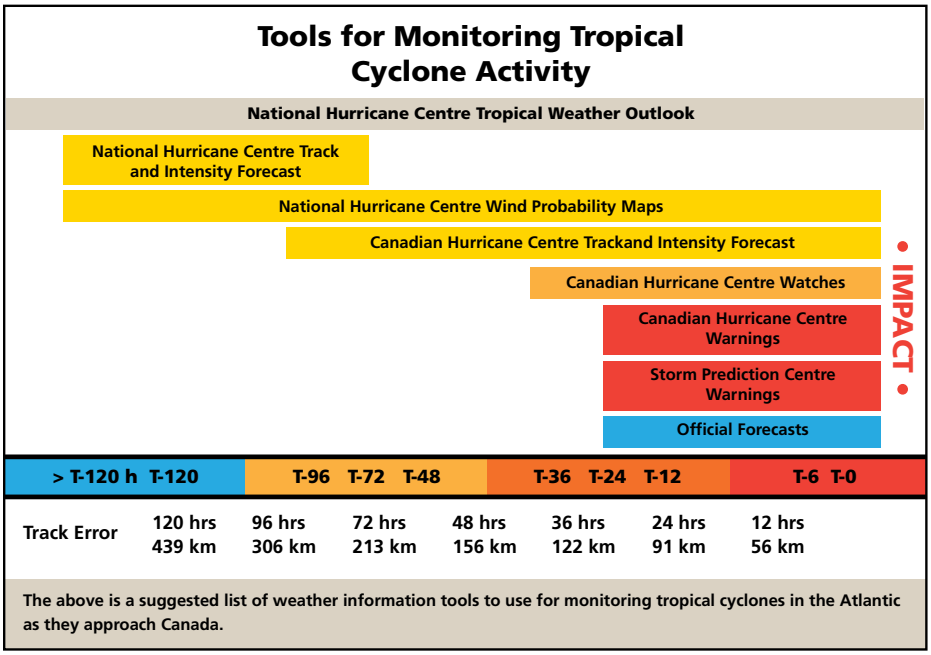
While the NHC has international obligations, it is primarily responsible for issuing watches and warnings for the United States. This specific task necessitates a strong collaboration with the Canadian Hurricane Centre, with whom the NHC shares a response zone boundary.

3.2 The Canadian Hurricane Centre

The Canadian Hurricane Centre is a federal entity operating under the Ministry of Environment and Climate Change, as a division of the Meteorological Service of Canada. Its core mission is to protect Canadians from the threat of hurricanes and tropical storms by warning the population of upcoming risks. The CHC also provides guidance to weather centres of Canadian regions at risk of being affected by these storms (Environment Canada, 2004).

Although the CHC is responsible for monitoring the entire Atlantic Ocean, its response zone (i.e. zone where the CHC has jurisdiction) extends 150-200 miles off of Canada's coast. The CHC starts issuing track and intensity forecast bulletins 72 hours before a tropical cyclone is expected to enter the response zone. At that time, the bulletins are updated every six hours. Hurricane watches and warnings typically start to be issued 36 hours before a storm's predicted landfall, when confidence in the path forecast has increased. During that period, warning bulletins are created and disseminated every three hours (see Figure 1). Determining when and where a storm will make landfall generally becomes easier to predict 24 hours before landfall. While it is impossible to identify with certainty which specific municipalities will be affected by a storm 24 hours before landfall, the error circles on the predicted track map become narrower as landfall approaches, allowing identification of a more defined area at risk for emergency managers.

Figure 1: Monitoring of tropical cyclones by the National Hurricane Center and the Canadian Hurricane Centre



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Source : Canadian Hurricane Centre

The CHC produces hurricane watches and warnings, which are cross-referenced with NHC forecast outputs. As a storm progresses into the Canadian response zone, the CHC communicates with meteorologists at the NHC to discuss and update specific storm characteristics (i.e. exact position, predicted track, etc.). The information bulletins produced by the CHC are disseminated via EC Alert Me, a closed circuit emergency communication tool. These warning bulletins are currently shared with municipal and provincial emergency managers, although there are plans to make these bulletins more publicly available in the future. Notifications are sent to emergency managers every time a new updated bulletin is produced.

These warning bulletins are one part of the warning product package generated by the CHC. The second part of the package consists of live briefings given by CHC representatives. When a severe storm is approaching, the live briefing (a conference call or webinar briefing) will take place daily at 9:15 AM Atlantic time. Public Safety Canada and provincial emergency managers can attend remotely. The briefing is scheduled 15 minutes after the warning bulletin is released (9:00 AM) in order to allow emergency managers to review the bulletin, and formulate follow-up questions. Separate briefings can take place when emergency managers have specific concerns related to their jurisdiction. Other provincial departments that have a role in emergency management (i.e. communications departments, police and fire services, etc.) attend these briefings. Municipal emergency managers are also invited to attend and participate in this briefing.

In addition to informing the response personnel of upcoming risks specific to the storm at hand, these sessions allow the various stakeholders present to discuss specific concerns and vulnerabilities, and start creating strategies to mitigate impacts.

3.3 Municipal and provincial emergency management

Emergency managers at the municipal and provincial level share a similar mission as the Canadian Hurricane Centre: protecting Canadians from the threat of hurricanes and tropical storms. However, within the hurricane warning structure, the emergency managers' role is to translate the information coming out of the Canadian Hurricane Centre into targeted risk mitigation actions. As such, the emergency managers' assessment of the severity and likelihood of a storm directs how resources are allocated to reduce risk before landfall.

While both municipal and provincial emergency managers are responsible for orchestrating the implementation of risk reduction measures before a storm, provincial EMOs tend to play a bigger role in communicating hurricane risk with the public. When hurricane warnings are created by the CHC, provincial emergency managers are the first to review and interpret the information presented on the bulletins. When communicating with the public, provincial emergency managers rely largely on social media to disseminate information on upcoming storms.

3.4 The role of insurers

When it comes to communicating hurricane risk with their policyholders, practices in the Canadian insurance industry vary from one company to another. Indeed, various approaches are used to disseminate information on upcoming storms within the company and with policyholders at risk. When asked how information is shared within the company before a storm strikes, 60% of respondents (n=9) mentioned that multiple approaches were used internally to share hurricane risk information internally. More specifically, 67% (10 respondents) of the surveyed companies mentioned relying on informal sharing of information within the company, 47% (7 respondents) use a formal sharing process led by claims staff, and 40% (6 respondents) rely on a formal sharing process led by regional staff. Other respondents mentioned using a formal process led by corporate communications (1 respondent), a formal process led by claims and underwriting staff (1 respondent), and discussions with non-claim stakeholders and vendors (1 respondent).

Although several respondents mentioned having a formal communication plan in place to disseminate hurricane risk information within their companies before the storm, few mentioned having a formal approach in place to share information with their policyholders before the storm. More specifically, 27% (4 respondents) confirmed they had a formal communication plan in place while 40% (6 respondents) mentioned they were informally sharing information with policyholders and 27% (4 respondents) indicated they were relying on intermediaries to communicate with their policyholders before a severe storm strikes. In addition, one respondent indicated that information on impending storms was not shared with policyholders and two respondents mentioned that information on upcoming storms was only shared occasionally, via email or through the company's website.

Canadian insurance companies are not currently part of the formal hurricane warning process used by the CHC and emergency managers. The information gathered through the insurance industry survey indicates that only a few companies have standard operating procedures in place to communicate with policyholders at risk before a storm strikes. Implementing a direct communication line between insurance companies and their policyholders could reinforce the dissemination of hurricane warnings among homeowners at risk. This potential is examined in Section 4.2.1.

4.0 Key findings and recommendations

The interviews with government representatives at the federal, provincial, and local levels provided critical insight into the status, style, and approaches used in hurricane mitigation, preparedness, response, and recovery in Atlantic Canada. Although the various spheres of government each possess their respective challenges, barriers, and factors complicating governance, this section outlines four recommendations that are broadly relevant. The recommendations (noted and explained in section 4.1 address various themes and factors through interview analysis, and have the potential to incrementally and meaningfully enhance the emergency management community's capacity for hurricane impact mitigation.

Section 4.2 presents two recommendations focusing on the role of the insurance industry in hurricane planning, response, and communication. These two recommendations hold the potential to improve hurricane planning and response plans, and to facilitate the tasks of various levels of government. Additionally, through these pathways, these recommendations could lead to stronger communication, and information dissemination with the public and improved emergency management outcomes.

The current emergency management approach employed in the various spheres of government in Atlantic Canada is well-developed, refined through personal and institutional experiences, and maximizes the benefit from strong working relationships and communication both within and between institutions. In the Halifax region specifically, the geographical proximity of various emergency management organizations and weather forecasters has promoted cooperation and collaboration. The current paradigm is also expansive and comprehensive, and includes the private sector (i.e. telecommunications companies) and utilities, with information disseminated to the public in various ways. Thus, the six recommendations do not propose to reform the fundamental characteristics of the established system, but seek to identify channels and areas in the current emergency management framework that could be further developed.

4.1 Potential avenues for reform in the governmental hurricane response complex

The four recommendations for government agencies are:

(1) provincial and local governments should consider mandating compulsory training in the CHC's severe hurricane interpretation course;

(2) the emergency management at the municipal level should be expanded to support all phases of emergency management;

(3) EMOs should heighten, develop, and expand sources of institutional memory; and

(4) the warning structure should be changed from a hazard-based analysis to a risk-based/impact-based analysis.

These recommendations represent tangible, measurable, and achievable options for tailoring the emergency management and response strategies for both the warning and insurance communities. Further elaboration of these recommendations is provided below.

Table 1: Interview Participant Codes

Acronym	Stakeholder
CHC Rep	Canadian Hurricane Centre Representative
MEM1	Municipal Emergency Manager 1
MEM2	Municipal Emergency Manager 2
MEM3	Municipal Emergency Manager 3
MEM4	Municipal Emergency Manager 4
PEM1	Provincial Emergency Manager 1
PEM2	Provincial Emergency Manager 2
PEM3	Provincial Emergency Manager 3
PEM4	Provincial Emergency Manager 4
PEM5	Provincial Emergency Manager 5
PEM6	Provincial Emergency Manager 6

4.1.1 Provincial and local governments should consider mandating compulsory training in severe hurricane interpretation

Hurricane forecasts, and severe weather forecasts more broadly, are sophisticated communiqués. Contemporary forecasts, according to the Canadian Hurricane Centre, include several storm parameters and characteristics, including projected path, rainfall and wind speed, pressure, and storm surge. Some of these characteristics are communicated in relatable, intuitive units (i.e. wind speed, rainfall amounts), familiar even to those lacking a background in meteorology and forecasting science. However, other storm characteristics, most notably pressure and storm surge, are critical hurricane characteristics that influence response, and disaster planning, but are presented in units unfamiliar to those without a strong background in weather forecast interpretation. Additionally, these characteristics do not lend themselves to frame of reference comparisons with other storms, either recent or historically noteworthy.

Emergency management professionals may lack the experience and background to both understand these forecast parameters and place them into current and historical context. The skill set required for effective management of emergency situations is primarily experience and expertise in planning for, and responding to, such situations. This skill set, obviously of critical importance in the context of severe hurricane planning and response, is most often developed through experience in law enforcement, communications, fire response, or emergency medical care. In these vocations, individuals are unlikely to acquire a detailed understanding of storm parameters, and forecast interpretation. However, severe hurricane planning and response requires emergency management professionals to be able to interpret forecasts quickly and accurately in order to rapidly assess threats, vulnerabilities, and action strategies in their jurisdiction.

In the current emergency management paradigm, emergency response professionals rely on the expertise of the Canadian Hurricane Centre and its weather forecasting experts for forecasting information to guide their hurricane response planning. The forecasts provided by the CHC are data rich, and are accompanied by formulaic plain-language summaries. However, emergency management professionals may not have the background to completely assimilate the breadth of data supplied in detailed CHC forecasts. Although clarification is available through well-established lines of communication and relationships between provincial governments and the CHC, and municipal governments and provincial governments, seeking clarification on weather forecasts may prove time-consuming. Delays in obtaining clarification may be significant, especially when severe hurricanes are imminent and federal meteorologists have an expanded portfolio of duties. Thus, improving the ability of emergency response personnel to understand and interpret CHC hurricane forecasts is of critical importance. For example, according to one emergency manager:

> *[MEM1]: I'll focus less on information I don't understand… If I don't know what the meaning is, then I won't bother. If it's charts I can't read, I ignore. I believe the Canadian Hurricane Centre or Environment Canada, through [CHC representative], has a one or two day weather interpretation course. I'd like to get all my people trained in that, but I just haven't got them trained in it yet. But if you can teach me, and a lot of other people how to read a weather chart so that I can, if nothing else, interpret what I see, then I'll make better use of it. Same with now, if you don't understand it you're going to glance over it, you could glance over something important.*

The importance of EMO officials having the ability to interpret complex weather forecasts has been noticed and addressed by the CHC. Warning Preparedness Meteorologists offer weather interpretation courses to emergency management personnel at the provincial and municipal level interested in improving their preparedness for hurricanes.

The course, currently offered and run by the CHC, runs 1-3 times a year. Emergency management professionals from the four Atlantic provinces have attended the two-day course, and all individuals interviewed who had taken the course spoke positively about the experience, indicating the course had improved their technical understanding of hurricane forecasts. An exchange demonstrating this sentiment is noted below.

> *[PEM2]: …[CHC rep] also has the weather interpretation course, and we have all sorts of other opportunities where [CHC representative] will come in and give a spiel on the science and how it works, and so on. But the course is, it's a pretty intensive course. Is it two or three days?*
>
> *[PEM3]: Two.*
>
> *[PEM1]: It's not a fluff course. It's technical, and you have to pay attention and work at it, or you're not going to make the grade.*
>
> *[PEM2]: So he puts a lot of that information out there, so we're at a point now, over the years, folks really understand, or are getting better at understanding what it is that he puts out there. It's handy information to have, for sure.*
>
> *INT: You find that kind of information, and being able to understanding quickly helps?*
>
> *[PEM2]: Absolutely.*

High winds from Igor toppled trees on Whiteway Street in St. John's, Nfld., Tuesday Sept. 21, 2010. Hurricane Igor ripped across eastern Newfoundland on Tuesday with a savagery that forced flooded, wind-battered towns to declare states of emergency, isolating some communities as rivers overflowed and roads washed away.

[THE CANADIAN PRESS/ Paul Daly]

[PEM1]: When we look at pressure variables, we look at those types of things, then we start understanding what that is going to be on a comparative basis to other storms. And that's helpful for us. And he may have something that is a relatively compact storm, and it has a very low pressure, what does that mean? So if we're not understanding that, we just ask [CHC rep], and then we have that interpretation, and this is what it means, about the eye, and then the speed, and the external speed, if there are other weather systems. You know, the complexities of that, and none of us are junior meteorologists in training or anything. But having that understanding is absolutely critical so we can get contexts that are comparative to understand more of the potential impacts.

Currently, participation in the course is optional. Although the professionals interviewed who had taken the course and felt it was worth the time investment, some emergency management professionals had not taken the course, despite an interest in the material, benefits, and clear relevance to their roles. These individuals cited a lack of available time for participation.

[MEM1]: They definitely want to have the weather interpretation course. What I want to be able to do is, again, A, from their point, they need to do less to get me to understand, so that if I can understand their symbology that means they don't have to translate it... If [CHC Rep] has to change everything he's got into a language that my people can understand, that requires that to happen. If I can teach my people to read his language, it's much better.

INT: Is it difficult to get access to the training?

[MEM1]: ...there is only so many hours in a day. And this is one of the things I want to do, but I haven't done. But what I'd like to do is get all my people in here trained for that. Get all of my volunteer groups trained for the same thing.

The CHC weather interpretation course covers material that is relevant to the mandate of emergency management organizations, and overlaps considerably with the job descriptions of individuals comprising these organizations. For these reasons, and given that emergency response professionals may not have a background that includes detailed knowledge of weather systems, parameters and meteorology, shifting the course from optional participation to required participation for those in positions involving forecast assimilation should be considered.

However, restricted time and resource availability will likely continue to characterize public services mandated to manage weather-related emergency situations. As such, if the weather interpretation course is to be made mandatory, perhaps course delivery options could be tailored to accommodate emergency management professionals unable to allocate the time required to attend in person.

Course delivery could be tailored to allow remote attendance or course consumption. Future course deliveries could be streamed live or recorded for future viewing. Additionally, the assessments included in the course could be reformatted and provided through an on-demand web-based program. Live streaming programs and web-based questionnaires are available either for free or for a nominal charge.

Recording classroom-based course material could also allow for emergency management officials to review and revisit material at the availability, or revisit complex concepts in advance of hurricane season.

In addition, an expedited, half-day course focusing on advanced material in a compressed manner (again, available in multiple formats) could help serve as a refresher for emergency management professionals who have already completed the course.

The weather interpretation course offers the potential to improve weather forecast comprehension, and related response and communication times related to severe weather. Changing the course from optional to required for appropriate individuals would require minor changes on the attending institutions and for the course organizers. Expanding the course delivery platforms would require resource investment by the CHC, but this would likely be minimal considering course material has already been developed.

4.1.2 Emergency management practices at the municipal level should be expanded to support all phases of emergency management

The municipal emergency managers interviewed generally characterized the role of their organizations with respect to hurricanes as primarily focused on emergency response, and supporting the emergency management efforts of EMOs at higher levels of government (i.e. regional, provincial). More precisely, emergency managers at the municipal level act primarily as coordinators and sources of information, knowledge and context with respect to municipal concerns and vulnerabilities.

The emphasis placed on emergency response by these individuals and organizations is of critical relevance, and improves the rate at which the risk from hurricanes and emergency situations can be mitigated. However, this interpretation of the role of municipalities in emergency management, particularly with respect to hurricane management, is focused predominantly on one phase of emergency management, the 'response' phase.

Widening the scope and purview of these municipalities to create greater integration of the other phases of emergency management would help reduce the overall risk posed by hurricanes to municipalities. Greater emphasis on risk and vulnerability mitigation would strengthen resilience to hurricane impacts.

Improved participation in the preparedness of members of the public would also improve overall outcomes. Municipalities are well-positioned to provide risk reduction advice on individual preparedness and emergency preparation, as they can effectively target areas and infrastructure known to be vulnerable, and may have established relationships in these areas. Municipal bodies are the scale of government best suited to engage in this type of hurricane risk reduction, and to provide accurate information and support in a timely manner.

Finally, municipal governments could also solidify their role in the recovery phase. Coordinating volunteer clean-up efforts could improve the speed of recovery and could free up municipal resources to be assigned for other tasks.

Expanding the role of municipal emergency managers beyond response to include the mitigation, preparation, and recovery phases of emergency management and planning to a greater extent would improve the comprehensiveness of the emergency management plans employed at the municipal level. By having fine-scale knowledge of local vulnerabilities and related risk, municipalities are well-positioned to act as key institutions in the emergency management process. As the risk of loss and damage from hurricanes is expected to increase as a result of climate change (Bender et al., 2010), municipalities will increasingly be key institutions in the attempt to mitigate the risk and impacts of hurricanes.

4.1.3 EMOs should heighten, develop and expand sources of institutional memory

The uncertainty that characterizes hurricanes, with respect to strength, landfall, rainfall, wind strength, speed, path, etc., dramatically complicates the task of emergency managers and emergency management organizations when preparing for, and responding to, hurricanes. These uncertainties often result in storms that create unique challenges and experiences for emergency managers and emergency management organizations. The combination of emergency response backgrounds possessed by emergency management professionals, the experience gained through planning for and responding to numerous storms, often carrying unique contexts or challenges, creates skill sets that are increasingly developed and refined over time.

These types of experiences and skill sets are critically important for emergency managers and the organizations they represent. Effective emergency management requires informed, thoughtful decision-making that incorporates local context, storm context, and effective execution. Developing this combination of competencies often takes many years, and is difficult to replace.

In the interviews, emergency managers referred to four hurricanes (Arthur, Bill, Juan, Sandy) three different emergency events (Calgary floods, Fort McMurray fire, Slave Lake fire) and several major snow events. Emergency managers often recounted how various scenarios, planning strategies or the responses required were unique to these particular events, and detailed the lessons learned and processes refined from these experiences.

[CP PHOTO/Charlottetown Guardian/Brian McInnis]

A Maritime Electric lineman inspects a jumble of power cables and poles on a Charlottetown street Monday September 29, 2003 in the aftermath of Hurricane Juan. Winds downed trees and power lines in the province's capital. At least 10 boats at a Charlottetown yacht club were sunk.

Interview questions directly asked interviewees about their experiences during Hurricane Juan. The storm, a Category 2 hurricane when it made landfall, is a critical example of the threat hurricanes pose to the Atlantic region. The hurricane resulted in $174 million (adjusted for 2017)(Insurance Bureau of Canada, 2017) of damage, destroyed 100 million trees, and resulted in eight fatalities (Fogarty, 2003). The storm remains one of the most costly weather events in the history of Atlantic Canada (CBC, 2012). Comments made by a representative from the CHC confirmed that formal changes were made to the organization's communication and warning structure:

> *CHC rep: So what they have in the US and in the Caribbean, is that they issue tropical storm or hurricane watches or warnings. We didn't have that when we got Hurricane Juan back in 2003. All we had at our disposal for issuing warnings was our wind warning, and our heavy rainfall warning, and our storm surge warning if the storm was going to produce storm surge.*
>
> *After Juan, Juan hit on the Sunday night after a nice sunny weekend, it was nice and warm, people were out enjoying the weather, the last weekend of September, and they weren't really paying attention to the weather forecast of an approaching hurricane. So one of the things that came out after Juan was if people heard the words 'hurricane warning' maybe they would have reacted a bit differently. So we said, 'ok, this is what we'll do. We'll start issuing hurricane watches and warnings and tropical storm watches and warnings'. So in addition to our wind warning and our heavy rainfall warnings, we can now use hurricane warnings or tropical storm warnings, depending on the storm that is approaching. So that was a big change for us, after Juan, is the language part of what happened there.*
>
> *Another change was in the structure of these briefings. Where this all kind of starts to gel together was after 2009 with Hurricane Bill, what had happened is that, as the Warning Preparedness Meteorologist... I got a call from EMO Nova Scotia wanting to set up a briefing. We didn't have these set times, so they called me saying they wanted a briefing. So I said, 'sure, what time do you want it. 9 o'clock, 930?', so they said, 'ok we'll set it up'. It wasn't a webinar, it was just a phone call.*

However, despite the historical and economic significance of Hurricane Juan, only two emergency management professionals could comment on institutional changes that occurred as a result of Juan. There are two possible explanations for this: either no significant institutional changes occurred, or the changes were implemented and installed, and their supporting rationale and learning outcomes from that storm were lost when the emergency managers that installed such changes left their respective organizations.

Losing employees, through retirement or otherwise, with this combination of experiences and skill sets represents a critical loss of institutional memory that emergency organizations depend on for effective, expedited emergency response. The current emergency management system employed in the Atlantic region does not currently include a formal system to maximize the retention of the considerable experiences gained by emergency management individuals and teams. Intellectual capital is lost as employees retire or leave their post. Although some loss of institutional memory and intellectual capital is unavoidable, EMOs would benefit from retaining as much of this information as possible.

Retaining the rational and learning outcomes driving reform through a formal system could improve the retention of intellectual capital and institutional knowledge. This information could provide another source of information to inform storm preparation strategies. Documented learning outcomes and policy changes could smooth the introduction process for new hires, and serve as an important tool to provide important context and summarize challenges, strategies and outcomes from previous storms.

Detailed information and note keeping would require time and resources. Such a process may be prevented by the natural inertia of hurricane response efforts, in that post-storm periods are often very busy and may not allow time for reflection, until the complete storm experience has passed. However, finding time when response and recovery has been completed to denote key experiences and strategy refinements would help retain institutional capacity and memory and intellectual capital, benefiting current and future emergency response professionals and emergency management outcomes. In particular, it is recommend that a series of case studies be prepared. These reports would seek to document the meteorology, impact, and lessons learned from each of the major hurricanes that have affected Atlantic Canada over the past 30 or 40 years.

4.1.4 Changing the warning structure from a hazard-based analysis to a risk-based and impact-based analysis

Currently, hurricane forecasting and forecasts employ methods and units relevant to forecasting science. This language, and its effectiveness, is partially examined in part in 4.1.2, but this analysis is focused on the technical complexity of forecasting language; it is also recommended that the fundamental style of forecasting language should change from its current hazard-based format to a style that directly communicates hurricane-associated risk.

The CHC provides hurricane forecasts in a similar manner to that of other storms, and all weather more broadly. Forecasts are provided in a hazard-based format: forecasts provide projections on storm path, path, wind speed, rain, storm surge, pressure, and other relevance parameters. However, emergency management professionals, by the nature of their work, are primarily concerned with storm-related impacts and risk to the public. Thus, the hazard-based nature of current storm forecasting provides information that, while incredibly useful and a critical information source, is provided in units that preclude easy translation to storm impact.

Thus, hurricane forecasts, in addition to their current format, should include risk and impact factors/ indexes. This change in language would shift communication towards the potential risk faced by the communities on the storm path (e.g. "This is a life threatening storm") as opposed to focusing exclusively on the characteristics of the storm itself and leaving impact and risk inference completely on the onus of emergency management professionals.

Although this recommendation could be interpreted as a substantial shift in communication strategy, generating risk and impact indexes may not be overly complex. Current forecasting products, or even discrete storm parameters (path, track, wind, rain, storm surge) could be overlaid with a set of risk/impact factors such as critical infrastructure (power plants, telecommunications infrastructure, transportation arterials, population centres, number of affected individuals). Factoring in the probability of impacts (similar to a probability of precipitation) would also be required, and outputs from this type of communication tool could help inform decisions related to resource allocation.

Further communication reform could make theoretical hurricane impacts and risk increasingly tangible, and that an impact/risk index would enable more detailed storm comparisons, and heightened experience referencing, for emergency management professionals. An emergency manager mentioned that this type of historical comparison frequently takes place, and is used to inform practice in real time. The example provided was a 'Groundhog Day storm surge', where the surge essentially reached the threshold where a surge any more significant would cause significant damage.

> *[PEM1]: When we look at pressure variables, we look at those types of things, then we start understanding what that is going to be on a comparative basis to other storms. And that's helpful for us.*

> *[PEM 2]: ...And he will generally put in historical data within the weather report. So storm surge, for instance. We always sort of base it on the Groundhog Day storm from 1976. That was the benchmark, because it was the most recent one that was really bad. So a lot of the storm surge can be compared. So here's the line from the Groundhog Day storm, and here's what we're going to be today, which is always good news, because it's always so far below that. So that's always good information to have, to have that comparison. And [CHC rep] embeds that right into his reports most of the time.*

This type of intuitive comparison makes the role of emergency managers much easier, and also speaks to the value of intellectual capital, institutional memory, and the recommendation made in Section 4.1.3.

Including an impact factor index along with traditional storm forecasting metrics would promote intuitive comparisons between weather events not only for emergency managers, but for the public more broadly. This would facilitate comparisons, inform the storm preparation undertaken by the citizenry, and could reduce the possibility of 'Chicken Little syndrome' influencing decision-making at the individual level (although given the uncertainty inherently characterizing weather forecasting this would be impossible to remove entirely).

Still, the benefits of an index would likely bridge the language barrier and more clearly articulate the destructive potential of severe weather. This would carry benefits to both emergency managers and the general public, and would rely on weather forecasting methods and output, and information (with respect to risk) that is readily available.

The challenge of closing the gap between forecasting what the weather might be and understanding what the weather might do has been recognized by the World Meteorology Organisation. The 2015 WMO Guidelines on impact-based warnings provide specific advice. WMO describes enhanced warnings that include illustrations of potential impacts. It goes on to suggest a longer-term goal of forecasts based on impacts models. (WMO, 2015)

4.2 The Canadian insurance industry: Its role in warnings and response

The insurance industry provides the majority of the funds needed to finance the recovery of homeowners and businesses following a hurricane or other extreme weather events. Insurers have a vested interest in protecting Canadians and reducing the risk of loss from severe weather events. Canada's property and casualty insurance industry has incurred billions of dollars in insured losses in recent years. Between 2009 and 2016, insurers have paid over $14.2 billion in claims from events of $25M or higher to rebuild homes and businesses damaged by catastrophic events.

Insurers with market shares in Atlantic Canada are particularly concerned about potential damage from severe hurricanes or tropical storms. As such, most companies monitor storms and forecasts as major storms approach the Atlantic provinces. When a hurricane or post-tropical storm threatens Atlantic Canada, companies tend to use various strategies to communicate with their policyholders located in the areas at risk. While most of the insurance companies surveyed for this study confirmed that information about upcoming storms was shared with policyholders before they strike, only 26.67% mentioned having a formal hurricane warning communication plan in place.

4.2.1. Establishing a clear and direct communication line with the Canadian insurance industry

Research has demonstrated that when it comes to hurricane warnings, repetition increases belief, especially when various sources reinforce the same information and message without contradiction or ambiguity (Gladwin et al., 2009). Considering that insurers have the ability to communicate directly with policyholders in at-risk areas, using insurance companies as an intermediary between the Canadian Hurricane Centre and the public could enhance the dissemination of hurricane warnings. In addition, transmitting first-hand information on upcoming storms to insurers could increase the response capacity of insurance companies in the immediate aftermath of a storm. Moreover, insurance companies may expand their role in communicating risk reduction knowledge and implementation. This may include promoting changes in building codes and offering financial incentives.

The hurricane warning bulletins that are currently being produced by the Canadian Hurricane Centre include physical characteristics of upcoming storms. They focus on information such as predicted track, wind speed, and predicted time of landfall. According to the survey results, the information currently available in Canadian Hurricane Centre's hurricane warnings bulletins is generally aligned with the information needs of the Canadian insurance industry. When surveyed on the type of information they were seeking before a storm, respondents indicated the following:

Table 2: Warning information of interest to insurance companies

Percentage of respondents	Number of respondents	Type of information surveyed by the company
83%	19	Forecasted track
83%	19	Expected rainfall amount and accumulations
70%	16	Peak wind speed
57%	13	Expected rainfall intensities
39%	9	Predicted storm surge

Most of the information that insurance companies are looking for in a hurricane warning is presented in Canadian Hurricane Centre's bulletins. However, it appears that companies currently identify the media over the Canadian Hurricane Centre as their main source of information before a storm. More specifically, when asked what sources of information they use to secure information before a storm strikes, the surveyed insurers identified the following:

Table 3: Sources of information used by insurance companies to secure information before a storm

Percentage of respondents	Number of respondents	Type of information surveyed by the company
79%	15	Media
58%	11	Canadian Hurricane Centre
47%	9	Provincial governments
42%	8	Insurance Bureau of Canada
26%	5	Commercial Vendors
11%	2	Local governments
5%	1	Policyholders

In addition to the sources mentioned above, other respondents indicated they were using information from their own tracking centre, local vendors, accuweather.com, Environment Canada weather line, and Environment Canada National Weather Network.

It appears that Canadian insurers also rely on several sources to secure information following a severe storm. The survey indicated that the following sources of information were used to secure information following a severe storm:

Table 4: Sources of information used by insurance companies to secure information after a severe storm

Percentage of respondents	Number of respondents	Type of information surveyed by the company
80%	12	Media
67%	10	Insurance Bureau of Canada
60%	9	Canadian Hurricane Centre
53%	8	Provincial governments
47%	7	Policyholders
33%	5	Commercial Vendors
27%	4	Local Governments

Moreover, 20% of respondents indicated using other sources such as social media or their companies' own data.

In addition to demonstrating that the media is the main source of information used by insurance companies prior to and following a severe storm, this data also highlights that a mean of 3 sources are used by each of the companies to secure information on major storms before they strike. This number rises to a mean of 4 sources used to access information following severe storms. The multiplicity of sources used by insurers to secure information on severe storms increases the likelihood of being faced with conflicting information. In addition, a larger number of sources implies that a greater amount of time is needed to collect crucial and timely data about severe storms, taking away from the time that could be used to communicate with policyholders in at-risk areas prior to the storm, and assist with response following the storm.

Each spring, since 2009, the Canadian Hurricane Centre has partnered with the Institute for Catastrophic Loss Reduction to provide a workshop for the Canadian insurance industry to review storm activity during the previous year and set out expectations for the current hurricane season. The Warning Preparedness Meteorologist interviewed for this research emphasized the desire of the Canadian Hurricane Centre to continually improve hurricane risk communication with its partners and with the public. While Warning Preparedness Meteorologists have frequent opportunities to interact with provincial and municipal emergency managers as well as representatives from the media, they rarely have the chance to exchange information with members of the Canadian insurance industry. As such, it is recommended that a formal communication channel be established between the Canadian Hurricane Centre and insurers in Atlantic Canada in order to facilitate communication of warnings related to severe storms. This communication could take the form of a short 'hurricane warning bulletin' that is specifically tailored towards the information needs of the insurance industry.

Establishing these informational needs, and determining how they differ from the information required by the established warning community, would be a primary step in creating a useful product. The results of the industry survey presented here offer a framework that could guide the development of this type of warning product, and more broadly, a communication channel between the CHC and insurance industry.

While insurers are interested in some of the information currently presented in the hurricane warnings shared with provincial and municipal emergency managers, the warnings directed to the insurance community would benefit from a reoriented focus. For instance, Canadian insurers might not benefit as much from receiving information related to predicted storm surge as this hazard is not currently covered for Canadian homeowners.

4.2.2. Focusing on a risk-based analysis when communicating with the insurance industry

The survey completed by insurance industry representatives indicates that insurers are keen to secure information that would help them understand the various levels of risk faced by their policyholders across specific geographic areas. Therefore, this report recommends integrating a risk-based analysis into hurricane warnings shared with the Canadian insurance industry.

Hurricane warnings are not broadly standardized, and can vary between countries. While some use warnings focused on the physical characteristics of a storm, others, such as the National Severe Weather Warning Service in the United Kingdom, integrate a risk-based approach by aiming to communicate the uncertainty and the likelihood of a severe hurricane affecting communities at risk (Neal et al, 2013). The latter approach incorporates a probabilistic component to warnings, which allows forecasters to gradually adjust the likelihood of a high impact storm as confidence in the event evolves (Neal et al., 2013). Information on hurricanes is generated, communicated, and interpreted through complex interactions among several actors (Demuth et al, 2012). Often, the information communicated in hurricane warnings necessitates a certain level of knowledge of weather to be fully understood. Considering that not all insurance companies have staff with the experience necessary to interpret meteorological information related to hurricane warnings, the information communicated by the Canadian Hurricane Centre to insurance companies would benefit from employing a risk-based approach, focusing on identifying the probability of certain at-risk areas to be affected by severe hurricanes or post-tropical storms.

When asked what information they would like to get before a storm strikes that is not currently available, insurers identified a few items. First of all, one respondent highlighted the importance of the precision of the forecast for both location and intensity, as it is instrumental in advising at-risk policyholders on risk mitigation measures. Others suggested including a brief history of recent storms in hurricane warnings and providing the population densities of communities located on the predicted storm path. These findings reinforce the desire of insurers to receive hurricane warnings that include a risk-based analysis.

The insurers surveyed for the purpose of this study also mentioned areas where more information would be welcome following a severe storm. More specifically, respondents indicated their interest in precise information on the affected locations as well as the extent of damages in these areas. This would include information on the intensity of the storm in the affected area. Obtaining this data would allow insurance companies to prioritize and better allocate resources to the claims response process.

5.0 Avenues for future research

The interviews conducted for this study, while primarily focusing on hurricane response and emergency management, also uncovered outstanding issues that, while beyond the scope of the present study, may represent potential options for future research into emergency management in Atlantic Canada. Three areas where future research could be directed are noted below.

5.1 Exploring inter-provincial and inter-regional communications and boundaries

Two interviewees identified jurisdictional boundaries as a complicating factor. The Nova Scotia-New Brunswick border, located on the Chignecto Isthmus, is an example of how jurisdictional boundaries can influence emergency management in practice. The Tantramar Marsh region, noted by municipal and regional EMO representatives in New Brunswick as being particularly challenging to deal with from an emergency management point of view, straddles the NS-NB border. Due to this border bisection, the Tantramar Marsh area does not receive a specific forecast, even though its weather conditions can vary substantially from those experienced in nearby towns on either side of the border.

> *[PEM5]: And one of those that I can point to is that we have, and you drove through it, the Tantramar marsh area, just on the border between Sackville and Amherst, has its own mini climate. And now I'm getting very specific, but when we talk about pixels, which is how computer models generate weather patterns. We've been pushing for two years now to get this Tantramar marsh area identified as a zone for weather forecasting by Environment Canada. They recognized the need, they see the peculiarity of it. But because it straddles a border, not happening.*
>
> *Environment Canada is a partner in that team, and they see the necessity to having a weather-specific forecast for that area. But because it straddles the border, they are kind of having a hard time getting the people in Ottawa to understand the need for it.*

Although this jurisdictional complexity as presented is not directly relevant for hurricane management and response, it represents an important issue. If weather forecasts for the surrounding regions (i.e. Nova Scotia and New Brunswick) do not effectively capture the potential for severe weather in the Tantramar Region, emergency management organizations may have difficulty planning for, and responding to, emergency situations. Further effort in this area could be focused on demonstrating the potential impact and implications of this forecast void for emergency management organizations.

5.2 Emergency management as regional demographics shift

The expected timescale for climate change impacts on the marine environment creates a potential issue for Atlantic Canadian emergency management organizations. Sea levels will gradually increase over several decades due to climate change, increasing the risk of storm surge (Bender et al., 2010). This climatic shift will coincide with shifts in the populations of the Atlantic Canadian provinces, as populations have become increasingly concentrated in urban centres (Statistics Canada, 2011), and are increasing in average age (Statistics Canada, 2017).

Thus, just as climate change impacts on hurricanes are expected to occur, resources available to emergency management operations in rural areas may decrease. This problem will likely arise over the long run; research into how severe hurricane response strategies should respond to the management challenges created by these demographic trends is warranted.

5.3 Warning fatigue and hurricanes

Emergency managers often referenced the potential for the public to become immune to weather warnings. Colloquially referred to as 'chicken little' syndrome, in practice this refers to warning fatigue, where the number of warnings forwarded may result in the public ignoring warnings or failing to understand their gravity. 'Near misses' contribute to this phenomenon, where storm forecasts and related warnings suggest significant weather events, but, when not experienced, result in less attention paid to future warnings.

Example 1:

> [*PEM5]: I'm not going to bother them every time it says we're going to get a shower this afternoon. Because then, they ignore me after a while. The sky is falling, the Chicken Little Syndrome and all the rest of that stuff.*

Example 2:

> *[PEM1]: And if there are repetitive storms, yes, there is a certain amount of inundation, and people become, you know, oh yeah, there they go again, and you always run the risk of being chicken little.*

Ensuring hurricane warnings are heeded by the public is a crucial aspect of efforts to mitigate injury and property damage. Minimizing warning fatigue and related storm preparation apathy is a rather multifaceted challenged in that its potential is related to uncertainty, a characteristic intrinsic to forecasting science, and the public's risk perception. While the recommendation made in Section 4.1.4 carries implications for public risk perception, further investigation into how the potential for warning fatigue could be addressed could improve warning assimilation, benefiting the entirety of the region's stakeholders complex.

6.0 Conclusion

Hurricanes in Atlantic Canada represent an important threat to Canadians that is of critical importance to all stakeholders in the Atlantic Canadian region. The general public, the private sector, and local and provincial governments all stand to be negatively impacted from future storms. Ensuring that the potential impacts of severe hurricanes are mitigated to the greatest extent possible requires accurate and effective forecasting, thoughtful planning, and preparation at various levels of government, and encompassing, thorough understandings of the implications of the various hurricane characteristics with respect to local, provincial and regional vulnerabilities.

Effective, efficient communication strategies represent the nexus of these fundamental goals. For EMOs, the general public, the private sector, and the insurance industry, maximally efficient communication systems carries significant benefits for the effectiveness and appropriateness of emergency planning, preparation, and response to severe hurricanes. Emergency management depends on effective transmission and assimilation of accurate information, and can improve outcomes for the entirety of the region's stakeholder complex.

This report includes six recommendations that offer the potential for tangible, incremental improvements to the emergency warning system currently in place in Atlantic Canada. The suggestions are broadly relevant, achievable, and work within the current framework of the larger emergency management community and communication processes. These recommendations have the potential to refine the communications system in critical ways, with the preparation, planning, and response phases of emergency management standing to benefit.

This report also identifies three potential avenues for future research into the challenges facing the emergency management community in the Atlantic region. Investigations into these challenges would promote further development and evolution of EMOs and the emergency management community in Atlantic Canada, and would carry indirect relevance for communication effectiveness and efficiency.

Emergency management, particularly with regards to hurricanes, is a critically important aspect of the public service. This importance will only increase. EMOs have invariably evolved to incorporate new information and understanding, either generated through research or from experience. For EMOs to achieve organizational goals in the future, this evolution must continue, and the wider emergency management community must continue to prepare for upcoming challenges by seeking ways to continually refine their methods. It is this underlying requisite that this report aims to assist.

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