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DISASTERS AND CLIMATE CHANGE ADAPTATION MANAGEMENT: A GUIDE FOR LOCAL GOVERNMENT

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Introduction

Global climate change is widely recognized as one of the world's greatest environmental, social, and economic threats. In Canada, climate changes observed over the past 35 to 40 years account in part for the exponential rise in economic losses from extreme weather events, premature weathering of infrastructure, stresses on water supplies, worsening air quality, and related health and economic impacts.

Efforts to adapt to and manage climate-related risks are not keeping pace with the challenges. Unfortunately, Canadians are becoming more vulnerable to impacts related to climate variability and change, due in part to increasing urbanization, a growing and aging population, and deteriorating public infrastructures.

Municipalities share in many of the responsibilities for managing risks from a changing climate. Most Canadians live in municipalities, and this level of government has primary responsibility for, or can significantly influence, many of the factors that determine Canadians' vulnerabilities to climate-related risks. Unfortunately municipalities have tended to focus on very short-term issues because they perceive that assessing risks related to changing climate is difficult, complex, and resource-intensive.

Increasingly, however, municipal officials are beginning to implement adaptive strategies—both seeking to better understand climate change and promoting adaptation responses. Yet many of the existing tools to help them in the process are complicated and time-consuming to use. To meet the need for a better and more straightforward strategic tool, the authors developed *Climate Change Adaptation Management: A Guide for Local Government*. The guide is designed to assist municipal planners, health officials, emergency management staffs, and conservation authorities in making optimal choices for adapting to a changing and more variable climate and to extreme events.

In this paper we address the following:

- The relationship between climate change adaptation, risk management, and emergency management.
- The development and structure of the guide.
- Current and future uses of the guide.
- The guide's role in supporting the objectives of the Hyogo Framework for Action (2009– 2011).

Climate Change Adaptation, Risk Management, And Emergency Management

Climate Change Adaptation

The Earth's climate is variable due to a number of factors, including the presence of naturally occurring greenhouse gases (GHGs) in the atmosphere. The Intergovernmental Panel on Climate Change concluded that, until the mid-1960s, the Earth's warming was attributable to both human-caused and natural factors. Since about 1970, however, the Earth's warming is attributed almost exclusively to increased atmospheric GHG concentrations from human activities.

Given the current concentrations and the persistence of GHGs, and the projected further increases in GHG concentrations, it seems certain that the climate will continue to change. International efforts to reduce GHGs, such as the Kyoto Protocol, will not stop change but will only slow the rate of change. To ensure that society is not unduly harmed by climate change impacts, adaptation is essential.

But adaptation to what? Some people mistakenly believe that climate change is simply a gradual global warming. It is increasingly evident, however, that other aspects of climate besides temperature are changing, in particular the frequency and intensity of extreme weather events. These two changes—the general warming and the increase in climate variability—have significant implications for our livelihoods' sustainability.

Risk Management and a Standards-based Approach

Until the late 1980s, risk management was an analytic tool used almost exclusively by the insurance and financial industries. Recently the process has been more frequently employed in other disciplines, such as engineering, health, environment, and climate change adaptation. The risk management process is based on determining the probability of an undesired event arising from a situation or hazard, the potential negative consequences that the event could bring about, and the actions that could be taken to avoid negative consequences or lessen their impact. Canada was one of the first countries to develop official guidance on this topic: in 1997, the Canadian Standards Association (CSA) issued CAN/CSA-Q850-97, *Risk Management: Guideline for Decision-Makers* (CSA 2002). Recently the International Organization for Standardization (ISO) has developed and promulgated ISO 31000, *Risk Management: Principles and Guidelines* (ISO 2009a), which emphasizes the need for stakeholder dialogue and documentation; and ISO 31010, *Risk Management: Risk Assessment Techniques* (ISO 2009b). The guide discussed in this chapter was written to be entirely consistent with two 1S0 documents.

Because of the uncertainties involved in anticipating climate change impacts, a risk-based framework is a very appropriate tool for adaptation planning. The many uncertainties—about vulnerability to the impacts of a changing or more variable climate; about the consequences of those impacts for the population, infrastructure, operations, and vital ecosystems; about the needs of stakeholders; and about the analytical processes to be used—can encourage denial, delay, or deferral of important or necessary action. The risk management process makes timely action easier by providing a systematic, broadly accepted framework that assists in the selection of optimal or most cost-effective adaptation strategies in the face of uncertainties.

Emergency Management

While the effects of climate change are relatively well understood in relationship to municipal infrastructure and operations, there is a growing sense on the part of municipal emergency managers that climate change is also becoming an emergency management issue. The Canadian standard for emergency management, CSA Z1600 *Emergency Management and*

Business Continuity Programs, indicates that a key step in developing an effective emergency program at the local government level is to conduct a hazard, risk, and vulnerability assessment (HRVA). Historically, HRVA's have been based on the study of a combination of natural and human-caused hazards. As emergency managers have developed a better understanding of the effects of climate change, there has been an increasing emphasis on including the effects of climate change in local-authority HRVAs. However, including these effects has in many cases proven to be challenging, as we indicate below.

Development Of The Guide

Identifying the Requirement

The team that developed the guide under discussion brought together three specific areas of specialization: climate change (Jim Bruce), risk management (Mark Egener), and local government emergency management (Robert Black). We brought these three specific study areas together because we recognized the dearth of tools available to local governments for effective and timely risk management, particularly as applied to the effects of climate change on emergency preparedness and management.

Challenges for Addressing Climate Change at the Local Government Level

Municipal staffs are accustomed to dealing with climate-related issues in the course of their planning and management activities. For example, they manage water supplies, design drainage systems and flood protection, design and implement heat and smog alert systems, and control mosquitoes and other disease vectors. But dealing with climate change is new and may be unfamiliar. The implications of climate change are not well understood across departments in many municipalities. Most municipal strategic or long-range plans do not address adaptation to climate change, and it can be difficult to get this issue on the municipal agenda.

In addition to being unfamiliar, climate change–related issues may not seem sufficiently urgent to municipal staffs, who often find it extremely difficult to attend to issues that do not have an immediate impact on municipal operations. In order to pursue a new initiative relating to climate change risk management, staffs may have to give it explicit priority over certain existing responsibilities, or at least equal priority.

Emergency managers typically adopt relatively short-range time scales to address risk. Because of the longer time frames associated with climate change, emergency managers may fail to incorporate climate change–related risks in their HRVAs and may miss opportunities to identify and implement risk mitigation measures in a timely and cost-effective manner.

In reviewing these factors, we determined that any tool for adaptation planning would have to be

- **Easy to use**. Municipal staff need a tool that can be used with a minimum of training or preparation and that relies as much as possible on existing standards-based risk management processes.

- **Results oriented**. To be of practical value to the user, the process has to include tangible recommendations for adaptation measures and to propose an implementation plan.
- **Strategically focused**. The process should provide local authorities with a strategic overview of climate change–related risk management and should make it possible to prioritize certain mitigation procedures for future evaluation and detailed technical planning.

Iterations of the Guide

We developed *Climate Change Adaptation Management: A Guide for Local Government* in order to meet the three needs listed above. The guide was designed to outline a process that would help municipal and other planners conduct a strategic analysis of the effects of climate change on their organization and also identify achievable adaptation measures.

Development of the guide has been an iterative process that included four distinct earlier projects. The first iteration of the guide was developed between 2001 and 2004 and was called *Adapting to a Changing Climate in the Caribbean Region: A Risk Management Guide for Decision Making***.** Dr. Bruce, along with Mr. Egener of Summit Enterprises International (S.e.i), developed a risk-based approach to building capacity for integrating adaptation to climate change risks into the physical planning process, in both the private sector and governments. The work was undertaken as part of a joint Global Change Strategies International Inc.–Canadian International Development Agency project. The project included the development of a training component and a guide or handbook to describe how a risk management process could be employed to assist in the analysis of climate change impacts, vulnerabilities, and the selection of optimal adaptation strategies.

S.e.i, now joined by Mr. Black of Black Shield Preparedness Solutions, next carried out a contract to adapt the Caribbean Community and Common Market (CARICOM) process for use across Canada; this work resulted in the guide's second iteration, *Adapting to Climate Change: A Risk-Based Guide for Municipalities and Local Governments***.** From 2005 to 2010, with the sponsorship of Natural Resources Canada, Indian and Northern Affairs Canada, the Insurance Bureau of Canada's Institute for Catastrophic Loss Reduction, and the Centre for Indigenous Environmental Resources (CIER), S.e.i. developed and user-tested a risk-based guide to assist in identifying, analyzing, and prioritizing climate change impacts, vulnerabilities, and optimal adaptation responses in a series of projects in Ontario, Alberta, British Columbia, and the North. During these projects, approximately 200 municipal and government representatives were trained in using the guide and developed examples or case studies of various climate impacts appropriate to the geographic region of the project.

In 2010, the Province of Ontario contracted with S.e.i to adapt the process specifically for use by Ontario municipalities. This resulted in the guide's third iteration, called *Risk-Based Adaptation to Climate Change: A Guide for Ontario Municipalities*. This project took the existing guide and specifically developed it for use by Ontario municipalities. A series of stakeholder workshops was held with representatives of Ontario municipalities and River Basin Conservation Authorities to refine the process, in particular to make it more user-friendly and facilitate its application by local authority staff.

Finally, in the project's fourth iteration, S.e.i in conjunction with ICF MARBEK developed and implemented *Adapting to Climate Change: A Risk-Based Guide for the Government of Alberta.* This project differed from the previous projects in that its focus was not directly on municipalities or on further developing the process, but instead on applying the process provincewide. Over a two-year period, the process outlined in the guide was applied to virtually the entire government of Alberta, providing a strategic overview of the risks associated with climate change and identifying and evaluating mitigation and adaptation measures.

Lessons Learned During Development

As with any iterative process, a number of lessons was learned in the development of the guide. Generally speaking these lessons tended toward making the risk management process simpler to understand and apply.

- **Customize for users**. The original guide developed for CARICOM was written in a relatively formal manner. As the guide was subsequently adapted for other users, it was found necessary to simplify terminology and process descriptions. For example, under the sponsorship of the CIER, a customized version of the guide was developed for Arctic and Northern communities. A copy of this version of the guide, including versions in several Northern languages, can be found at http://ccrm.cier.ca/.
- **Offer simplified climate predictions**. Municipal policy makers commonly complained either that there was too much climate change information to allow a rational decision, or that there was too little. To assist users in understanding climate predictions, Dr. Bruce developed a relatively simple template that reduced the effects of climate change in the targeted area to a short list of key factors and that used terminology and measurements understandable to the average user. An example of one of these templates is included as annex A.
- **Rely on templates**. Each iteration of the guide relied more on templates. Previous experience showed the team that risk management practitioners have often expended considerable time developing unique tables and charts to record data. The guide simplifies this process by including standardized tables and charts along with explanations of how to use them. An example of one of these charts, the Likelihood Analysis Template, is shown in annex B. These templates help users capture and display essential information and present results to senior management.
- **Consult with stakeholders.** In developing the guide, we found it essential to consult with potential users to solicit comments and input. Local knowledge of the environment and understanding of the processes followed by local authority were essential to customizing the guide to the final user.

Structure

The guide presents a risk-based approach that can be used to facilitate municipalities' efforts to adapt to climate change through both longer-term planning and short-term responses. It is envisioned as

- A reference manual that allows users to incorporate risk management into ongoing municipal planning and management activities, particularly those related to climate adaptation, and that guides comprehensive strategic planning initiatives focused on climate adaptation for all municipal operations.
- An illustration of successful examples and methods for managing climate-related risks to help build support for adaptation efforts.
- A training facilitation tool for municipal staff.

A Summary of the Guide

The guide follows the framework for risk management described in the International Organization for Standardization's ISO 31000 document, *Risk Management: Principles and Guidelines*. The process described in ISO 31000 is shown in figure 1. For ease of reference, the individual steps have been numbered, and a sixth step, the implementation plan, added. The guide is designed to address high-level or strategic issues and opportunities over a broad range of climate impacts during a 40-to-50-year time frame. However, the same process outlined here can also be used in a more detailed technical analysis of a specific issue or event.

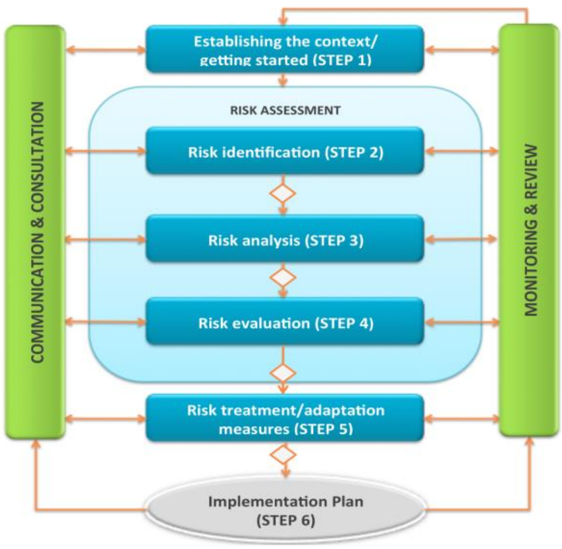

Figure 1. Risk Management Process (ISO 31000)

Source: ISO 2009a. © International Organization for Standardization. Used with permission; further permission required for reuse.

Establishing the Context or Getting Started: Step 1

If the process is undertaken by a group or team, the initial step involves establishing membership and responsibilities, deciding on the terms of reference (especially the specific climate change risk issue to be examined), identifying the important stakeholders, and drafting an initial work plan.

Risk Assessment: Steps 2, 3, and 4

The risk assessment itself is a three-step process:

- **Step 2: Risk Identification**. The team analyzes climate change impacts and identifies the risk events, such as increased rainfall leading to flash flooding and opportunities, such as a longer growing season that these impacts create. The team conducts a preliminary estimation of frequency and consequence to make an initial estimation of the level of risk. Some lower-level risk events will be discarded at this stage and not considered further.
- **Step 3: Risk Analysis**. The team conducts a more detailed estimate of the frequency or likelihood and consequences of the risk events and opportunities identified in Step 2. The analysis also considers perceptions of those people or groups affected.
- **Step 4: Risk Evaluation**. The team compares the risk levels estimated in Step 3; the acceptability of the risks are considered from the team's and from stakeholders' perspectives. Low-level risks are again discarded, and the remaining risks are ranked. The team gives preliminary consideration to potential risk controls or adaptation measures.

Risk Treatment or Adaptation Measures: Step 5

For those risks assessed as unacceptable in Step 4, the team proceeds as follows:

- Adaptation measures or risk control strategies are identified to reduce risks to acceptable, practicable levels.
- The effectiveness of the adaptation measures is evaluated, including costs and benefits.
- Optimal adaptation measures are selected, and the acceptability of residual risks is considered.
- Consideration is given to how the opportunities identified in the previous steps could be optimized or improved.

Implementation Plan: Step 6

While not strictly part of the ISO 31000 process, the final step involves considering how the adaptation measures could be implemented, how the opportunities could be exploited, and how both should be monitored. Again, it is important to take into account the effect on participants and key stakeholders as well as their perceptions of the implementation plan.

Other Considerations

Documentation. The key information used in the process, minutes of meetings and discussions, and decisions that were taken during the process should be carefully documented and archived in readily retrievable form.

Communication and consultations. Accurate, inclusive, and timely dialogue with all participants and stakeholders on a continuing basis is vital throughout the whole risk management process—particularly in a government setting, where other departments or agencies and the public may be affected by the risk events or opportunities being considered.

Monitoring and review. Risk management is an iterative process. The process should be repeated or reviewed periodically, and whenever significant new information becomes available on climate change impacts, risk events, or adaptation measures or opportunities. Adaptation measures and opportunity exploitation plans should also be monitored continuously to determine whether the anticipated risk reductions or benefits are being achieved or whether plans should be modified or revisited. The review and monitoring process should also address the residual risks that were accepted in the initial planning process and determine whether they have altered or their acceptability has changed.

Workbook

The guide includes a workbook section that contains templates to assist users in recording information and presenting results clearly.

Current Status

Support and Usage

Through its various iterations the guide has had the support and input of the following:

- Canadian International Development Agency
- Natural Resources Canada
- Aboriginal Affairs and Northern Development Canada
- Insurance Bureau of Canada
- Institute for Catastrophic Loss Reduction
- Provincial Governments of Ontario, Alberta, and British Columbia
- Metro Vancouver
- Centre for Indigenous Environmental Resources

The guide is currently in use, or available for use, in CARICOM, Ontario, Alberta, British Columbia, Nunavut, the Northwest Territories, and the Yukon.

Feedback from Users

Generally, users have been very supportive of the guide and the results achieved with it. Some of the feedback that has been received:

- The strategic screening of climate-related risks tended to focus follow-up and more-detailed analyses on the highest-priority areas (usually climate-related disaster or emergency events).
- In spite of the guide's design for ease of use and its inclusion of step-by step directions, there is a real reluctance on users' part to undertake the risk assessment without further guidance, usually in the form of a learning workshop or knowledgeable "champion."

- The risk-based approach to climate change over a 40-to-50-year horizon creates useful inputs to shorter-term strategic and enterprise risk management plans.
- Because it uses experts from within municipalities or organizations to outline risks to their operations posed by a changing climate, the process leaves a legacy of senior managers who have been through the process and can more easily undertake detailed follow-up studies of key vulnerabilities.

The Guide and the Hyogo Framework for Action

Table 1 relates the guide to some of the findings of *Canada: National Progress Report on the Implementation of the Hyogo Framework for Action (2009–2011)*.

HFA Priority for Action (PAC)	HFA Comment	Guide Comment
PAC 1: Core Indicator 4: A national multisectoral platform for disaster risk reduction is functioning.	Substantial achievement attained but with recognized limitations in key aspects, such as financial resources and/or operational capacities	The guide can be used as a strategic analysis tool across the spectrum of organizations and is flexible enough to be used by governmental and nongovernmental organizations.
PAC 3: Core Indicator 3: Research methods and tools for multi-risk assessments and cost benefit analysis are developed and strengthened.	Institutional commitment attained, but achievements are neither comprehensive nor substantial	The guide provides an inexpensive and relatively simple process for conducting high-level and strategic climate change adaptation risk assessments.
PAC 4: Core Indicator 1: Disaster risk reduction is an integral objective of environment-related policies and plans, including for land use, natural resource management, and adaptation to climate change.	Institutional commitment attained, but achievements are neither comprehensive nor substantial	The guide has been used, specifically by the Province of Alberta, Ontario Conservation Authorities, and Arctic and Northern communities, to assist in developing climate change adaptation measures related to the environment.
PAC 4: Core Indicator 6: Procedures are in place to assess the disaster risk impacts of major development projects, especially infrastructure	Comprehensive achievement with sustained commitment and capacities at all levels	The process outlined in the guide can be applied to any development situation to provide a strategic assessment of the potential effects of climate change and extreme events.

Table 1 : The Guide and the Hyogo Framework for Action

Source : DFAIT 2011

Challenges

The authors of the guide have identified the following challenges involved in its use:

- Because municipal governments tend to focus on very short-term issues and are highly resource constrained, it is difficult to get them to focus attention on long-term risk assessments.
- "Champions" are vitally important for getting local governments to commit to undertaking climate change risk assessments.
- Some organizations dedicate considerable resources to developing their own climate change risk assessment process rather than using the existing ISO 31000 process with its associated terminology, definitions, and analysis process. The value of beginning with a simple, high-level strategic screening to identify the highest-priority areas is often lost in this development process.
- The climate change risk assessment process should be accompanied by a process to monitor results and measure progress in order to ensure that risk reduction measures are implemented and actually work.

Future Intentions

The development team intends to continue improving the process and guide. In particular we will do the following:

- Pursue continuing engagement at the provincial and federal levels to promote and encourage the climate change risk assessment process.
- Consider partnering with some national organizations concerned with climate change and disaster reduction, such as the insurance industry, engineering, and medical/health associations.
- Encourage publication of a generic version of the guide on an appropriate website.

Conclusion

The development of *Climate Change Adaptation Management: A Guide for Local Government* through multiple iterations confirms that one of the most serious risks posed to local governments by climate change is the increasing frequency and severity of emergency and disaster events, including inland and coastal flooding, extreme rainfall events, major storms, and drought. The inputs provided by hundreds of users also confirm that municipalities continue to be challenged by numerous obstacles to effective climate change adaptation risk management, including overly complex procedures, unclear climate projections, and a lack of resources.

The guide has been specifically developed to address these issues. Using recognized international risk management standards, it provides a straightforward and relatively simple strategic overview process to help municipal planners, health officials, emergency management staffs, and conservation authorities understand climate change and make optimal choices in adapting to a changing and more variable climate and extreme events.

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Annex A: Climate Change Projection Example (Northern Ontario)

TEMPERATURE (See Note 1)

Temperature °C (1950–2007)

	Observed Max. °C	Observed Min. °C	By 2050 (from 2010) °C
Annual	1.5N to 2.5S	0.5N to 2.5S	2 to 5
Winter	1.5 to 2.5	0.5 to 2.5	4 to 6N 2 to 4S
Spring	1.5 to 3.5	1.5 to 2.5	2 to 4
Summer	1.5 to 2.5	-0.5 to 1.5	2 to 4
Autumn	0.5 to 1.5	-1.5 to 1	2 to 4

Some potential impacts: Permafrost thaw most of northern half. Ice season shorter. Shorter winter road season. Structural problems. Increased freeze/thaw.

Temperature Extremes (1950–2007)

Observed trends	By 2050 (from 2010)	Some potential impacts
Frost-free season 10 to 20 days Warm days T_{max} >25 °C: 10 to 15 days	T_{max20} 2 to 4°C T_{min20} 4 to 6°C 20 days 15 days	Agricultural opportunities in southern half.

PRECIPITATION (See Note 2)

Precipitation (1950–2007)

	Observed %	By 2050 (from 2010) %
Annual	-20 to 20	5 to 15
Winter	-10 to 5	20 to 30N 10 to 20S
Spring	-10 to 5	10 to 20
Summer	0 to 10	0 to 10
Autumn	0 to 15	0 to 10

Some potential impacts: Snowfall increases especially in northern parts.

Ratio of Snow to Total Precipitation

	Observed (1950-2007) %	By 2050 (from 2010) %
Annual	-5 to -10	-15
Winter	0 to 3	-10
Spring	-6 to 3	-5
Autumn	-3 to 0	-15

Some potential impacts: Winter recreation season shorter and interrupted.

Intense Precipitation (1958–2007)

Observed trends	By 2050 (from 2010)	Some potential impacts
Amounts in severe events (>99%): 31% (adjacent USA) Frequency heavy rain amounts (>99%): 27% (adjacent USA) Number of days with amounts ≥ 95th percentile: 3 to 6	P_{20}: 5% to 10% severity $P_{20} \rightarrow P_{10\ to\ 15}$ frequency	In southern half more flash floods. Drainage overflows. Water contamination episodes.

Freezing precipitation (rain and drizzle) average (1961–1990)

Observed trends	By 2050 (from 2010)	Some potential impacts
Precipitation: <35hrs Rain: <10hrs	60% to 85% increase in freezing rain events	Power and communications outages. Transportation chaos. Ecosystem damages.

RIVERFLOW See Note 3	**Dates of Spring Breakup (1950–2002)** Earlier, mostly significant **Snow Pack**	Earlier still As ice-free season on Hudson and James Bays increases toward late November and into December, greater snow pack will develop in early winter in coastal areas.	Winter and spring peak flows and ice jams, flooding more frequent, especially in north-flowing rivers.
See Note 4	**Ice Cover (1973–2008)** Lake Superior: from 40% to 10% average in winter	Continued decrease	Higher water temperature. Water quality decline. Easier shipping.
	Streamflow (1967–1996) % Annual: -40 to 10 Minimum Daily: -30 to 10 Maximum daily: -40 to 10	% -20 -20 -10	Reduced summer water availability. Cold-water ecosystems negatively affected.
Forest Fires	Area burned increased 27% from 1981–1990 to 1991–2000 (But large fire year 1980)	50% to 500% increase in area	Greater threats of fire. Greater threats to economies in forestry-based communities.
Permafrost and Peat lands	Thawing evident southern edge of permafrost.	Greatest impact Northern area with peat lands drying out	Infrastructure and construction problems.

Note 1: Ranges in observed and projected values indicate differences over the region.

Note 2: Wind disaster records of Public Safety Canada indicate for storms >100km/h national frequency rose 16% from 1970 to 1990, with most in coastal regions, except for tornadoes.

Note 3: Major floods and landslides (from Public Safety Canada database), from intense rains, or rain on snow, apparently increased 80 percent nationally between the 1970s and 1990s. However, 1970s event recording may have been less thorough than in 1990s. Database extends only to 2005. Spring floods earlier but summer rain–induced floods more frequent.

Note 4: Wind speeds over warmer waters with less ice cover on Lake Superior have been increasing (Austin and Colman 2007). This suggests greater possibility of shoreline damages due to wind set up and higher waves.

Annex B: Example Template

Step 3 of the six-step risk management process includes this template to determine an event's probability.

Probability Range Type of Event	Very Low	Low	Moderate	High	Very High
Significant Single Event; or	Not likely to occur in period	Likely to occur once between 30 and 50 years	Likely to occur once between 10 and 30 years	Likely to occur at least once a decade	Likely to occur once or more annually
Ongoing/ Cumulative Occurrence	Not likely to become critical in period	Likely to become critical in 30–50 years	Likely to become critical in 10–30 years	Likely to become critical in a decade	Likely to become critical within several years