Adapting to Climate Change

A Risk-based Guide for Local Governments in British Columbia

Volume 1

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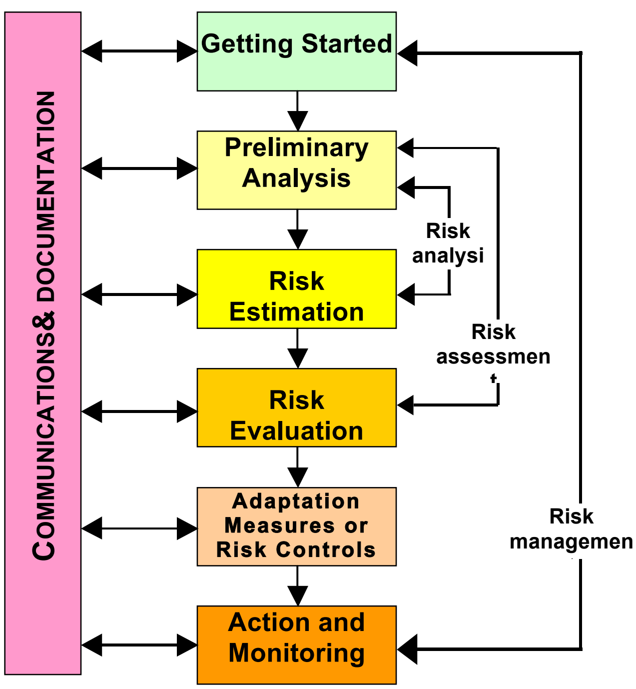
Summary

Adapting to climate change may be one of the greatest challenges facing northern communities during the next century. This Guide has been written to primarily to assist local and regional governments understand the risks of predicted climate impacts and how to manage them. The Guide should also be useful for health officials, emergency managers, and businesses.

Risk management is a process for selecting the best course of action in uncertain situations. It does this by helping us identify, understand, analyze and communicate about risks. The Guide follows the framework for risk management described in the Canadian national standard *"Risk Management: Guidelines for Decision-makers"* (CAN/CSA-Q850-01).

There are six simple steps in the process:



Step 1: Getting Started

For a specific climate change problem the team members and concerned stakeholders are identified and an initial work plan is drafted.

Step 2: Preliminary Analysis

Team members do a general analysis of the climate change hazards and identify risk scenarios created by these hazards. For each risk scenario vulnerabilities are identified and a preliminary risk estimation of frequency and consequence is done.

Step 3: Risk Estimation

A more detailed analysis is made of the frequency and consequences of the events in the risk scenarios from Step 2. Also, the perceptions of those people or groups affected by this process are identified and the effects of these perceptions on the risk scenarios are assessed.

Step 4: Risk Evaluation

The project team evaluates and compares the risk scenarios from extreme to negligible. Negligible risks are eliminated from further consideration. The remaining risks are ranked and effort is focussed on those deemed unacceptable.

Step 5: Risk Controls and Adaptation Decisions

For those risks assessed as unacceptable in Step 4:

- Adaptation measures or risk control strategies are identified to reduce risks to acceptable levels.
- The effectiveness of the adaptation measures are evaluated including their costs, and benefits.
- Optimal adaptation measures are selected and the acceptability of residual risks is considered.

Step 6: Implementation and Monitoring

The adaptation and implementation plan is developed including a monitoring process.

Following these six steps will:

- Ensure the participation of the appropriate key people and organizations;
- Ensure that the most serious climate change adaptation issues are identified; and

- Provide a format to present climate change adaptation issues to senior decision makers.

This Guide suggests using a short version of the process as a useful technique for getting started. It focuses on using readily available data and a small risk management or project team. This will help the team explore the issues and possible outcomes rapidly and inexpensively. The results, supported by good documentation can be used to make a strong business case for taking action. The documentation from the overview process can also support a more comprehensive risk management study if one is needed.

Communication and Documentation

Accurate, inclusive and timely communication with all participants is vital throughout the whole risk management process. As well, it is important to ensure that careful records are kept to support conclusions and to allow for a review of risk scenarios as the climate change situation changes.

Presentation

The Guide includes a workbook section (see Volume 2 of the Guide) that contains templates for recording information that will assist in presenting the results in a clear and lucid manner.

Also included in Volume 2 are case-study examples from a variety of regions of the country that will help the reader and the risk management team understand and apply the process laid out here.

Foreword

Additional text can be added here by BC government departments or local governments to.

The BC government, together with Natural Resources Canada and the Institute for Catastrophic Loss Reduction, supported the development of this Guide to help municipalities understand and manage risks associated with climate change and variability. This is an important tool that can assist municipalities and others organizations to reduce their vulnerabilities to the adverse impacts, of our changing and more variable climate.

Based on what is known about our changing climate, communities and governments need to proceed with urgency to examine their vulnerability. As outlined later in this Guide, there is now convincing evidence that the climate is changing in response to rising concentrations of greenhouse gases in the atmosphere and that the change is accelerating.

Warming in most of Canada, particularly in the northern regions, has been greater than in most of the rest of the world. Warming is projected to be even greater in the future and changes even faster than in the recent past.

Canada has unique characteristics that makes the examination of climate impacts and the responses to them urgent and very important. Some factors that are particularly important include, large temperature increases during the annual climate cycle, in many regions, widely separated communities with small populations and modest resources, sparse transportation infrastructure and huge geographic areas.

This Guide has been specifically written to address the unique conditions in British Columbia and it emphasizes simplicity and common sense in its use.

1. Introduction

Global climate change is widely recognized as one of the world's greatest environmental, social and economic threats. In Canada, climate changes over the past 35 to 40 years are in part responsible 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 effects. Extreme events and rising temperatures are becoming more damaging as recent severe rainfalls, thawing permafrost and melting sea ice have demonstrated.

Efforts to manage and adapt to climate-related risks are not keeping pace with the challenges. It is virtually certain that the climate will continue to warm and become increasingly variable over the coming decades. We are becoming more vulnerable to the impacts of climate variability and change because of increasing urbanisation, a growing and aging population and deteriorating public infrastructure. These changes put more people, property and ecosystems at risk.

Regional and community governments have primary responsibility for or can significantly influence many of the factors that determine Canadians' vulnerabilities to climate-related risks and many of the decisions that help to manage these risks.

The province's municipal legislation, environmental laws and emergency management arrangements among other legislation or policies all require in one way or another that local governments take action to prevent, mitigate or respond to threats to human health and safety, public property and the environment

Local government officials increasingly understand projected climate impacts and are beginning to implement adaptive strategies. Unfortunately, there are few tools available to help them.

1.1. About the Guide

This Guide will assist regional and local government planners, health officials, emergency managers, infrastructure managers and others understand the risks of potential climate impacts and the priorities and means of managing them. The guide should also be useful for other organizations such as local industry and businesses to help understand how to anticipate and deal with a changing climate.

The Guide describes a risk-based approach that communities can use to adapt to climate change through long-term planning and short-term responses. It can be used in three main ways:

- As a reference manual to incorporate risk management into planning and management activities related to climate adaptation,
- As a source of examples that illustrate techniques for managing climate-related risks and promoting adaptation efforts, and
- As a training tool for regional and local government staff.

The Guide explains how to use the risk management process as a simple, quick and logical way to determine the best solutions to climate adaptation. The Guide suggests a straight-forward and simple approach that will get communities started thinking and acting about adapting to our changing climate. A time-consuming, expensive or complicated analysis process is not needed to reach decisions about climate adaptation.

Chapter 2 and Annex 1 provide insights into what could be expected in the future climate. It offers some suggestions to help officials incorporate a risk-based approach into planning.

Chapter 3 explains the risk management process used in the Guide. It is based on the Canadian National Standard, *"Risk Management: Guidelines for Decision-makers"* (CAN/CSA-Q850-01). A standard provides the benefits of having a nationally accepted process and terms and is a credible starting point for the process.

Chapter 4 explains each step in the risk management process and includes:

- A description of the purpose of each step;
- An explanation of what to do and how to do it;
- A description of the expected output;

- A description of the decision to be made at the end of each step;
- A checklist to help ensure that the main tasks for this step have been undertaken, and
- Case studies or examples illustrating in detail what is done in each step are included in Volume 2.

The examples are based on observed and projected impacts of climate change and evidence to date of adaptation efforts.[1] They are also based on the actual experiences of municipal and other users in workshops during the development and testing of the Guide.

1.2 Reducing vulnerability to climate change

Climate change literature refers to "adaptation", "adaptive capacity" and "vulnerability" and for the purposes of this guide:

- **Adaptation to climate change** means making adjustments in natural or human systems to moderate harm or exploit benefits arising out of actual or expected climatic changes
- **Adaptive capacity** is the ability of a system, region or community to adapt.
- **Vulnerability** means how susceptible social, economic and environmental systems are to the adverse effects of climate change or climate variability.

Adaptation to climate change aims to reduce vulnerability to the adverse effects and to enhance adaptive capacity.

1.3 Why risk management?

Risk management is a framework that can be easily used to identify and understand the impacts and vulnerabilities of climate change and also for estimating and ranking risks. The process helps us select the best actions to reduce risks to acceptable levels even when there are uncertainties about future climate.

[1] e.g. Chapters 7 and 8 of *"From Impacts to Adaptation: Canada in a Changing Climate 2007"*, NRCan, 2008 See http://adaptation2007.nrcan.gc.ca

The impacts of a changing and more variable climate involve almost every aspect of society and create risks to the social, economic, cultural and environmental fabric of our communities. Making decisions about how to avoid these risks or to reduce them to an acceptable level can involve many different decision-makers and other players, some with conflicting values and competing interests.

The process outlined in this Guide is a simple way of getting started, engaging the people who are affected and identifying other key people who should be involved. It will also clarify the important issues that will have to be considered and how to decide what are the best adaptation options.

For every climate impact there is a range of possible responses in time, complexity and cost. For example to deal with increasingly frequent and severe extreme weather events short term responses might range from better warnings, increased maintenance of water management infrastructure, reduction of storage levels in reservoirs. Longer-term responses might include upgrading water management systems and better communications equipment. Multi-jurisdictional responses could involve the re-routing major transportation arteries and changes to building codes among others. The risk management process will help identify the best solutions and a range of possible responses.

Most local governments tend to be focussed on current issues. Adapting to an uncertain future climate may not be a high priority. In this environment, spending time and effort to identify the best adaptation responses may be a real challenge for an already overburdened staff. Decision-makers may delay or defer important actions. However, climate change impacts are increasingly evident making early adaptation important, even urgent.

In some communities the adaptation problem may be addressed as a strategic issue similar to the way that some have done for other environmental issues. Others will deal with climate change issues pragmatically as problems arise such as smog, heat waves, wastewater or emergency management concerns. Whatever the scope, the process described in this Guide will help officials to identify the issues and produce well thought-out recommendations.

In summary, risk management offers a simple, practicable and highly credible approach for identifying and ranking risk issues and selecting the best risk-reduction strategies. The process can be used to make a rapid assessment of a risk issue to outline the possible scope and its complexity. This is the approach recommended in this Guide. However, the process can also cater to a larger fully comprehensive assessment that could involve a large number of representatives from many agencies over a longer period of time. Whatever the scope, the assessment will provide a persuasive business case for adaptation action to submit to decision-makers.

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2. *Climate Change Adaptation Decision-making in Local Governments in British Columbia*

The Earth's climate is naturally variable due to a number of factors, including the presence of naturally occurring greenhouse gases (GHG) in the atmosphere. The Intergovernmental Panel on Climate Change concluded that, up until the mid1960s, the Earth's warming was attributable to both human-caused and natural factors, but since about 1970, 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 only slow the rate of change. Most assessments of future climate change impacts have been based on greenhouse gas emissions, and atmospheric concentration scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) and published in 2000. The International Energy Agency, in a 2007 report, indicated that greenhouse gas emissions to 2030 will increase more rapidly than the fastest of the IPCC scenarios. At the same time, the rate of increase of global atmospheric concentrations of CO2 have risen since 2000 to 1.9 or 2 parts per million per year compared to earlier (since 1970) increases of 1.6 ppm/yr. Thus, climate change impacts are likely to proceed at a more rapid pace than hitherto expected and generally reported upon. For example, Arctic sea ice and Greenland ice cap melting have recently occurred more rapidly than in earlier projections. Thus, adaptation is an essential response to ensure that society is not unduly adversely affected by climate change impacts.

But adaptation to what? Some people mistakenly believe that climate change is simply a gradual global warming. It is increasingly evident that other aspects of climate are changing, too, especially the frequency and intensity of extreme weather events. These two changes, the general warming and the increased climate variability, have significant implications for many aspects of our sustainable livelihoods.

2.1 Climate trends and projections for British Columbia

Over the last 35 years British Columbia's climate has changed in a number of ways. Some of the changes are presented in Tables 1. It is instructive to compare recent climate trends to those projected for the coming decades, to consider whether modeled projections can reliably inform adaptation decision-making.

Table 1: Present estimates (2008) of observed and projected climate changes for British Columbia

Change	To date (2000 from 1950)	By 2050
Mean annual temperature	1 TO 2°C	2°C to 3°C coastal up to 4°C interior
Mean spring temperature	1.5 to 3°C	2°C to 4°C coastal up to 5°C interior
Frost free days	+10 per decade	+10 per decade
Growing degree days	+5 to 16% per century	+10%
Precipitation – Annual	+10 to 25%	+10% North; +5% South
Precipitation – Spring	10% North; +30 to 40% South	+10% North; +5% South
Rain intensities	Heavy precip days: +5%/decade South	5% to l5% increase
River flows	Increased Winter Spring; Declined Summer and Fall	Peak 15 to 40 days earlier Trends to continue

Change	To date (2000 from 1950)	By 2050
Snowpack, April 1	20 to 60% decline	Continued decline
Glaciers	Rapid decline 1965 to 2005	Mostly disappear by 2100
Sea Level	Rise 4 to 12cm over century	0.3 to 0.6 plus metres by 2100
Significant wave heights	+1cm/decade	More than +1cm/decade
Intense Winter Storms	Increased frequency 10%	+13% frequency
Other increasing extremes	Insect infestations, wildfires Winter floods, storm surges	Threats continue to increase

Note: The above figures are estimates of average changes. Trends in specific locations, particularly in mountainous areas, may be different.

Many social systems are already vulnerable to various climate-related and non-climate-related risks. Projected climate changes will exacerbate many of these pre-existing vulnerabilities. Adaptation measures to reduce these vulnerabilities are increasingly urgent.

Annex 1 contains additional information about climate change impacts for British Columbia, and Canada.

2.2 The local government planning context

Local governments 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 and as yet, there are few staff appointments explicitly responsible for adapting to climate change. Most municipal strategic or long-range plans do not address climate change. It can be difficult to get this issue on the municipal agenda.

In Canada, the provincial and territorial governments have a number of laws and policies which, although they may not reference climate change and adaptation directly, include strong provisions for dealing with risks to municipal infrastructure and the health, safety and environmental protection of their residents. This creates a strong and justifiable case for adaptation planning in a number of key areas.

Another major problem facing municipalities is that, because of heavy staff workloads, it is extremely difficult to attend to issues that do not have an immediate impact on municipal operations. Sometimes, in order to pursue a new initiative such as climate change, staff may have to make a case for the work to take priority over existing responsibilities. This could require a strong business case for approval by senior management. For example, this Guide suggests that a relatively quick initial run-through of the process will produce enough evidence of the urgent need to take adaptive action to form the backbone of a business case for a more thorough study.

Whether the project is a large one, such as writing a strategic adaptation plan or a smaller, one focussed on a particular hazard or adaptation issue, it is important that the project has the support of council and senior managers so that it has adequate resources to carry it through.

3. Overview of the Risk Management Approach

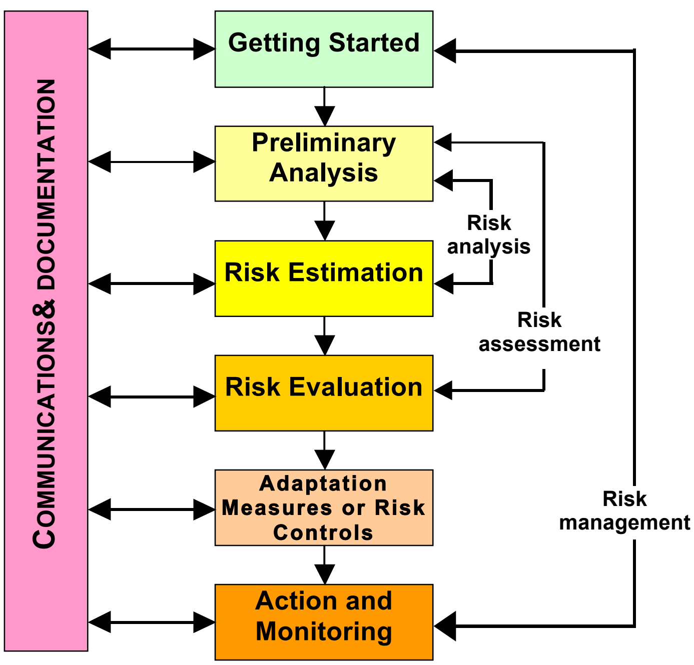
3.1 The risk management process

Risk management is a systematic process for selecting the best course of action in uncertain situations.

Risk management provides a framework for developing strategies to respond to potential climate changes that create or increase risk. As mentioned above, whether it is as a study around a specific issue such as extreme rainfall events or as large as a community strategic plan for climate adaptation, the risk management process will guide us towards the best solution.

The framework in this Guide is based on the Canadian national standard *"Risk Management: Guidelines for Decision-makers"* (CAN/CSA-Q850). The decision-making process consists of six steps shown in Figure 1 below.

Figure 1: Steps in the risk management process



The key activities of identifying, estimating, evaluating and ranking risks and selecting options to lower risks to acceptable levels include:

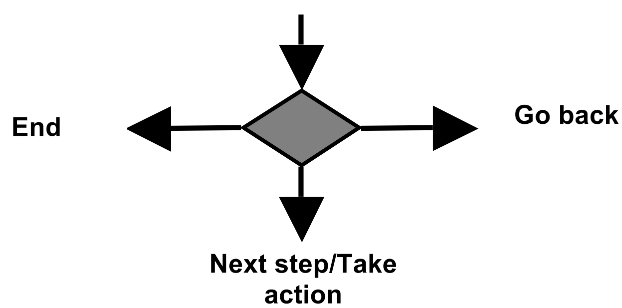
- For each climate related risk or situation, developing a list of all the events or impacts each could create;
- Estimating the probability and potential consequences of events arising from situations or hazards;
- Identifying actions that can be taken to avoid negative consequences or lessen their impact, or to exploit potential benefits; and
- Understanding stakeholders' perceptions of probabilities and consequences.

A very important part of the process is a continuous dialogue with all those involved and affected by the issue.

Information about a risk situation can be interpreted differently by various groups of people, resulting in quite different perceptions of risk[2]. For example parents may be more concerned about water quality for their children than consultants designing water delivery systems. For this reason the risk management process emphasizes the need to understand how events might affect or be perceived by different groups.

Each step leads logically to the next, unless the risk issue is resolved, in which case the process is ended. Steps can be repeated to include new information or new analyses, as these become available. At the completion of each step there is a decision to be made as shown in the "Decision Diamond" in Figure 2.

Figure 2: Decision diamond – decision options at completion of each step



[2] See Annex 3 for a fuller explanation of risk perception.

The process is should be repeated as new information becomes available or new risk controls become known.

Throughout the whole process it is important to have a continuous dialogue with stakeholders and to keep careful records of all actions taken.

- **Communications** with all people and groups that are or might be affected by the issue, even marginal ones, ensures that their concerns are considered. This helps to build support for the results.
- **Good record keeping** of all the major activities in the process helps to ensure accountability and consistency. It provides a record for future reference. This is especially important so that the decision process can be revisited if new information becomes available.

For relatively simple risk issues, a short version of the process can be completed quite quickly, usually in one or two days. A small team consisting of two or three people with moderate resources can undertake it. More complex risk problems may require a larger team and take more time.

This Guide suggests using a short version of the risk management process as a useful technique for getting started. It focuses on using readily available data and a small risk management or project team. This will help the team explore the issues and possible outcomes rapidly and inexpensively. The results, supported by good documentation can be used to make a strong business case for taking action. The documentation from the overview process can also support a more comprehensive risk management study if one is needed.

3.2 Guiding principles

The risk management process is built upon several important principles:

- **Engaging important affected or involved groups**
  These groups and individuals should be identified and involved during the entire process. The project team may be modified to include members of these groups if it will help deal with the particular issue being addressed.

- **Communication**
  The project team should develop an open and trustful dialogue that continues throughout the decision-making process, with groups and individuals who may be affected of involved with the risk in order to:
  - Acquire useful information;
  - Build awareness of the particular risk and gain support for the process;
  - Facilitate consultation;
  - Evaluate how the people involved or affected accept risks; and
  - Serve as a part of the monitoring and review mechanism.

- **Documentation**
  Records should be thoroughly and carefully taken of important meetings, information sources, and all activities stored in a "risk information library" so that it can easily be retrieved in the future. This will help to:
  - Ensure consistency in execution
  - Promote accountability and transparency
  - Retain records for future reference.

- **Use of existing tools, human and technical resources**
  The project team should make maximum use of existing resources, such as community data, local knowledge and technical expertise, and previously documented experiences.

- **Public Education and Awareness**
  Public education and awareness is important for successfully implementing a larger risk management process. It helps to ensure stakeholder support for its results.

4. Steps in the Risk Management Process

Introduction

This section describes each step in the risk management process, explaining its purpose the actions to be taken and the expected outputs. A checklist is also provided. Examples or case studies in Volume 2 illustrate what is done in each step. The case studies were developed by community representatives in a one-day workshops during the testing of this Guide.

As explained earlier in this Guide, there may be reluctance to commit busy staff to a risk management process that is often believed to be lengthy, difficult and costly. However, faced with increasing evidence and the risk of warming trends, extremely heavy rains and floods, and other climate related events many communities are now convinced that they need to include these risks in their planning.

The initial process recommended in this guide is an overview or simplified examination of the risk or risks that face the community using a small project team and readily available information. This will help define the issues and provide some readily useable results. The outcome may also support the need to do a more comprehensive analysis with which this guide can also assist.

All the forms and tables suggested in this chapter 4 are available for photocopying in the **Workbook** in Volume 2 of the Guide.

STEP 1: Getting Started

Purpose

This step starts the process and completes the following preparatory activities;

- Identification of the specific problem or hazard and the associated risks to people, property or the environment.
- Identification of the members of the project team and principal people or groups that may be affected or involved;
- Determination of the responsibilities of members of the project team and the resources needed to complete the study; and
- Development of a workplan.

The team leader is usually a community planner or a member of the lead department involved. It is important to have the support of a senior manager or if it is a large study, the community council.

The time required by the team to complete the process depends on the scope of the study, i.e. a study of a specific climate impact or a larger strategic study of all impacts. However, as suggested in the previous section, it is recommended that a relatively simple overview of the problem using readily available data, as explained in Steps 2 and 3, would be very useful in developing a better understanding of the issues and scope of the problem. To do this, the team would require only a day or several days to complete a preliminary overview.

Out of this quick preliminary run through of the risk management process the team could expect to:

- Have a better understanding of how simple or complex the issue is,
- Obtain a sense for what the main risk control measures could be, and
- Determine whether the preliminary study is sufficient or a larger more comprehensive study is needed, and
- Know who the important stakeholders are and how they are likely to perceive the risks.

What to do and how to do it?

(1) Establish the project team and its terms of reference, and for a larger study, develop the work plan and the key milestones:

- Select team members with the necessary expertise to deal with the risk issues being considered.
- Ensure that there are representatives from the main organizations that will be responsible for implementing the risk controls. For a larger study, some support or clerical staff may be needed to handle the administrative and

documentation matters. Others, such as legal, technical or financial advisors may be involved at times or review or advise on certain aspects of the work.

- The team leader should ensure that members of the team know their roles and responsibilities with respect to the project and are familiar with the risk management process.

(2) Ensure that the team is clear about the risk issue to be investigated and any restrictions on the scope of the study.

(3) For a larger study, estimate the resources required.

- Determine the internal capacity that is available for the project, including available data, tools (e.g. GIS), human and financial resources.
- Identify the external resources needed and prepare the justification to obtain them if needed.

(4) Assign project team responsibilities, allocate resources and set schedules.

(5) Do a preliminary analysis to identify the principal people or groups that may be affected or involved and begin an estimate which would:

- Identify any individuals or groups that can affect or may be affected by decisions or actions resulting from the risk management process. This group could be quite large.
- Consider their probable interests, concerns, rights and likely issues. Begin to think about how members might perceive various risk issues and how this might affect the decision process and communications with them.
- Recognize that this group may evolve throughout the process.

(6) For a larger project develop a risk communication plan and initiate a dialogue with principal people or groups that may be affected or involved:

- Key questions to consider include: Who is responsible for the communication process? Who are the key audiences? How will the impact of the communications be evaluated? Should some on-going, formal structure be considered for communicating with this group such as a panel? (Annex 2 provides additional information to help with risk communications.)

(7) Start the record keeping and for a larger project, a risk information library:

- The records or risk information library should contain copies of all the information collected throughout the project, including information on the risks, data that are used to analyse the risks, a record of decisions taken, views of the people or groups that may be affected or involved, records of meetings and any other information that may be obtained during the risk management process.
- These careful records will provide the means to trace the logic behind any decisions made. Also it will make it easy for the project team to review the process, should any additional information become available.

Expected results and outputs

- Risk issues are defined.
- Project team established.
- Terms of reference and budget for project team developed and approved.
- Principal people or groups that may be affected or involved have been identified and preliminary analysis of their needs, concerns and probable issues completed.
- Communications or dialogue with groups that may be affected has been considered.
- Collection of records and documentation begun.

Decision

There are three decision options (see the decision diamond in Figure 2 on page 6: End, Go back or Next step/Take action.

- **End** the process if the hazard(s) and risk(s) are considered by the project team to be acceptable.
- If the risk situation continues to be a concern, proceed to the **Next Step, Step 2 Preliminary Analysis**.

Checklist

Step 1: Getting started	
Have you:	
	1. Defined the hazards and vulnerabilities, and their potential management implications?
	2. Established a project team, project workplan and team members' responsibilities?
	3. Identified the resources required to undertake the project, and any existing capacity that is available to the project team?
	4. Identified the principal people or groups that may be affected or involved and begun to define their probable issues, needs and concerns?
	5. Developed a plan for communicating with stakeholders?
	6. Started a risk information library?

For examples of how others have done Step 1 see Step 1 in the case studies in Volume 2.

STEP 2: Preliminary Analysis

Purpose

This step is the beginning of the risk assessment part of the process. The sequence of events or scenario and vulnerabilities are carefully laid out for more detailed examination. The project team now starts:

- To define the climate-related hazard and the potential risks that may cause harm, in terms of loss of life, injury, damage to property, monetary losses to the community or impacts on the environment.
- To consider what the time scales are for the possible outcomes from the risk situation.
- To determine in a very general sense how complex the process is likely to be, confirm the probable time-frame for completing the work and a get a sense for whether the project team and resources assigned are sufficient.

What to do and how to do it?

(1) Develop risk scenarios or sequences of events that could result from the hazards and vulnerabilities identified in Step 1.
- Outline the sequence of events that could flow from each climate-related hazard that could cause adverse effects.
- Expand each risk scenarios to show the types of losses or impacts that could occur. Losses or impacts could include:
  - Injuries or deaths,
  - Health losses due to illness,
  - Property losses,
  - Other economic losses
  - Cultural impacts, and
  - Environmental or ecosystem losses or impairment.
- The risk scenarios will form the basis for more detailed risk estimations and evaluations in Steps 3 and 4.
- A simple table, such as Table 2 below, may provide an easy way to develop and record this information.

Table 2: Preliminary Hazard and Risk Scenario Assessment

HAZARD: .

RISK	EVENT OR RESULT	FREQUENCY			CONSEQUENCE			COMMENT or POSSIBLE CONTROL
		1	**2**	**3**	**1**	**2**	**3**	
	Add as many rows as needed for each risk							
Add as many rows as needed								

Notes: Make rough estimates of (these will be expanded in Step 3)

Frequency:

1. Unlikely to occur
2. Moderately frequent occurrence
3. Almost certain to occur

Consequences:

1. Low
2. Moderate
3. High

(2) Collect data and identify the risk baselines. The first time through the process use whatever data, community opinions anecdotal information and other sources that are readily available:

- Review the existing information on current vulnerability and climate-related risks, based on previous studies and experiences and expert opinion. For example for a flood hazard what information can be taken from the most recent flood experience in your community or others in the region?
- Identify and describe the risk controls currently in place to manage the specific climate-related hazard being considered. Describe their effectiveness and any gaps. Examples of risk controls for a flood situation would be a warning system and evacuation plan, stockpiled sandbags and so on.
- Develop a risk baseline that summarizes the current level of risk using recent historical data and current climate variability, such as recent flood levels, injuries and losses from the last floods, any improvements that were made to protection systems.
- Risks related to climate change will be compared later against current or baseline risks in order to evaluate the need for and benefit of additional risk controls.

(3) Make initial rough estimates of frequency and severity of the events in the risk scenarios. Useful information may be found in historical records, climate change projections (such as those in Annex 1) and by consulting subject matter experts, other communities and other sources to help develop these initial estimates.

(4) Continue the analysis of those people or groups that could be affected by the risk scenarios:

- Now that there is more information on the potential risks, identify any additional stakeholders that should be involved.
- Refine the analysis of their needs, interests and concerns.
- Consider engaging key people of representatives of groups that may be affected by the risks in the management

process, if you have not done so already.
   - Create a database of these people or groups that includes their contact information and the results of your stakeholder analysis. Update the database throughout the process.

(5) If your project team thinks that you may need a risk communication plan, start to outline what this would consist of and begin to implement a dialogue with key people and groups.

(6) Update the risk information library:
   - Organize all the information collected in this step and keep it in a safe, dedicated space. This is where all the information, assumptions, concerns, decisions and changes made throughout the process are kept.
   - The library should include:
     - Baseline data and information on the hazards or trends;
     - Roles and responsibilities of the risk management team;
     - Identification of decision-makers, and scope of decisions to be made;
     - Complete descriptions of the risk scenarios;
     - All stakeholder information, including minutes of meetings with them or other records of stakeholder communications;
     - A record of all decisions and assumptions
   - Record the source of the information and the date it was collected, and any weaknesses or inaccuracies in the data

Expected results and outputs

- Risk scenarios are developed and a preliminary analysis is completed for each, event showing initial estimates of potential losses and frequency.
- Baseline information has been collected, or plans are in place to collect additional baseline information.
- Additional analysis of people or groups who might be affected by the risks has been completed.
- An outline of a communications plan for these people or groups has been developed if it is needed.
- The risk information library is started.
- Important reference material is documented and stored.

Decision

There are three decision options (see the decision diamond in Figure 2 on page 6): End, Go back or Next step/Take action.

- **End** the process if the hazard(s) and risk(s) are considered by stakeholders and the project team to be acceptable.
- **Go back** to Step 1 or the beginning of Step 2 if the project team considers that it is necessary to improve on any aspect of the information developed in those steps or to make any changes, if appropriate. Given the nature of the climate change issue, it is not unusual to have to improve data collection and revisit assumptions in order to enhance the credibility of the entire risk management process.
- If the risk situation continues to be a concern, proceed to the **Next Step.**

Checklist

Preliminary analysis	
Have you:	
	1. Developed risk scenarios and completed a preliminary analysis of their probabilities and consequences?
	2. Established a baseline of data for each of the risk scenarios?
	3. Developed a stakeholder database?
	4. Refined your stakeholder analysis?
	5. Updated the risk information library?

For examples of how others have done Step <u>2 see Step 2 in the case studies in Volume 2.</u>

<u>STEP 3</u>: Risk Estimation

Purpose

In this step a more detailed consideration is given to the probability or frequency and consequences of the events in the risk scenarios and the initial estimates that were developed in

Step 2 Based on the initial estimates made in Step 2 low concern risks can be discarded from further consideration.

What to do and how to do it?

(1) Consider what methods your team should use for estimating frequency and consequences. Some options are:
  - Historical records, including community records and newspapers, to determine trends of climate events and impacts,
  - Technical data and projections from Annex 1, IPCC reports (on line), NRCan publications (also on line) or from provincial, territorial, or other federal government sources, and
  - Expert or knowledgeable opinions.

(2) Estimate the frequency or likelihood of possible outcomes**
  - For the simple analysis suggested in this guide, an easy four or five tier comparative rating system (such as a scale from "occurs very often" to "occurs almost never") is useful for assessing the relative frequency of risk scenarios.
  - For climate change assessments, events should be estimated to a future date that stakeholders can relate to, for example 10 or 20 years into the future, or for major projects, 40 or 50 years out.
  - For familiar hazard and events such as floods, fires or diseases, estimates can typically be derived from readily available historical data such as, in research reports, insurance company records or from similar risk situations in other communities, regions or countries.
  - If the team has the technical experience, the use of sensitivity-type analyses, technical projections, expert judgment or other practicable and credible methods to put some boundaries or estimate of uncertainty on the projection of the frequency of the outcomes.

(3) Estimate the consequences of possible outcomes**:**
  - As with frequency estimates, a simple comparative impact rating system (such as a four or five tier scale from "very minor effects" to "extremely serious effects") may be useful for making relative estimates of various consequences from a particular risk scenario. If extensive loss and other impact data are available, explicit values could be used in a tabular form so that the comparative severity can be compared. At this stage, definitive measures are not necessary as this is a ranking process to determine which risks are the most severe.
  - Estimate the magnitude of the various impacts of a risk situation, in the event that the risk scenario occurs. Use measurable, verifiable data wherever possible. Again, look for data and information in research reports, insurance company records or information from similar risk situations in other regions or countries.

(4) Assess the perceptions of risk by those people or groups who might be affected. As explained in more detail in Annex 2, these perceptions of the importance, particularly of the consequences of risks, is very important and may have a very big influence on the ranking of risks.

(5) Display the frequency and consequence estimates in a tabular or graphical format that clearly indicates the relative importance of each scenario.
  - Determine how best to present the frequency and consequence estimates. Consider how stakeholders may interpret the estimates. Table 3-1 shows one way of displaying frequency or probability
  - It may be helpful to consider the expected consequences under several sub-categories, for example, social, economic and environmental aspects. This may make comparing the losses or consequences easier and provide a baseline for later evaluation of risk control measures. Table 3-2 shows one way of displaying these. The headings in this table are generic and the project team should give some consideration to what factors are important to them.

It is important that the project team reach a consensus about the levels of frequency or probability and consequences for each event in the risk scenario. If at the end of this step there is disagreement among team members, the step should be repeated or the disagreement flagged for review later.

TABLE 3-1: Frequency / Probability Rating

Probability or Frequency / Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Events from scenario (list each)	Not likely to occur during the planning period	May occur sometime but not often during the planning period	Likely to occur at least once during the planning period	Likely to occur several times during the planning period	Happens often and will happen again during the planning period

Note: If the event is ongoing the frequency should be related to it reaching a more severe level than what is occurring now.

TABLE 3-2: Impact Rating Matrix

Impact / Degree	Social factors				Economic factors			Environmental factors			
	Health & Safety	Displace-ment	Loss of Livelihood	Cultural Aspects	Property Damage	Financial Impact	Impact on communit y	Air	Water	Land	Eco-systems
Very low											
Low											
Moderate											
Major											
Very Severe											

Note: In both tables 3.1 and 3.2 the measurements are expressed in comparative terms ("very unlikely" to "virtually certain" and "very low" to "very severe"). It is also possible to express these in numerical values so that adding or multiplying them gives a quantified relative frequency or impact consequence. The problem with using numerical values is that the reader may think that it implies more accuracy than actually exists. The project team should consider the method to be used to compare relative frequency and impact or consequence values and agree on the most appropriate way of assigning relative values.

(6) Consult with the key people or groups that might be affected or concerned and refine the stakeholder analysis

- If the project team considered it important in Step 2 to engage them in a meaningful dialogue this should begin to be implemented now. Discussions should be held about the risk estimates and their issues and concerns. In a simple study this may be through conversations with a few representatives of the most important stakeholders. For larger studies, the project team might consider using focus groups, workshops or public meetings.
- Communicate information openly and in language and detail that these people of groups can understand. Provide information on the risk baseline (that is the risk frequency and consequences that exist now), methods for developing the risk scenarios and for estimating frequencies and consequences, assumptions, third party analyses and any other relevant information.
- Some people may not agree with the frequency or consequence estimates. Record their different views. Later in the process, return to this step, if necessary, to test and discuss the sensitivities of the proposed adaptation measures to these different views of frequency or consequences.
- Stakeholders' issues and concerns will probably change as they become more familiar with the risk scenarios and the risk management process. Document these changes on an ongoing basis.

- Consider using a chart such as the one shown in Table 3.3 below to list the stakeholders and their attitudes about various risks.

TABLE 3.3 Suggested display for stakeholders and risk perception.

Climate Factors: (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community	Stakeholders and perception of Risk
	Use a many rows as needed	

(7) Update the risk information library with all data from this step. Carefully document all sources used.

Expected results and outputs

- Estimates of frequency and consequences of risk scenarios.
- Presentation of frequency and consequence estimates in a format that is easy-to-understand by non-experts.
- Estimates of the acceptance by stakeholders of risk, or a record of reasons for non-acceptance, based on a dialogue with the stakeholders and a careful documentation of their perception of the risks.

Decision

- **End** the process if the estimated risks are much lower than initially estimated in the preliminary analysis, and stakeholders agree that there is no longer a significant concern.
- **Go back** if:
  - There is new information that needs to be considered;
  - Additional risk scenarios need to be considered;
  - There are doubts about data quality or analytical methods; or
  - Not all important stakeholders are comfortable with the level of uncertainty associated with the analysis.
- Proceed to the **next step** if the project team is comfortable with the data, assumptions and outcomes of the risk estimation process.

Checklist

Risk estimation	
	1. Are you satisfied with the quality of your data?
	2. Have you analyzed and assigned appropriate levels of frequency to each event in the risk scenario?
	3. Have you calculated the expected loss or other consequences from each risk scenario?
	4. Are you comfortable that stakeholders' perceptions have been assessed for each of the risk scenarios? Have stakeholders endorsed your analysis?
	5. Has the process been carefully documented and the risk information library updated with all relevant information?

For examples of how others have done Step 3 see Step 3 in the case studies in Volume 2.

STEP 4: Risk Evaluation

Purpose

In this step, the project team develops a process for comparing or ranking each risk scenario. They do this by:

- Evaluating the risks in terms of costs, benefits and acceptability, considering the needs, issues and concerns of the principal people or groups that may be affected or involved.
- Identifying unacceptable risks and ranking them for risk reduction or control measures.

What to do and how to do it?

To this point in the process, only the hazards, events and risks have been analyzed. Now the risks will be compared in terms of the values that were used in Step 3. Other factors may also be brought into consideration such as the costs and benefits of that might accrue, such as changing authorized land uses or the location of recreation facilities.

(1) Compare the risks considering the probability and consequence analyses from Step 3. The team will have to arrive at an overall consequence rating from the more detailed assessment of social, economic and environmental consequences. It is suggested that the team use a simple and convenient consequence scale ranging from very low to extreme along with the frequency or probability estimates.

- Consider using a “risk evaluation matrix” to assist in comparing or prioritizing the various risks. The chart below in Figure 3 is an example for such a display. Combine the frequency and consequence ratings for each risk as determined in Step 3 into a single value to be entered into the matrix. Establish acceptability values against which the various risks can be compared. This chart uses qualitative measures such as “very low”, “low”, “moderate”, “major” and ”extreme”. Other comparators such as numerical values may be used so long as they do not imply an unrealistic accuracy.
- Because experts and non-experts generally view risks differently, it is important to maintain an open and interactive dialogue with the principal people or groups that may be affected or involved in order to accurately gauge their level of acceptance of risks.

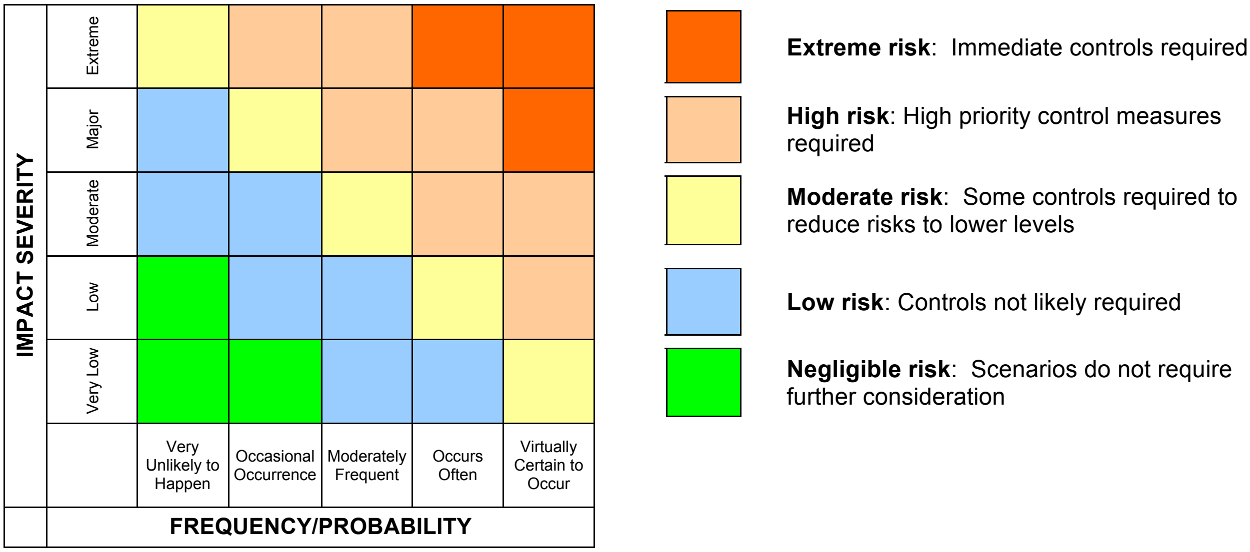
(2) It is helpful at this stage to also consider the costs and benefits of each risk scenario including not only the direct costs and benefits but also the important indirect ones. For example, shorter freezing cycles may create problems for winter recreational facilities but it may also bring benefits such as less snow removal costs.

(3) Assess how the principal people or groups that may be affected or involved view the acceptability of risks in your risk matrix.

(4) During the dialogue with stakeholders about their perceptions and the acceptability of the risks, begin to identify risk control options to help reduce unacceptable risks to acceptable levels. These will be considered in the next step.

(5) Update the risk information library

Figure 3: Risk Evaluation Matrix



Expected results and outputs

- Risks evaluated in terms of probability, consequence, with some sense of costs and benefits.
- Risks ranked or prioritized.
- Unacceptable risks identified.
- Meaningful dialogue has occurred with stakeholders about acceptability of risks.
- Risk information library updated.

Decision

- **End** the process if:
  - Stakeholders agree that all the risks are acceptable; or
  - The risks are completely unacceptable, cannot be reasonably dealt with, and all stakeholders agree that the process should be ended.
- **Go back** if:
  - There is insufficient data or information to make a decision;
  - The principal people or groups that may be affected or involved were not adequately consulted; or not all key stakeholders agree with the conclusions; or
  - There is new information that might materially change the frequency or consequence estimates.
- Proceed to the **Next Step** if stakeholders agree that the risks are unacceptable and that risk control measures will have to be implemented

Checklist

Risk evaluation	
	1. Are the risk evaluation and ranking completed?
	2. Are all of the major considerations accounted for?
	3. Have you consulted with all key stakeholders on the acceptability of risks?
	4. Have you given preliminary consideration to controls for unacceptable risks?
	5. Is the risk information library updated?

For examples of how others have done Step 4 see Step 4 in the case studies in Volume 2.

STEP 5: Risk Controls and Adaptation Decisions

Purpose

In Step 4 the risks were evaluated and ranked, and a dialogue was held with the principal people or groups that may be affected or involved about the acceptability of the risks. For unacceptable risks, some consideration was given about potential risk control or adaptation measure being introduced to bring risks down to acceptable levels. In this step:

- Feasible adaptation measures or risk control strategies will be identified for reducing unacceptable risks to acceptable levels.
- The effectiveness of the adaptation measures or risk control strategies will be evaluated including the costs, benefits and risks associated with the proposed adaptation measures.
- Optimal adaptation or risk control strategies will be selected and consideration will be given to the acceptability of residual risks.

What to do and how to do it?

(1) Identify feasible adaptation or risk control options:
  - Identify all potential adaptation actions that could reduce the frequency or the consequences of the risks.
  - Typically, an adaptation or risk reduction strategy will consist of a portfolio of measures, for example some short-term actions to deal with immediate concerns and some more comprehensive longer-term actions. Together, these measures should offer a cost-effective means for reducing unacceptable risks to acceptable levels.
  - Some examples of risk control measures could include: inspection, monitoring, research, planning, relocation, changed guidelines or standards, mapping, updating emergency plans, developing capacity, etc.

(2) Evaluate the adaptation or risk control options in terms of effectiveness, cost, residual risks and stakeholder acceptance.
  - Estimate the effectiveness of the proposed options using historical data and the professional judgement or the project team.
  - Identify and assess residual risks caused by the control option.
  - Communicate with the principal people or groups that may be affected or involved on potential control options in order to gauge their acceptance of risk controls and perceptions of residual risks.
  - Evaluate the risk control options in terms of:
    - Its effectiveness in reducing losses or impacts or changing probabilities.
    - The implementation and maintenance costs.
    - The needs, issues and concerns of affected stakeholders.
    - A suggested table for displaying this information is shown below.

Table 5.1: Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure (Use as many rows as needed	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation

The costs and benefits of adaptation measures can be difficult to assess, so it is important that the project team has access to the relevant expertise if they need it. An example would be the impact of reduced use of a wastewater treatment facility because of expected higher water levels. To build a new facility would be very costly. In the short term the community might have to forgo other developments. In the longer term, better facilities might strengthen the community's treatment capacity and allow more residents and businesses without additional infrastructure costs. Any of these outcomes has associated economic, social and cultural costs and benefits that could affect the analysis.

(3) For a larger study it may be desirable to develop an implementation plan for the adaptation or risk control measures.

(4) If needed, develop a risk communications plan related to residual risks

- Sometimes it may be possible to encourage private adaptations to further reduce residual risks. For example, communities can encourage residents to keep valuables out of lower levels that may flood during a heavy precipitation event. The community can influence the amount of losses from extreme weather events.

(5) Update the risk information library

Expected results and outputs

- Feasible risk control options are identified
- An adaptation plan is completed.
- The implementation of adaptation measures has been considered.
- The principal people or groups that may be affected or involved have accepted risks and residual risks.
- Risk information library updated.

Decision

- **End** if there are no feasible adaptation options.
- **Go back** if:
  - Adequate data are not available for evaluating the cost-effectiveness of potential risk controls.
  - Key stakeholders have not been consulted.
  - Assumptions and uncertainties associated with estimates are not acceptable to stakeholders, or
  - New risks will be introduced if the proposed control options are implemented.
- Proceed to the **Next Step** if:
  - Feasible adaptation or risk control options are defined and can be implemented.
  - Proposed actions are feasible from a cost and effectiveness perspective and are acceptable to stakeholders, and
  - Residual risks are acceptable to stakeholders.

Checklist

Adaptation and risk control	
Have you:	
	1. Identified and evaluated feasible adaptation or risk control options, in terms of costs, effectiveness, stakeholder acceptance and other criteria?
	2. Selected the complement of adaptation or risk control options that best reduce risks to acceptable levels?
	3. Determined the costs and benefits of the risk control measures?
	4. Assessed and addressed any outstanding stakeholder concerns?
	5. Developed a risk communication plan for the proposed adaptation or risk control measures and for the residual risks?
	6. Ensured that the risk information library is updated?

For examples of how others have done Step 5 see Step 5 in the case studies in Volume 2.

STEP 6: Implementation and Monitoring

The implementation and monitoring component should be considered even in the preliminary overview that is the primary focus of this Guide. It would be done only in cursory form until the risk management study has been reviewed and approved by the senior administrator or by the municipal council.

Some of what is discussed below would be required only in a larger study or if the study is approved to move ahead to a more detailed planning stage.

Purpose

- To develop and implement the adaptation plan.
- To ensure that the implementation plan will be monitored for effectiveness and costs of the adaptation responses.
- To decide to continue or terminate the risk management process.

What to do and how to do it?

(1) Develop the outline of how the adaptation plan will be implemented.
  - Consider priorities for action for each adaptation measure and develop an outline implementation plan.
  - Link the implementation plan to other community programs where possible. For example, there may be a program to protect public health when water quality is compromised. Your risk control or adaptation measures for flood risks could be linked to this program.
  - Decide the timing for the implementation of adaptation or risk control measures. Some risk issues may not surface for years, or it may not be feasible to address them immediately. In these cases, defer implementation of some components until a future date.
  - Establish a date to review the adaptation plan and record it in the risk information library.
  - Before submitting the implementation plan for approval, review any similar climate change risk management initiatives, for example, from neighbouring communities, and compare your results to theirs.
  - Look for opportunities to collaborate with other communities or organizations. Unfortunately, climate change impacts will not be related to political boundaries, but adaptation responses could be. Collaborate where possible to improve the effectiveness of adaptation responses.
  - As part of the implementation plan identify special expertise or external assistance that may be required.

(2) Develop and establish the monitoring process
  - Monitor the adaptation measures or risk controls by measuring environmental or performance indicators, stakeholder reactions, costs and benefits, or other indicators. Some may have been suggested during Steps 2, 3 or 4, or during the various stakeholder communications.
  - The project team could suggest that a monitoring and review team be established to continue this function for as long as needed.

(3) Submit the implementation plan for approval.

(4) Continue to communicate with the principal people or groups that may be affected or involved.
  - At this stage, communications might include ongoing public education and outreach or information sharing with other communities and sectors on your experience with the risk management process. Consideration should be given to ensuring that the residual risks are understood and communicated and that they will continue to be acceptable.
  - Record all communications in the risk information library.

(5) Review and repeat the process, as needed:
  - Consider repeating the risk management process if it involves complex issues that are not fully understood.
  - In the second iteration, include new information as it becomes available and improve the analytical methods for drawing results and conclusions.

Expected results

- Outline implementation plans that include:
  - An overview of costs and milestones.
  - A list of experts and expertise that was revealed during the risk management process that can contribute to the adaptation response and risk controls.

- A database of ongoing activities that could facilitate the implementation of the plans.
  - Consideration of information exchange across sectors and between other communities.
  - Mechanisms for training and capacity building in the risk management process and on climate change impacts.
  - Considerations for reporting on progress and evaluating results.
  - An evaluation and monitoring process plan.
- Implementation initiated
- Risk information library updated. Include documentation of the methodology for implementation that can be made available to other vulnerable sectors and other regions.

Checklist

Implementation and Monitoring	
Have you	
	1. Developed a feasible outline implementation plan?
	2. Identified links with ongoing activities in the community and beyond (e.g. national, regional or local initiatives)?
	3. Identified resources to implement the plan?
	4. Established an effective monitoring and review program?
	5. Submitted the implementation plan for approval?
	6. Developed a communication strategy to support implementation?
	7. Ensured that the risk information library is updated?

For examples of how others have done Step 6 see Step 6 in the case studies in Volume 2.

All the forms and tables suggested in this Chapter 4 are available for photocopying and use in the **Workbook** in Volume 2 of the Guide.

5. Summary and Conclusions

This Guide is intended to be a tool to help community and local governments and other organizations make sensible and practicable decisions to adapt to a changing and more variable climate.

It uses a process that is based on a national risk management standard that is accepted by senior managers, scientists and the financial community across Canada. The guide is written to emphasize the simplicity and practicality of the process. It also recognizes that larger studies of climate risks and adaptation responses may be desired or necessary and the process is equally applicable to these situations.

It is not easy to get started; municipal governments have many pressing issues that demand attention and their staff are torn between conflicting priorities. In spite of mounting evidence that gives credibility to climate change and increasing variability some communities have not fully accepted the need to start now to examine their situations and what the future may hold.

Another important aspect is that the costs of climate change are already becoming apparent in every aspect of community life; damages from sever weather events, additional construction costs for unstable soils and so on. The sooner that adaptation measures can be implemented the sooner that measures can be developed to control costs related to climate change.

This Guide suggests that some preliminary analyses could be undertaken at little cost that would provide a convincing case for adaptation action. Officials of local governments could use these analyses to promote a higher priority for, and early consideration of, climate risk.

Even though it is evident that climate change is already occurring there is still time to take effective adaptation actions. Climate change predictions indicate that there are major challenges and opportunities facing our communities. The Guide includes a summary of the most important current documentation and a list of references if further research or information is desired.

The risk management process outlined here provides a simple and very credible technique for assessing the most important actions that will be needed to address the changing climate risks. It is not only methodical and easy to use but it also emphasizes the importance of communicating with those affected by these risks and gauging acceptability of proposed adaptation measures.

The process does not end with the first iteration. It requires that the adaptation or risk control measures be monitored and periodically validated. It also requires that new information and new technologies that would alter the risk estimations be included in a repeat of the analysis.

The case studies and examples in Volume 2 of the Guide are intended to illustrate how to do the process. In order to keep the text as short as possible, the examples have purposely been kept simple to demonstrate the process not the detail of the risk. The forms and tables used in Chapter 4 are available for photocopying in the **Workbook**: in Volume 2 of the Guide.

Finally, a brief description of the importance of risk perception and a glossary of risk terminology is included. The recognition that different people and organizations perceive the same risks very differently is vitally important to a successful risk management process. Also, differing risk terminology has been and is still being used by various professional bodies and sciences. The glossary of terms that is taken from the Canadian national standard will provide some relief for users of this guide from the inevitable arguments about terminology.

Annex 1: *Climate Change Projections for British Columbia*

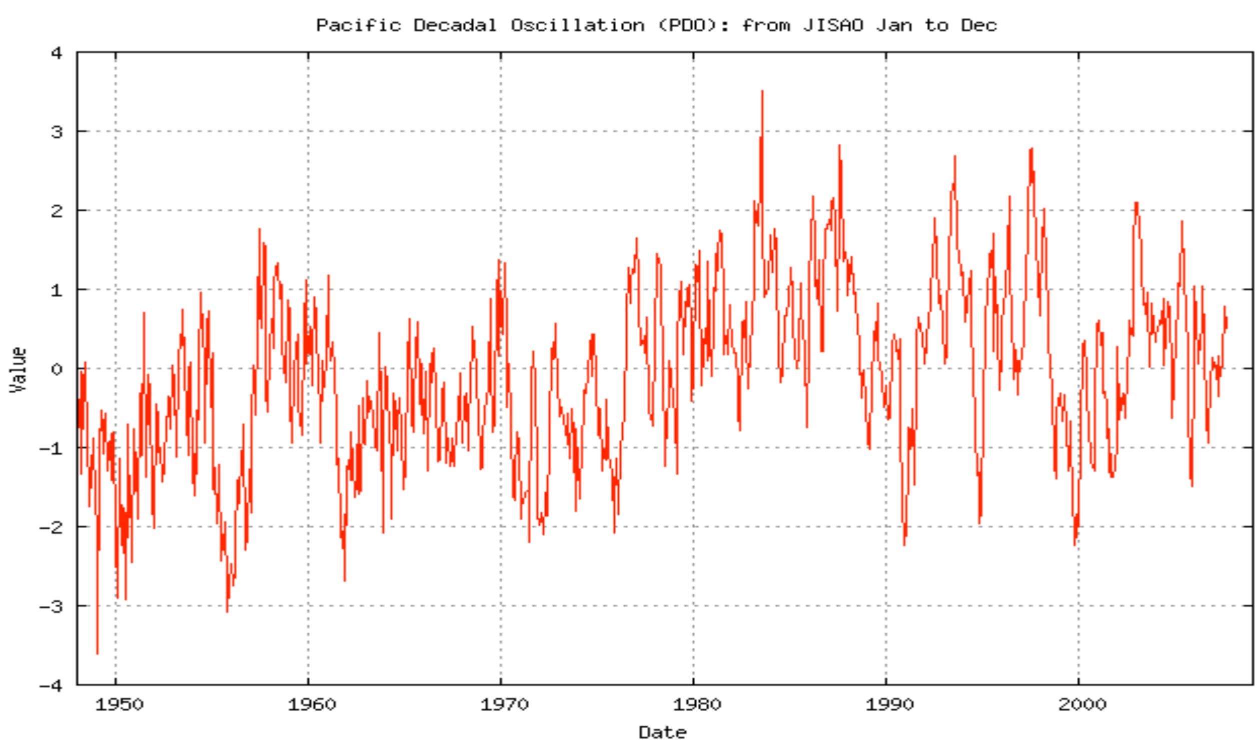
INTRODUCTION:

The following summary of observed and expected climate change in British Columbia is drawn from an extensive literature. Questions of impacts of the changes and adaptation options are not discussed here since they are extensively covered in Chapters 7 and 8 of the publication of Natural Resources Canada, *"From Impacts to Adaptation: Canada in a Changing Climate 2007".*
http://adaptation2007.nrcan.gc.ca

1. FACTORS INFLUENCING CLIMATE

Future climate in Canada's western-most provinces will be influenced by long-term (decades to centuries) changes induced by increasing greenhouse gas concentrations in the atmosphere, and by behaviour of the natural modes of variation in the climate system. For western Canada, the oscillation between El Nino and La Nina (ENSO) in the tropical Pacific Ocean and the Pacific Decadal Oscillation (PDO) in the North Pacific, influence the year to year or even decade to decade climate. In some publications, the warming of the west has been attributed almost entirely to the shift in PDO from negative to positive about 1976. However, as can be seen from Fig. 1, the PDO was not consistently positive from 1976 on but was in a negative phase in late 80s and early 90s, and again in the period around 2000. However, the ENSO phenomenon appears to be more important especially in extreme cases. For example, in the record western drought in 2001-2002, the PDO was mostly negative, normally resulting in wetter conditions. However, in this period an El Nino condition prevailed and apparently dominated in the influences of the Pacific Region resulting in drought conditions especially in Alberta. El Nino and La Nina events occur on average every 7 years, but are quite irregular in timing and intensity.

A positive PDO and El Nino in winter results in temperatures 1 to 2°C above normal in B.C. In contrast a negative PDO and La Nina indicate winter temperatures below normal. In general, positive PDO results in warmer and drier conditions on average in the whole region than does PDO in its negative phase, but this can be significantly modified by the ENSO conditions (Shabbar, 2008).



Shabbar, Amir, EC

Recent papers, (Bonfils, et al., and Pierce, et al., Dec. 2008), ;have sought to determine the factors to which may be attributed observed changes in temperature, and snowpack April 1, in mountainous western U.S.A. However, the results have applicability at least in southern parts of B.C. and the East Slopes in Alberta. They found observed winter temperature trends were only slightly less (~0.5^{o}C) from 1950-1999, near and just over the Canadian border, when PDO/ENSO effects were taken out. The Bonfils, et al., 2007) study also considered effects of solar variability and volcanic emissions on temperature trends, and found that they were insignificant compared to the anthropogenic (greenhouse gas and aerosol) forcing. Pierce, et al., found that for the observed decline in snow water equivalent at 1 April, divided by precipitation for that year to show the effect of winter melt, was about ½ due to anthropogenic forcing over this whole western U.S. area. The balance was due to natural variability effects of PDO/ENSO.

2. OBSERVED TRENDS IN GREENHOUSE EFFECT

Greenhouse gas concentrations in the global atmosphere have been increasing since the late 1800s. By 1970 the additional energy they induce in the climate system had overcome the effects of natural forcing factors such as changes in solar energy reaching earth, and volcanic emissions (IPCC, 2007). Thus, trends of climate factors from say 1950 have been increasingly driven by the greenhouse effect and have covered several Pacific Decadal Oscillations. These trends are useful indicators of future climate trends since greenhouse gases will overwhelmingly dominate changes to mid 21st century and beyond. One must envisage a generally warming trend with temperatures temporarily above and below the trend line depending on the state of the PDO and ENSO.

3. ACCELERATION OF CLIMATE CHANGE

Recent information on GHG concentrations, emissions and impacts lead to the view that climate change is advancing more rapidly than estimated earlier. CO2 global atmospheric concentration increases averaged 1.6 ppm/year from 1970 to 2007, but 1.9 ppm/year from 2000 to 2007 (Levinson, 2008).

2. TEMPERATURE TRENDS OBSERVED:

At the same time the International Energy Agency in late 2007 reported that global energy use and greenhouse gas emissions have been rising very rapidly. They project a 55% increase in world energy needs between 2005 and 2030 and a 57% increase in greenhouse gas emissions. This could be tempered by aggressive global efforts to reduce emissions, not evident to date. Of course, an economic downturn could have short term effects on these rates of change.

A 57% increase to 2030 is substantially more rapid an increase than the most rapid increase in SRES emission scenarios of IPCC that have been used in previous climate projections. The evidence in the climate system of the acceleration of greenhouse gas emissions and concentrations can be seen in several manifestations. The decline in ice cover in the Arctic has been more rapid than any of the IPCC scenario modeled results. Ice melt in Greenland, and effects in Antarctica have recently exceeded the rates of change projected by IPCC.

Thus, it would not be unreasonable to assume that the rate of change is accelerating.

4. REGIONAL SCALE MODELLING:

Recent regional scale climate modeling suggests some modification to the usually quoted changes in climate from General Circulation Models to 2050 (Salathé, et al., 2008). These appear to be particularly important in coastal British Columbia and to a lesser extent in south central B.C

II. SPECIFIC PROJECTIONS FOR BRITISH COLUMBIA:

1. INTRODUCTION:

With greenhouse gas concentrations increasing, temperatures rise, with positive and negative departures from the average increase due mainly to the state of ENSO and PDO in the Pacific. The observed trends of temperature and precipitation since about 1950 cover several PDO sign reversals and a number of El Nino and La Nina situations. These trends then can be assumed to be due largely to the greenhouse effect (Bonfils, et al., 2008)

Table II -1

Temperature Increases ºC, B.C. 1950-1998 (Ref: Zhang, et al., 2000)										
	Winter		**Spring**		**Summer**		**Fall**		**Annual**	
	T. max ºC	T. min ºC	T. max ºC	T. min ºC	T. max ºC	T. min ºC	T. max ºC	T. min ºC	T. max ºC	T. min ºC
Coastal	1 to 2	1 to 1.5	*1.5 to 2.5	*1.5 to 2.5	*.5 to 1.0	*1.0 to 1.5	.5 to -.5	.5 to 1	1 to 2	1
Southern	.5	.5 to -1	1.5	*1.5 to 2	.5 to 1	*1.5	.5	.5	1	*1.5
Northern	2 to 3	2 to 3	2 to 3	2 to 2.25	.5 to 1	1.5	.5 to -.5	0 to -.5	1 to 2	1 to 1.5

Notes: T. - Temperature
* - significant at 95%
Ratio of snow to precipitation total, declined 5 to 10% in coastal region in winter and 5 to 20% in most of province in spring

Warm nights were more frequent by 30 to 50 days over 54 year period in southern and central region, (1952 – 2003) (Vincent and Mekis, 2006). Warm nights were defined as a 95% probability of increase over the average of 1900 to 1951 period. Warm days also increased but at a lesser rate. Cold nights declined to 30 from 50 days over most of the province and cold days by almost as much. Frost days declined by up to 50 for the 54 years over most of B.C.

The B.C. Ministry of Water, Land and Air protection (2002) reports that the average summer temperature of the Fraser River has risen with increased mortality of migrating salmon. Impacts of changing ocean temperatures on anadromous fish are discussed in Ch. 9 of NRCan's volume from Impacts to Adaptation (Bruce and Haites, 2008).

There has been a 5 to 16% increase over a century in growing degree days. An estimated 5% decline in average heating needs has been offset in the interior by a 24% increase in cooling requirements.

Projected Temperatures: General circulation models, assuming high IPCC greenhouse gas projections (perhaps still conservative) project by 2050, a 2+ degree warming over most of B.C. Mesoscale modeling suggests a larger temperature increase on Vancouver Island and in coastal regions in all seasons (Salathé, et al., 2008). The frequency of warm nights is expected to continue to increase by 7 to 10 days per decade. Frost days are projected to decline by about 1 day per year on average.

2. PRECIPITATION:

Table II - 2

Precipitation Trends, %, B.C. 1950-1998 (Ref: Zhang, et al., 2000)					
	Winter %	**Spring %**	**Summer %**	**Fall %**	**Annual %**
Coastal	-10S to +10N	+10 to +15	+10 to +15	-5S to +10N	+10 to +15
Southern	-10 to -25	*+30 to +40	+25 to +40	+25 to + 40	*+25
Northern	-5 to +10	0 to +10	+10 to +20	+10 to +20	+10 to +20

Notes: T. - Temperature
* - significant at 95%

Precipitation Projected: Precipitation in the North is expected to continue to increase, by about 10% more by 2050. In the South and Coastal regions an additional increase of about 5% is projected by 2050. Seasonal distribution of changes observed to date (Table 2) is likely to continue. However, more of the precipitation will fall as rain rather than snow as observed since the 1950s.

3. SNOWPACK April 1:

Declined 1950-1997 by 20 to 60%, except some increase in Okanogan area (Mote, 2003).

4. GLACIERS:

Melt water from glaciers is important in sustaining streamflow, especially in late summer and early fall. For example, it is estimated that 10 to 20% of the annual flow of the Columbia River in Canada, and 60% of summer flow, originates from glaciers. These are nearly all in retreat and most have been projected to disappear this century (Walker and Sydneysmith, 2008). Mass balance measurements over time are rare, but for Place glacier in southwestern B.C. the decline in water equivalent since 1965 has been an estimated 34.6m. water equivalent (Global Glacier Changes, UNEP, 2008).

For North American glaciers as a whole, including these in B.C., 1946 to 1955 was a period of growth, but since then, declining mass balance has accelerated. In the latest decade to 2005, it has been at a rate of 0.65m water equivalent per year.

Glaciers contribute to river flow as they melt, up to a tipping point when their shrinking size means declining flows. It is not certain how close B.C. glaciers are to their tipping point, but it is estimated that those on Rocky Mountain east slopes have already passed this point..

5. RIVERFLOW:

As in most of western Canada, annual flows of rivers in the south have been declining since 1967 and increasing in the north (Zhang, et al., 2001). Throughout B.C., spring runoff is occurring earlier and except in the north there is a trend towards longer periods of low flows in late summer and autumn. In southern and central regions, 7-day low flows have declined significantly in the past 40-60 years (Ehsanzaleh and Adamowski, 2007).

For interior basins such as the Columbia and Okanogan, spring peak flows have been earlier and droughts (e.g. in 2003) have placed increased stresses on water supplies for hydro power, agriculture, aquatic ecosystems and community supplies.

Projected: By 2050, winters flows are projected to continue to increase, with more melt periods. Peak flows are expected to be from 15 to 40 days earlier, and due to declines in 1 April snow packs and glacier contributions, less flow in summer. Demand will increase. For example, in the Okanogan, a combination of increased population and warmer conditions would result in a near doubling of residential demand by 2050 and a 60% increase in crop water demand by 2080 (Cohen, 2006).

6. SEA LEVEL:

Globally, mean sea level has been rising at an accelerating pace from 1.8mm/year since 1961 to an average 3.1mm/year since 1993. Observations on the B.C. coast showed a 20th century relative rise of 4cm in Vancouver, 8cm in Victoria and 12cm in Prince Rupert. Land on most of the coast is rising from isostatic rebound and tectonic forces, partially off-setting sea level rise. However, these factors actually result in a decline in relative sea level of 13cm at Tofino on western Vancouver Island.

However, in one critical area of the lower mainland, subsidence is occurring, increasing the threats of sea level rise and storm surges. This is the Roberts Bank and Fraser River Delta region including Delta, Richmond and parts of Vancouver Surrey and Burnaby near the Fraser Rivers. Subsidence is because of human interventions, including dykes, which inhibit deposition of river sediment in this area. Indeed, in this region some 220,000 people live at or below present sea level and are protected from river floods and the sea by dykes that were not build to accommodate sea level rise. Subsistence is as much as 3mm/year (Bornhold, 2008). The important ecosystems on the Banks and on land, as well as the safety of these residents are at risk in the event of a major storm surge, especially in El Nino Conditions, on top of the generally rising sea. Of course, if these sea level events were to occur simultaneously with a major flood on the Fraser River, losses could be enormous.

A study of sea level rise at Prince Rupert indicates that superimposed on the inexorable but slow mean sea level rise, strong El Nino conditions (1982-3, 1997-8) can result in as much as an average 3.4mm/yr additional rise, and combined with greater wave action and storm surge incidents can result in serious shore erosion damages.

Projected mean sea level rise by 2090-2099, from 1980-1999 is 0.3 to 0.6m with the highest IPCC emission scenario. However, this does not include very uncertain estimates of contributions from major ice fields of Greenland and Antarctica (IPCC, 2007) which could add an additional 2/3 metre to the rise. In addition, as storms south of 60ºN continue to increase in intensity (see next section) storm surges and wave action will increase flooding and erosion episodically.

7. EXTREME EVENTS:

B.C. is not immune to the global trends towards more extreme weather events. In the 21st century, severity and costs of extreme events in B.C. has risen dramatically including wildfires, insect infestations, storm surges, high waves, heavy rains causing landslides and floods, and drought. In winter, ice jams, winter flooding and freezing rain events have caused hardship and damages. Significant wave heights have risen on the coast by about 1cm/decade (Gulev & Grigorieva, 2004) since 1950, due to more intense storms (Lambert, 2004).

While regional estimates of frequency of high intensity rains were not available, the U.S. Global Change Program reports a 16% increase (1958 to 2007) in amounts falling in heavy events (heaviest 1% of daily events) next door in Washington State. A similar trend was likely in southern B.C. Highest 5-day precipitation amounts, very wet days (greater or equal 95th percentile) and heavy precipitation days (greater or equal to 10mm) all increased in the southern mainland since 1950 (Vincent and Mekis, 2006). Similar trends at a lower significance sere observed over much of Vancouver Island. **Projections:** The frequency of intense winter storms south of 60^{o}N is projected to increase by ~18% in the decade 2018 to 2027 although total numbers of winter storms is projected to decline (Lambert, 2004). Significant wave heights and storm surge heights will thus increase on the coast.

Rain intensities are projected to continue to increase as a warmer atmosphere holds more water vapour (precipitable water). An ensemble of models project an increase in the 20 year return period heavy rain by 10 to 15% along the coast and 5 to 10% inland by mid 21st century (Kharin, et al, 2007)

Minimum temperatures experienced only once in 20 years on average are projected to increase over much of B.C. by 2^{o}C by mid century. Little change is expected in extreme maximum temperatures (Kharin, et al, 2007)

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Annex 2: Risk Communications and Perceptions

Introduction:

An individual or a work team that will be making decisions about risk should understand the risk in terms of the needs, issues, and concerns of the affected stakeholders. There will also be a requirement to communicate with a broad variety of individuals, organisations, informal groups, the news media and governments about risk. This Annex provides some insights into the difficulties of understanding perceptions about risk and some thoughts about how to effectively communicate about risks.

Risk Perception - How Different People Value Things Differently:

The value associated with something that may be lost or is at risk differs from one individual to another. It can also differ for the same individual, depending on his or her circumstances at the time. For example, take individual responses to extremely hot weather. A worker in an air conditioned building, who travels to work from an air conditioned apartment complex in air conditioned public transit may not feel much stress or discomfort. On the other hand, an outside worker who lives in an uncooled apartment and drives to work in a car without air conditioning would find the heat very stressful. The two individuals perceive the value of air conditioning quite differently because of their differing needs and priorities at the time. The inside worker would find the risk of losing his air-conditioned environment much more disturbing than the outside worker

This sense of value may also vary a lot depending on the time or other transient factors. For example, the inside worker's valuation of his air-conditioned environment may be substantially lower in the cool early morning than in the heat of the afternoon. If the air conditioning is too cold, it may not be wanted at all. In fact over air conditioning may generate a negative value if the person gets sick from being too cool.

Now consider the risk of losing the air-conditioning completely. If the weather is very hot, the inside worker may find any risk of losing the air-conditioning unacceptable. If, on the other hand, the weather is very cool, he or she may be indifferent to losing the air-conditioning.

The acceptability of the risk depends on the value or utility placed on the item at risk (in the example above, air-conditioning), which depends on the needs of that individual, at that specific time.

Not all considerations of utility are time-sensitive. For example, if we value the environment, we probably always will value the environment. If we are concerned about a changing climate, we will probably always be concerned about the changing climate and how to adapt to it. The terms "needs", "issues", and "concerns" are often used to refer to those factors that affect our perceptions of risk.

Different people can value the same loss differently because the loss may affect their overall satisfaction, or their needs, issues, and concerns, differently.

The issue of perceived value has been often overlooked in dealing with risk situations when the risk is based on the simple equation:

Risk = Probability x Consequence

Many think that this equation is inadequate as a practical definition of risk when the perception or acceptability of risk is included and that a more appropriate expression of risk would be:

Risk = Probability x Consequence x Perception

Consider another example related to the perception or acceptability of risk of lowered water levels in a lake by two communities with different concerns and perceptions. One community derives much of its income and employment from commercial marine traffic in its harbour. Another community, also situated on the lakeshore, values the lake for its scenery and for light recreational use.

As a result of a changing climate, both communities are told that lake levels are likely to be between 1 and 1.5 metres lower by 2050. The first community will face disastrous employment and economic losses because the main shipping channel for which it is the principal port will be too shallow for the heavy marine traffic that now uses it. An alternate channel with greater depth will still be navigable and another port city would benefit from the shift in traffic.

The impact of lower water levels on the second community would be relatively minor and its shoreline is fairly steep and would still accommodate recreational boating and marinas.

How each community perceives the risk and what kinds of actions will be needed on the part of decision-makers will depend upon the value placed on the impact of the changed water levels. For the first community, huge amounts of resources will be needed to deepen the main shipping channel and the harbour facilities themselves. This in turn may be very threatening to the marine ecosystems in the area. For the second community, very little financial or environmental costs are anticipated.

Even though both communities face the same risk of lowered water levels the first sees this as a major challenge that threatens the viability and economic well-being of its residents. The second views it as a minor inconvenience. Even though the probability associated with lowered water levels is the same, and the consequence of the potential loss is very different.

The acceptability of the risk and how it can vary from one community to the next is not the same because the value placed on the potential loss can differ completely. This is because the needs, issues, and concerns differ widely. Decision-makers often overlook or ignore these differences in perceived value and, as a result, many decisions create controversy.

Risk Communications – How to Talk to People about Risks:

General: Risk communication goes beyond simple messages providing information. It is based on a dialogue that allows stakeholders to participate in the decision-making process.

Some reasons why providing information through simple public relations releases or one-way public education are not useful strategies include:

(a) They will not reduce the conflict that will probably develop concerning a risk and what to do about it,
(b) Because people do not have the same ability to understand and relate to a particular risk, these strategies do not ensure that decisions will be easily understood and supported by stakeholders, and
(c) Providing people with scientific information alone will not enable them or the decision-maker to resolve important risk issues.

Not to communicate with stakeholders or to delay communicating about risk is not effective an effective strategy and may be very costly in the long term. The reasons are that stakeholders resent risks that are imposed on them and risk decisions made without their input. Most people believe that they have a right to be involved in the decisions that affect them and that the decision-making process should be accessible. Involving stakeholders builds acceptance and can bring out constructive ideas. Effectively communicating about risks is important.

Effective Risk Communication: Effective risk communication is the responsibility of the decision maker, not the stakeholder. The most important benefits of an effective risk dialogue strategy are that it leads to shared understanding, shared goals and better decisions. It builds trust and encourages buy-in by reducing misperceptions and improving the understanding of the science and technical aspects of the risk.

On the other hand, ineffective risk communications may lead to some or all of the following:

- Irreplaceable loss of credibility,
- Unnecessary, costly and possibly bitter and protracted debates and conflicts with stakeholders,
- Difficult and expensive approval processes for projects,
- Diversion of management attention from important problems to less important problems,
- Non-supportive and critical co-workers and employees, and
- Unnecessary human suffering due to high levels of anxiety and fear.

Credibility: Credibility, being seen by stakeholders as trustworthy and competent, is a key goal. The characteristics of credibility include candour, commitment, competence, dedication, empathy, honesty, resolve, respect, and understanding. Credible messages must be based on known facts and with previous statements. They should be framed in stakeholder terms, not self-serving language or jargon, and be consistent with the messages of others. Credibility is very difficult to establish, easy to lose and almost impossible to regain once lost. For this reason some specialised training in risk communications is recommended prior to initiating the risk management process.

Stakeholders: It can be extremely important to include even minor stakeholders in the process if these stakeholders believe that the outcome of the decision is important to them. These "minor" players may be much more influential than the risk management team anticipates. Even a small group of stakeholders may effectively mobilize public opinion and halt or delay an activity they feel presents an unacceptable risk.

> *For example, a local environmental group rallied to stop a greenhouse gas collection project being built because they believed the facility could worsen the community's air pollution problem. Even though the risk was very small from a technical point of view the environmental group believed that it was still unacceptable. Because the company sponsoring the project failed to address these specific concerns and even though all the other key stakeholders supported the project, this small group effectively mobilized public opinion against it. The company, after spending a large amount of time, effort, and money, was forced to withdraw its permit request.*

It is important that stakeholders with the potential to stop a project be identified as early in the process as possible.

Regardless of whether stakeholders might actually be affected by an activity or decision, they must be included as legitimate stakeholders if they believe themselves to be affected. These stakeholders may be able to mobilize public opinion against a proposed project regardless of the scientific risk. They may also choose to leave the decision process if they receive enough credible information to understand that the activity really does not affect them.

> *For example, in the greenhouse gas collection project described above, if the company had analysed the environmental groups' concerns it would have found that their information was based on a number of misconceptions related to some technical and social aspects of the activity. Through a dialogue process, the concerns of the environmental group were addressed, and the misconceptions about the technical issues were corrected. As a result the group's concerns were alleviated and the project went ahead.*

This stresses the need for an effective communication process to facilitate this transfer of information between the decision-maker and other stakeholders.

It is important that the risk management team clearly considers what the stakeholders' needs, issues and concerns are before proceeding with a stakeholder dialogue. There are numerous examples of decision-makers addressing the wrong issue.

> *For example, again in the greenhouse gas collection project when the company carefully analysed the environmental groups' concerns they believed that the key issue for the group would be emissions from the project. However, through a careful dialogue with the group the company also found out that a secondary issue was related to transportation. The group thought that the new GHG collection facility, because it was the first in the region, would result in a dramatic increase in tourist traffic that would create a risk for their children. Once this and the emissions issues were addressed, the stakeholders were satisfied.*

Trust: Stakeholders often believe that the process of communicating with them about an issue is as important as the eventual resolution of the issue. It is through the dialogue process that the risk management team has the opportunity to gain stakeholders' trust. If the risk management team fails to communicate to the satisfaction of the stakeholders, trust in the process could be quickly lost.

Research in the area of stakeholder perception has shown that "trust" is a key determinant of stakeholders' acceptance of risk. That is, if stakeholders trust those who are charged with managing the risk, they are more accepting of higher levels of risk. Where this trust is absent, stakeholders demand higher levels of safety, and may refuse to accept any risk at all.

The development of trust between stakeholder and decision-maker is only one of the benefits of an effective communication process. Stakeholders are often the source of information critical to the decision-process.

> *For example, during a prolonged extreme heat episode, a municipality issued instructions through the Chief of Police that people who were suffering heat stress effects should report to the local militia armouries for help. Very few people showed up even though there was a lot of evidence to suggest that many citizens were suffering.*

> *The Mayor had a new announcement put out through the city's Medical Officer of Health for people with heat stress to come to the local high school for help. Most affected citizens responded positively to this announcement.*

The communication process is necessary so that information may be passed effectively from the risk management team to stakeholders. The same process is used to evaluate stakeholder acceptance of risk. Sometimes stakeholders just want to be involved in the decision process so that they can monitor the performance of the decision-maker and to see what is going on. Again, by involving stakeholders "who just want to watch" provides the decision-maker with the opportunity to build trust with these stakeholders.

Annex 3: Terms Used in this Guide

The following definitions apply to the terms used in this Guidebook. The definitions are drawn from the Canadian standard *"Risk Management: Guidelines for Decision-Makers"* (CAN/CSA-Q850-97) unless otherwise specified.

Adaptation – Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climate or its effects, which moderates harm or exploits beneficial opportunities. (Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC, TAR, 2001)

Adaptation benefits – the avoided damage costs or the benefits following the adoption and implementation of adaptation measures. (IPCC TAR, 2001)

Adaptation costs – costs of planning, preparing for, facilitating, and implementing adaptation measures. (IPCC TAR, 2001)

Adaptive capacity – the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or cope with the consequences. (IPCC TAR, 2001)

Adverse effects – one or more of:

- Reduction of the quality of the natural environment for any use that can be made of it;
- Injury or damage to property or plant or animal life;
- Harm or material discomfort to any person;
- An adverse effect on the health of any person;
- Impairment of the safety of any person;
- Making any property or plant or animal life unfit for human use;
- Loss of enjoyment of normal use of property; and
- Interference with normal conduct of business.

Climate change – a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. (UNFCCC)

Climate scenario – projection of future climatic conditions

Climate variability – climate variability refers to fluctuations in climate over a shorter term - the departures from long-term averages or trends, over seasons or a few years, such as those caused by the El Niño Southern Oscillation phenomenon. (UNFCCC)

Consequences – Risk is often expressed as the product of the consequences flowing from an event and the frequency of the event. In this manual, we use the term "impacts" for consistency with the terminology of climate change.

Dialogue – a process for two-way communication that fosters shared understanding. It is supported by information.

Hazard – a source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these.

Hazard identification – the process of recognizing that a hazard exists and defining its characteristics.

IPCC – Intergovernmental Panel on Climate Change. A large (several thousand) group of qualified experts which reviews and assesses periodically, all climate change research published in many countries.

Impact – Something that logically or naturally follows from an action or condition related to climate change or climate variability.

Kyoto Protocol – an agreement (1997) under the UNFCCC by most countries of the world, by which most developed countries will begin to limit their greenhouse gas emissions by 2008 to 2012.

Loss – an injury or damage to health, property, the environment, or something else of value.

Mitigation – used in 2 ways in connection with climate change. It is often used to mean reduction of greenhouse gas emissions in order to slow climate change. It is also used to indicate a measure implemented to reduce impacts (Authors).

Organization – a company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

Residual risk – the risk remaining after all risk control strategies have been applied.

Risk – the chance of injury or loss defined as a product of the frequency of occurrence and the severity of the consequence such as an adverse effect to health, property, the environment, or other things of value. The level of risk is also affected by how it is perceived by stakeholders.

Risk analysis – the use of information to identify hazards and to estimate the chance for, and severity of, injury or loss to individuals or populations, property, the environment, or other things of value.

Risk assessment – the overall process of risk analysis and risk evaluation.

Risk communication – any two-way communication between stakeholders about the existence, nature, form, severity, or acceptability of risks.

Risk control option – an action intended to reduce the probability and/or severity of injury or loss, including a decision not to pursue the activity.

Risk control strategy – a program that may include the application of several risk control options.

Risk estimation – the activity of estimating the frequency or probability and consequence of risk scenarios, including a consideration of the uncertainty of the estimates.

Risk evaluation – the process by which risks are examined in terms of costs and benefits, and evaluated in terms of acceptability of risk considering the needs, issues, and concerns of stakeholders.

Risk information library – a collection of all information developed through the risk management process. This includes information on the risks, decisions, stakeholder views, meetings and other information that may be of value.

Risk management – the systematic application of management policies, procedures, and practices to the tasks of analysing, evaluating, controlling, and communicating about risk issues.

Risk perception – the significance assigned to risks by stakeholders. This perception is derived from the stakeholders' expressed needs, issues, and concerns.

Risk scenario – a defined sequence of events with an associated frequency or probability and consequences.

Stakeholder – any individual, group, or organisation able to affect, be affected by, or believe it might be affected by, a decision or activity. The decision-makers are also stakeholders.

Stakeholder analysis – Identification of individuals or groups who are likely to have an interest in the risk management issue including a consideration of what their needs issues and concerns would be and how the stakeholder should be included in the process.

TAR – Third Assessment Report of the IPCC

UNFCCC – United Nations Framework Convention on Climate Change (1992)

Vulnerability – the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is the function of the character, size, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. (Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC TAR, 2001)

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