VOLUME 1

Managing the Risks of Climate Change

A GUIDE FOR ARCTIC AND NORTHERN COMMUNITIES

Written By: Robert A. Black, James P. Bruce, I.D. Mark Egener
Edited By: Creative Communications

TABLE OF CONTENTS

CENTRE FOR INDIGENOUS
ENVIRONMENTAL RESOURCES

ACKNOWLEDGEMENTS

Volumes 1 and 2 of this Guide were developed by Summit Enterprises International (S.e.i.) Inc. and authored by Dr. James P. Bruce and I.D. Mark Egener with assistance from Robert A. Black. Volume 1 of this Guide was edited by Creative Communications. The authors are indebted to the participation by representatives of Arctic communities and the territorial governments whose insights and assistance greatly improved the quality of the Guide. We thank Guppy Graphic Design for their design work on the Guides and Ron Mongeau for the use of his photos from Pangnirtung.

The Government of Canada through Indian and Northern Affairs Canada's Climate Change Adaptation Program generously provided the financial support that made the development of these Guides and the companion website possible.

The project to create these guides and the companion website was facilitated and managed by the Centre for Indigenous Environmental Resources. Please contact Shaunna Morgan at smorgan@cier.ca for any questions or comments on these Guides.

1 Introduction

1 INTRODUCTION

This Guide outlines convincing evidence that the world's climate is changing due to increased greenhouse gases in the atmosphere, and that the change is gathering speed.

Based on this knowledge, communities and governments need to seriously look at what is happening in their jurisdictions, and how it may affect them in the future.

The North has unique characteristics that make it more vulnerable to changes in the climate, particularly warming trends. Identifying things that could occur, or perhaps are already starting to occur, due to these changes is important. Planning how to respond to those issues is even more important.

And that is what this Guide is all about. It explains how to use the Risk Management Process as a simple, quick and logical way to determine the best solutions for dealing with issues caused by climate change. The straight-forward and simple process will encourage communities to be more proactive in finding ways to adapt to a changing and more variable climate.

This Guide was specifically written to address the unique conditions in Canada's North. It is intended to be a tool to help local governments and other organizations make sensible and practical decisions.

The Centre for Indigenous Environmental Resources, together with Indian and Northern Affairs Canada, supported the development of this publication.

WHAT IS RISK MANAGEMENT?

The Risk Management Process is a simple, practical and highly effective approach for identifying risks, ranking them, and then selecting the best way to reduce those risks.

It is a quick process that results in a clear picture of the complexity of an issue, and how best to deal with it. It can be applied to all kinds of situations.

OUR CHANGING CLIMATE

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 economic losses. These losses are from extreme weather events, premature weathering of infrastructure (such as roads and bridges), stresses on water supplies, worsening air quality, and related health and economic effects.

Extreme events and rising temperatures are becoming more damaging, particularly in the North, as recent severe rainfalls, thawing permafrost, melting sea ice and changes to wildlife behaviours have demonstrated.

Efforts to manage and adapt to climate-related risks are not keeping pace with the challenges. It is virtually certain that our climate will continue to warm. There will be increasing extremes over the coming decades, especially in the northern regions. Temperatures in the North are expected to increase from 3 to 5 °C over the next 30 to 40 years. Large changes in permafrost, ice coverage and sea levels will also continue. (See Annex 1 for more details.)

All communities and all activities throughout the North are being affected by the impacts of climate change. These changes put people, property and ecosystems at risk. Regional and community governments must look at these issues and be proactive in making decisions that help to manage these risks.

OUR CHANGING CLIMATE *continued*

Policies, environmental laws and emergency management arrangements are some of the ways that local governments can 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. There are few tools available to help them, which is why this Guide was produced.

WHAT IS RISK MANAGEMENT?

Risk management is a framework that can easily be used to identify and understand the impacts and vulnerabilities of climate change. The process helps to select the best actions to take in reducing risks to acceptable levels, even when there are uncertainties about future climate conditions.

The Risk Management Process is a simple, practical and highly effective approach for identifying risks, ranking them, and then selecting the best way to reduce those risks. It is a quick process that results in a clear picture of the complexity of an issue, and how to best deal with it. The process can be applied to all kinds of situations.

The impacts of a changing and more variable climate affect almost every aspect of society. They 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 interested parties. Some of these groups may have conflicting values and competing interests.

The process outlined in this Guide is a simple way of getting started. It is a way to engage the people who are affected and identify 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 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 include better warnings, increased maintenance of important infrastructure, and reduction of water levels in reservoirs.

WHAT IS RISK MANAGEMENT? *continued*

Longer term responses might include upgrading water management systems and installing better communications equipment. Multi-jurisdictional responses could involve the construction of flood channels, realigning transportation routes, dealing with shoreline erosion or making changes to building codes. The risk management process will help identify the best solutions and a range of possible responses.

Most regional and 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. Staff are often overburdened with work and decision-makers may delay or defer important actions. Climate change impacts are increasingly evident and figuring out plans to deal with these impacts is important – in some cases it is urgent.

Whatever the scope, the process described in this Guide will help officials identify the issues and produce well thought-out recommendations. The final document can provide a persuasive business case for action to submit to decision-makers.

IMPORTANT TERMINOLOGY

Although there is a glossary of terms in Annex 3, the following words and phrases are used frequently in this Guide, so a short explanation of their meaning will help the reader:

- **Adaptation to climate change** means making adjustments in natural or human systems to moderate harm or to take advantage of 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**.

2

Making Decisions to Adapt to Climate Change

2 MAKING DECISIONS TO ADAPT TO CLIMATE CHANGE

The Earth's climate has always varied due to a number of factors, including the presence of naturally occurring greenhouse gases (GHGs) in the atmosphere and changing amounts of the sun's energy reaching earth. The Intergovernmental Panel on Climate Change (IPCC) concluded that, until the mid 1960s, the Earth's warming was due to both human-caused and natural factors. But since about 1970, the Earth's warming is due almost exclusively to increased atmospheric GHG concentrations from human activities.

Given the current concentrations and the long-term persistence of GHGs – and projected further increases in GHG emissions and concentrations – it seems certain that the climate will continue to change. International efforts to reduce GHGs, if successful, may slightly slow the rate of change. Most assessments of future climate change impacts have been based on projected greenhouse gas emissions that were published in 2000[1]. In a 2007 report, the International Energy Agency[2] indicated that greenhouse gas emissions to 2030 would increase more rapidly than the fastest of the IPCC scenarios.

Also, since 2000 the increase of global atmospheric concentrations of CO^2 have risen to 1.9 or 2 parts per million per year (ppm/yr), compared to earlier (since 1970) increases of 1.6 ppm/yr. This means that climate change impacts are likely to be more rapid than expected.

For example, Arctic sea ice and Greenland ice cap melting have recently occurred more rapidly than in earlier estimates. Thawing of permafrost, increased coastal erosion and shifts in distribution of wildlife are also being observed (reported by Natural Resources Canada (NRCan) in 2007). It is clear that adaptation is essential to ensure that society is not affected more adversely.

Some people mistakenly believe that climate change is simply a gradual global warming. It is increasingly evident, though, that other aspects of our climate are changing too. We are seeing a dramatic change in the frequency and intensity of extreme weather events. These two changes – the general warming and the increased climate extremes – have important implications for many aspects of daily lives, especially in northern regions.

[1] *Intergovernmental Panel on Climate Change, 2000. Special Report on Emission Scenarios, ed., N.Nakicenovic and R.Swart Cambridge University Press, 612p.*

[2] *International Energy Agency (IEA), 2007. World Energy Outlook, OEDC/IEA, Paris.*

CLIMATE TRENDS & PROJECTIONS

FACTORS INFLUENCING OUR CLIMATE

The Canadian North, as addressed in this Guide, includes Nunavut, the Northwest Territories (NWT) and Yukon Territory. Communities in other areas such as Nunavik, in northern Quebec, and the northern tip of Labrador may also find the Guide useful.

While similar climatic changes occur in Yukon Territory and the NWT's Mackenzie River basin, the Arctic regions are quite different in the west than in the east. Despite these variations, overall changes experienced in the North in the past few decades are expected to accelerate, as greenhouse gases accumulate in the global atmosphere.

The enormous size of Canada's Arctic makes it difficult to create a brief summary of historical climate changes and projections for the future. However, it is necessary to have an understanding of the likely changes to the climate so we can make sensible short and long-term adaptation decisions.

Warming in most of the North has been greater than in most places on the planet, and it is projected to be greater in the future. Snow and ice reflect much of the sun's energy. Once warming begins to melt that snow and ice, the exposed water and land no longer reflect the incoming energy from the sun. They absorb it, and this, in turn, increases the greenhouse effect.

CLIMATE TRENDS & PROJECTIONS *continued*

Statistics on climate changes that have been observed since 1950 and projections of future climate to 2050 are included in Annex 1. This Annex summarizes a very large amount of literature, including the *Arctic Climate Impact Assessment* (2005) and Chapter 3 on Northern Canada in *From Impacts to Adaptation 2007 – NRCan*. A full reference list is given for those who wish to pursue this further. For use of this Guide, the summary in Annex 1 should be sufficient.

PLANNED COLLABORATION

Climate related changes to the northern environment can have profound effects on the people and the economy. It is important to take actions that reduce negative impacts or vulnerabilities, and enhance opportunities that may emerge. These actions are known as "adaptations". One way or another, we have to adapt. Doing it in a planned way, rather than a rushed reaction, is more beneficial for all.

Some adaptations will require careful planning and the collective action of more than one organization or level of government. Many needs can be assessed by the experiences and traditional knowledge of residents of the North, as well as by scientific studies. Collaboration between northerners and climate scientists may provide more rounded-out information. Workshops using this risk management guide provide a way of achieving this collaboration in a mutually respectful manner.

THE ROLE OF LOCAL GOVERNMENTS

Community and regional officials have often dealt with issues relating to climate. For example, they manage water supplies, design drainage systems and flood protection, and design and implement warning mechanisms for extreme weather events.

With a changing climate, future issues may include figuring out how to deal with changes in animal, insect and disease populations. There is already evidence of animals coming further north that had always stayed farther south. Along with this could come new insects and diseases. Some of these changes may be beneficial and others may not. The key is to think ahead and adapt as efficiently as possible to whatever changes do occur.

Dealing with climate change, however, is new and unfamiliar territory. Some of the impacts are slow and subtle, so they don't seem like a real problem. There are not that many people getting paid to work on climate change issues and ways to adapt. Most community or regional plans do not address climate change, and it can be difficult to get this issue on the community's agenda.

In Canada, all provincial and territorial governments have a number of laws and policies which deal with risks to public safety, emergency management and disaster preparedness, community infrastructure, workers' health and safety, and environmental protection. These areas can be linked to climate change and the need in those departments to make adaptation plans.

THE ROLE OF LOCAL GOVERNMENTS *continued*

Sometimes, in order to pursue a new initiative such as climate change, staff may have to make a case for priority over, or at least equal to, an existing responsibility. This could require a strong argument to support work on climate change issues.

Whether the project is large or small, it is important that the work has the support of local councils and senior managers, so that it has adequate resources to carry it through.

3

Overview of the Risk Management Approach

3 OVERVIEW OF THE RISK MANAGEMENT APPROACH

THE PROCESS

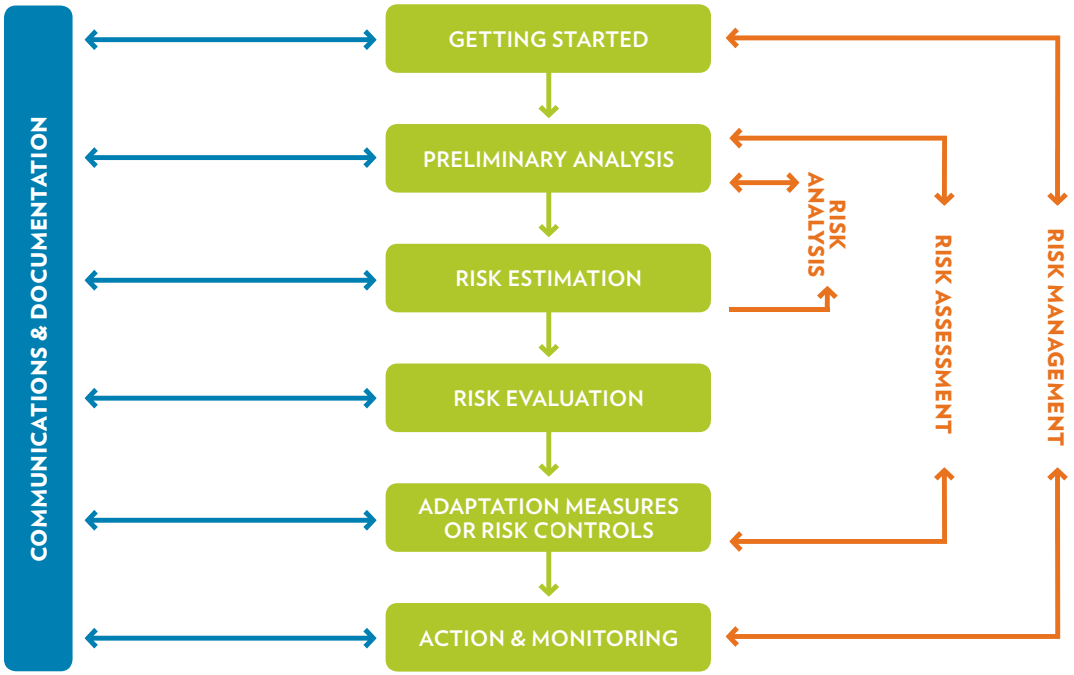
Risk management is a systematic process for selecting the best course of action in uncertain situations. It does this by helping us identify, understand, analyze and communicate about risks.

It provides us with a framework for developing strategies to deal with predicted climate changes that will cause problems. The risk management process will guide us towards the best solution.

The framework in this Guide is based on the Canadian national standard, entitled "Risk Management: Guidelines for Decision-makers" (CAN/CSA-Q850-01).

The decision-making process consists of six steps, which are shown in Figure 1 below.

FIGURE 1: Steps in the Risk Management Process



THE PROCESS *continued*

Simply put, the key activities in the process are identifying the risks, estimating their consequences, and then evaluating and ranking the risks. The next step is selecting options to lower those risks to acceptable levels.

These activities will include:

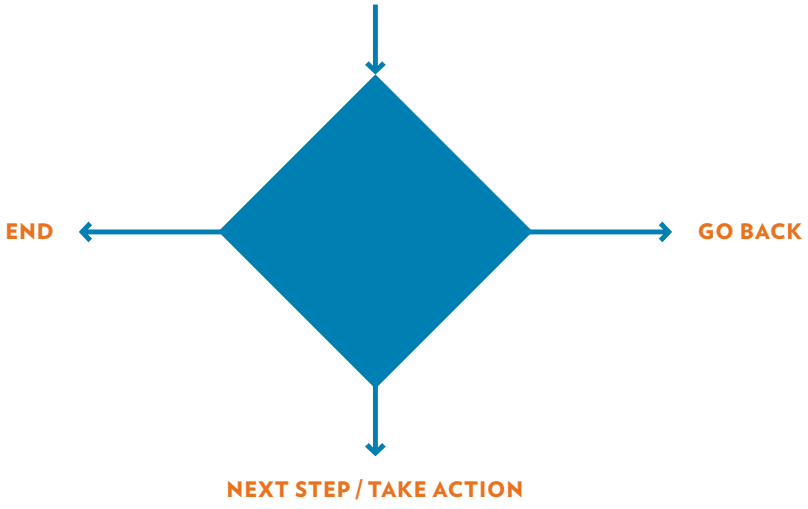
- Developing a list of all the events or impacts each climate related risk or situation could create.
- Estimating the probability and potential consequences of events arising from situations or hazards.
- Identifying actions that can be taken to avoid negative consequences or lessen their impact, or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

A very important part of the process is a continuous dialogue with all those who are involved or affected by the issue. Information about a risk situation can be interpreted differently by various groups of people, resulting in different perceptions of the risk [3].

For example, parents may be more concerned about water quality for their children, than consultants who are 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 following "Decision Diamond" in Figure 2.

FIGURE 2: Decision Diamond — DECISION OPTIONS AT THE COMPLETION OF EACH STEP



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

OVERVIEW OF THE RISK MANAGEMENT APPROACH *continued*

The process 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:

- **Communication** with all people and groups that are or might be affected by the issue, even slightly, 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 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 for getting started with any risk situation. 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.

GUIDING PRINCIPLES

The risk management process is built upon several important principles:

- **Involving Key Groups and Individuals**
  These groups and individuals should be identified and involved during the entire process. The project team may be changed throughout the process 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 with groups and individuals who may be affected or involved with the risk. Open communication is needed throughout the decision-making process 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
  - → serve as a part of the monitoring and review mechanism.

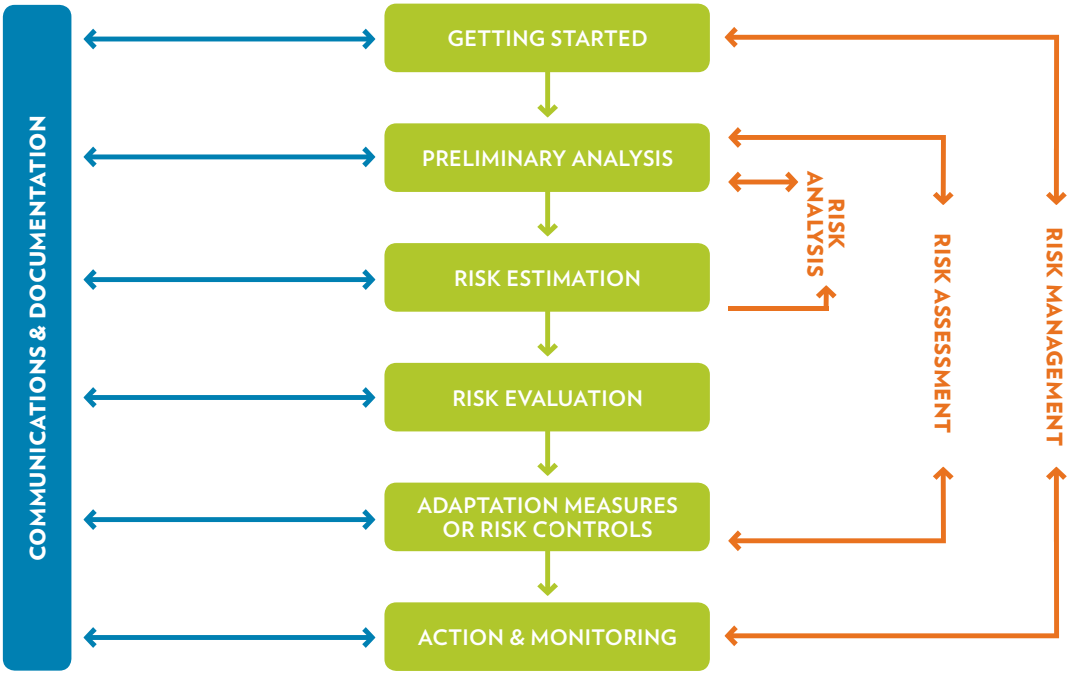
GUIDING PRINCIPLES *continued*

- **Documentation**
  Thorough and careful records should be taken of important meetings and information sources. This should be stored in a "risk information library", so it can easily be retrieved in the future. The "risk information library" can be a simple binder of information. Having good records will help to:
  - → ensure consistency
  - → promote accountability and transparency
  - → develop records for future reference.
- **Use of Existing Resources**
  The project team should make maximum use of existing resources, such as community data, local knowledge and technical expertise. Determine if there are any 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.

RISK MANAGEMENT PROCESS – AT A GLANCE

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. This 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.

OVERVIEW OF THE RISK MANAGEMENT APPROACH *continued*

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 that are deemed unacceptable.

STEP 5: RISK CONTROLS & 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 & 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
- provide a format to present climate change adaptation issues to senior decision-makers.

COMMUNICATION & 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.

TEMPLATE TOOLS

This Guide includes a Workbook section in Volume 2 that contains templates for recording information. This will assist in presenting the results in a clear manner that can be easily understood.

4 Risk Management Process

4 RISK MANAGEMENT PROCESS

INTRODUCTION

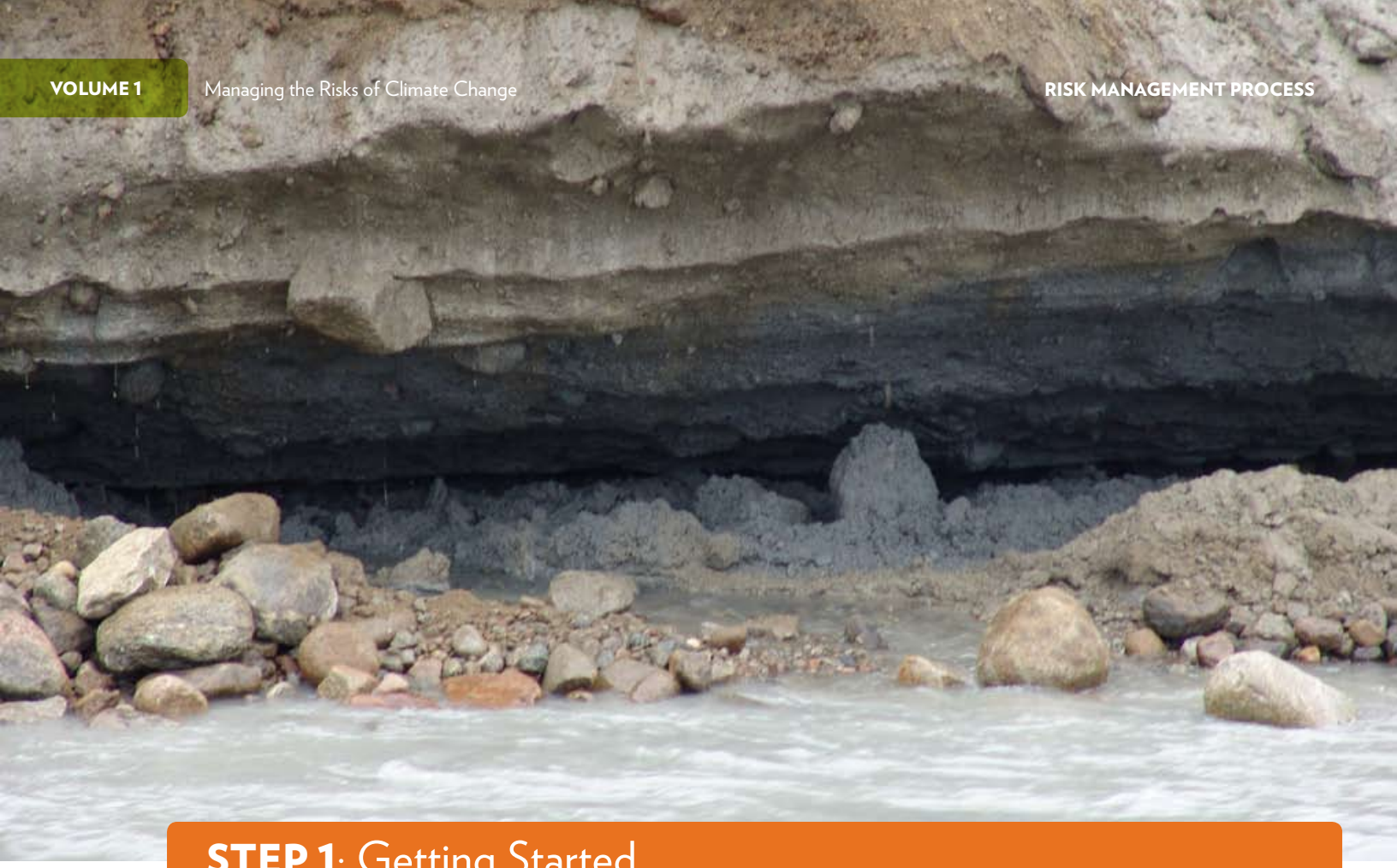
This section describes each step in the risk management process, explaining its purpose, the actions to be taken and the expected outputs. Checklists are also provided.

The example in Volume 2 is an illustration of what is done in each step. The example was developed by community representatives in a one-day workshop during the testing of 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, most 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 section are available for photocopying in the Workbook section in Volume 2.



STEP 1: Getting Started

PURPOSE

This step starts the process and includes the following preparatory activities:

- identification of the specific problem or hazard and the associated risks
- 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
- development of a workplan.

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.

As suggested in the previous section, it is recommended that a short version of the process initially be used. A relatively simple overview of the problem, using readily available data, 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.

STEP 1: Getting Started *continued*

Out of this overview of the risk management process, the team can 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
- determine whether the preliminary study is sufficient or if a larger more comprehensive study is needed
- 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 develop the work plan and the key milestones:
   - Select team members with the necessary expertise to deal with the risk issues being considered.
   - Ensure there is clerical support to handle the administrative and documentation matters. There may be a need during the study for legal, technical or financial advice, and the team should know how to contact these advisors.
   - 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.
3. Assign project team responsibilities, allocate resources and set schedules.
4. 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. (Annex 2 provides additional information to help with risk communications.)
   - Recognize that this group may evolve throughout the process.
5. Start the record keeping and a risk information library:
   - The records or risk information library should contain copies of all the information collected throughout the project. It should include 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.

STEP 1: Getting Started *continued*

EXPECTED RESULTS AND OUTPUTS

- ✓ Risk issues and potential management implications 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. 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 - End the process if the hazard(s) and risk(s) are considered acceptable by the project team.

Go Back - Go back and redo any part of the process that requires more work.

Next Step/Take Action - If the risk situation continues to be a concern, proceed to the Next Step.

STEP 1: Getting Started *continued*

STEP 1: Getting Started Checklist

HAVE YOU:

- [ ] Defined the hazards and vulnerabilities, and their potential management implications?
- [ ] Established a project team, project work plan and each team members' responsibilities?
- [ ] Identified the resources required to undertake the project, and any existing capacity that is available to the project team?
- [ ] Identified the principal people or groups that may be affected or involved, and begun to define their probable issues, needs and concerns?
- [ ] Developed a plan for communicating with stakeholders?
- [ ] Started a risk information library?

See Step 1 of example in Volume 2.

STEP 2: Preliminary Analysis

PURPOSE

This step is the beginning of the risk assessment part of the process. This is where the sequence of events or scenario, and possible results, 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, cultural effects or impacts on the environment.
- Consider what the time scales are around the possible outcomes from the risk situation.
- Determine, in a very general sense, how complex the process is likely to be; confirm the probable timeframe for completing the work; and 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 or results 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
     - → cultural impacts
     - → other economic losses
     - → 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.

STEP 2: Preliminary Analysis *continued*

TABLE 2: Preliminary Hazard and Risk Scenario Assessment

HAZARD :				
RISK	EVENT OR RESULT	FREQUENCY	CONSEQUENCE	COMMENTS
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	

Notes: *Just make rough estimates for Frequency and Consequence at this time (these will be expanded in Step 3). Use the key beside to assign a value:*

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 experiences and opinions. For example, for a flood hazard, what information is available from the most recent flood experience in your community or in the region?
   - Identify the risk controls currently in place. 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 of 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 elders, 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.
   - Review and update the analysis of their needs, interests and concerns.
   - Create a list of these people or groups that includes their contact information and the results of Your stakeholder analysis.
   - Consider how you will communicate with the stakeholders.

STEP 2: Preliminary Analysis *continued*

5. Update the risk information library:
   - Organize 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 the 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.
- ✓ 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 - End the process if the hazard(s) and risk(s) are considered to be acceptable by stakeholders and the project team.

Go Back - Go Back to Step 1 or the beginning of Step 2 if the project team considers it 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.

Next Step / Take Action - If the risk situation continues to be a concern, proceed to the Next Step.

STEP 2: Preliminary Analysis *continued*

STEP 2: Preliminary Analysis Checklist

HAVE YOU:

- ☐ Developed risk scenarios and completed a preliminary analysis of their probabilities and consequences?
- ☐ Established a baseline of data for each of the risk scenarios?
- ☐ Developed a stakeholder database?
- ☐ Refined your stakeholder analysis?
- ☐ Updated the risk information library?

See Step 2 of example in Volume 2.

STEP 3: 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 are discarded from further consideration.

What to do and how to do it?

1. Consider what methods your team should use for estimating frequency and severity. Some options are:
   - historical records to determine trends of climate events and impacts, including community recollections and records, online information such as newspapers and other data sources
   - technical data and climate projections from Annex 1, IPCC reports (online), NRCan publications (also online) or from provincial, territorial or other federal government sources
   - 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. For major projects, estimate 40 or 50 years out.
   - For familiar hazards and events such as floods, fires or diseases, estimates can typically be derived from readily available historical data such as, research reports, insurance company records or from similar risk situations in other communities, regions or countries.

STEP 3: Risk Estimation *continued*

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, specific 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 risk is the most severe.
   - Look for data and information from online sources, 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 levels of risk are 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, such as social, economic, environmental and cultural 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.*

STEP 3: Risk Estimation *continued*

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

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

TABLE 3–2: Impact Rating Matrix

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on community finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low													
Low													
Moderate													
Major													
Very Severe													

Notes: *In both Tables 3.1 and 3.2, the measurements are expressed in comparative or qualitative 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.*

STEP 3: Risk Estimation *continued*

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 stakeholders 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 key people or 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 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

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 of risk by stakeholders, or a record of reasons for non-acceptance, based on dialogue with the stakeholders and a careful documentation of their perception of the risks.

STEP 3: Risk Estimation *continued*

DECISION

Select one of the three decision options – **End**, **Go Back** or **Next Step/Take Action**:

- **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
  - → not all of the 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, the assumptions and the outcomes of the risk estimation process.

RISK ESTIMATION

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

See Step 3 of example in Volume 2.

STEP 4: Risk Evaluation

PURPOSE

In this step, the project team compares and ranks each risk. They do this by:

- Evaluating the risks in terms of overall frequency or probability and consequences using the results from Step 3. Also by considering the 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?

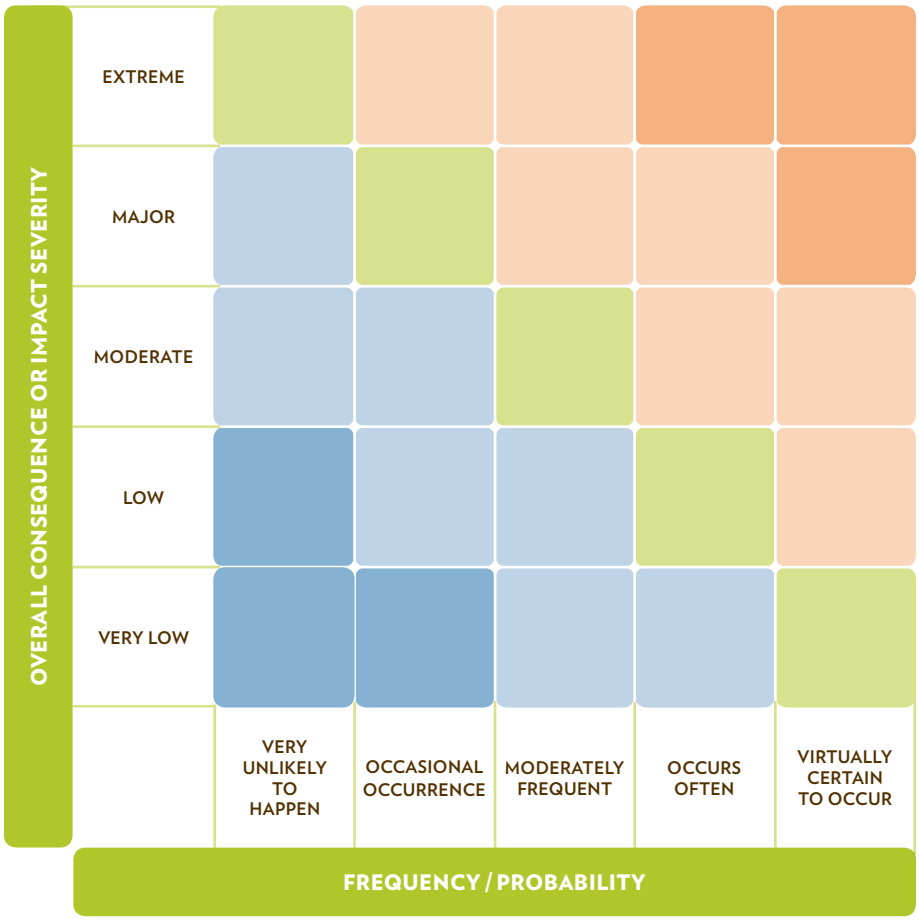
To this point in the process, the hazards, events and risks have been analyzed. Now the risks will be compared in terms of the values that were developed in Step 3.

1. Compare the risks while 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, environmental and cultural 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. This chart uses simple qualitative measures such as "very low", "low", "moderate", "major" and "extreme". Other comparators such as numerical values may be used as 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.

STEP 4: Risk Evaluation *continued*

2. Assess how the principal people or groups that may be affected or involved view the acceptability of risks in your risk matrix.
3. 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.
4. Update the risk information library.

FIGURE 3: Risk Evaluation Matrix



EXTREME RISK: Immediate controls required

HIGH RISK: High priority control measures required

MODERATE RISK: Some controls required to reduce risks to lower levels

LOW RISK: Controls not likely required

NEGLIGIBLE RISK: Scenarios do not require further consideration

STEP 4: Risk Evaluation *continued*

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

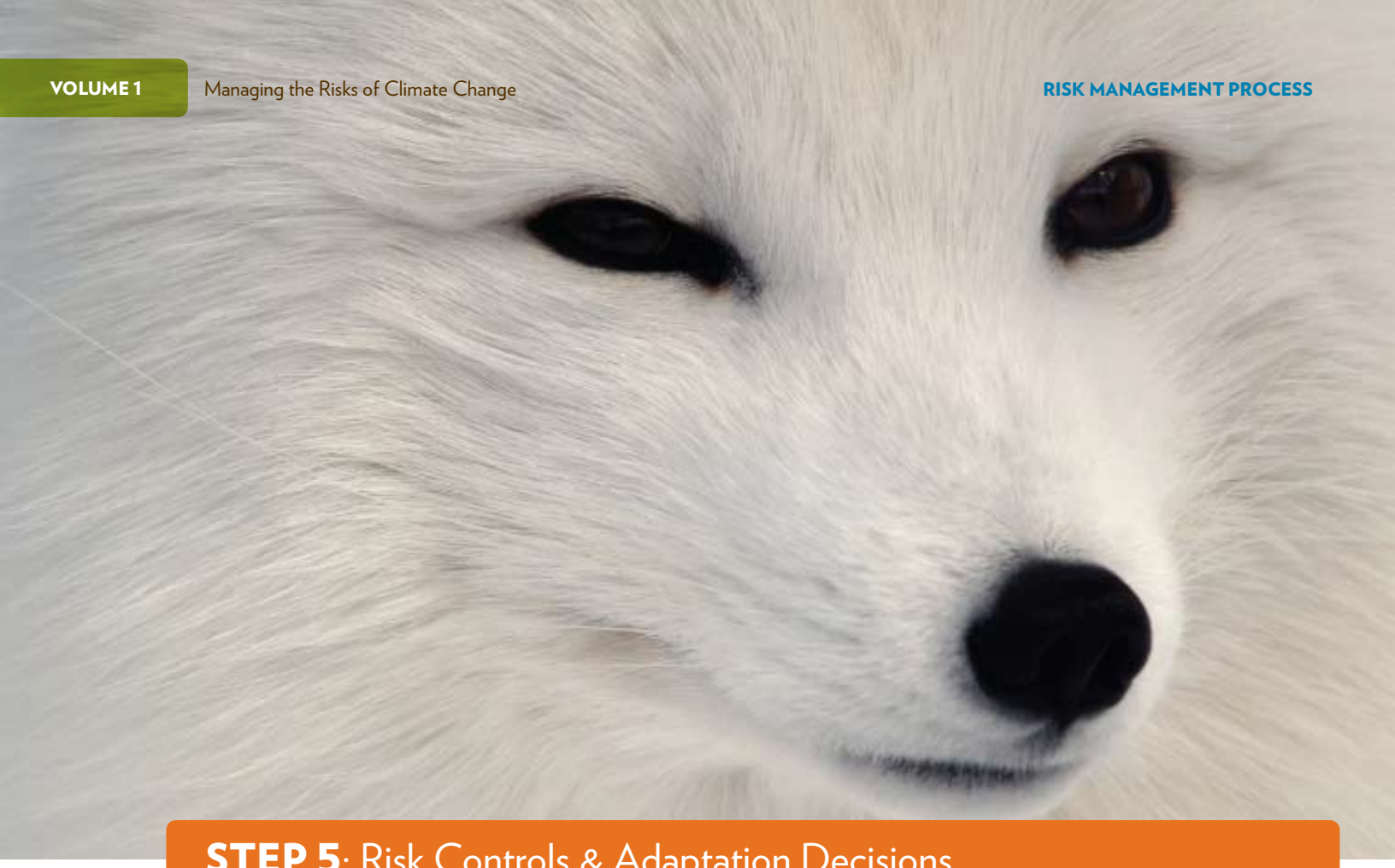
Select one of the three decision options – **End**, **Go Back** or **Next Step/Take Action**:

- **End** the process if:
  - → stakeholders agree that all the risks are acceptable
  - → 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
  - → 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.

RISK EVALUATION CHECKLIST

- ☐ Are the risk evaluation and ranking completed?
- ☐ Are all of the major considerations accounted for?
- ☐ Have you consulted with all key stakeholders on the acceptability of risks?
- ☐ Have you given preliminary consideration to controls for unacceptable risks?
- ☐ Is the risk information library updated?

See Step 4 of example in Volume 2.



STEP 5: Risk Controls & Adaptation Decisions

PURPOSE

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

- Feasible adaptation measures or risk control strategies are identified for reducing 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.
- The best adaptation or risk control strategies will be selected and consideration will be given to the acceptability of residual risks.

STEP 5: Risk Controls and Adaptation Decisions *continued*

WHAT TO DO AND HOW TO DO IT?

To this point in the process, the hazards, events and risks have been analyzed. Now the risks will be compared in terms of the values that were developed in Step 3.

1. Identify feasible adaptation or risk control options:
   - Identify all potential adaptation responses 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, there may be some short-term actions to deal with immediate concerns, as well as 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 of 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.

STEP 5: Risk Controls and Adaptation Decisions *continued*

TABLE 5–1: Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability

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 an ice runway for air cargo because of a shorter frozen season. To create a gravelled, all-weather strip might be very costly. In the short-term the community might have to forgo other developments. In the longer term, better air facilities might strengthen the community by bringing in more residents or businesses. 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 the ground level of dwellings that may flood during heavy rain events. 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 developed.
- ✓ 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.

STEP 5: Risk Controls and Adaptation Decisions *continued*

DECISION

Select one of the three decision options – **End**, **Go Back** or **Next Step/Take Action**:

- **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
  - → 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
  - → residual risks are acceptable to stakeholders.

STEP 5: Risk Controls and Adaptation Decisions *continued*

RISK CONTROLS AND ADAPTATION CHECKLIST

HAVE YOU:

- [ ] Identified and evaluated feasible adaptation or risk control options, in terms of costs, effectiveness, stakeholder acceptance and other criteria?
- [ ] Selected a complement of adaptation or risk control options that best reduce risks to acceptable levels?
- [ ] Determined the costs and benefits of the risk control measures?
- [ ] Assessed and addressed any outstanding stakeholder concerns?
- [ ] Developed a risk communication plan for the proposed adaptation or risk control measures, and for the residual risks?
- [ ] Ensured that the risk information library is updated?

See Step 5 of example in Volume 2.

STEP 6: Implementation & 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 rough draft form until the risk management study has been reviewed and approved by the senior administrator or band/community 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.

STEP 6: Implementation & Monitoring *continued*

- 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, compare your results to those from neighbouring communities.
- 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 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 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 round, 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 so that it can be made available to other vulnerable sectors and other regions.

STEP 6: Implementation & Monitoring *continued*

IMPLEMENTATION & MONITORING CHECKLIST

HAVE YOU:

- [ ] Developed a feasible outline implementation plan?
- [ ] Identified links with ongoing activities in the community and beyond (e.g. national, territorial, regional or local initiatives)?
- [ ] Identified resources to implement the plan?
- [ ] Established an effective monitoring and review program?
- [ ] Submitted the implementation plan for approval?
- [ ] Developed a communication strategy to support implementation?
- [ ] Ensured that the risk information library is updated?

See Step 5 of example in Volume 2.

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

Annexes

ANNEXES

ANNEX 1: Climate Change Projections for the Arctic & the North

SOURCES OF INFORMATION

Four major studies have provided insights into the changes in climate, forced by greenhouse gas increases in the global atmosphere, for the two Canadian Territories and the Arctic Archipelago. They are:

1. From Impacts to Adaptation: Canada in a Changing Climate 2007 (NRCan, Ottawa),
2. Arctic Climate Impact Assessment, 2005 – Arctic Climate Science Committee,
3. Intergovernmental Panel on Climate Change, 2007, especially WGII, Impacts, Adaptation and Vulnerability, Chapter 15 – Polar regions, and Chapter 14 – North America, and
4. Mackenzie Basin Impact Study, Final Report, 1997, Environment Canada.

In addition, a number of scientific papers have appeared which add more information about the changes that have taken place and are expected in coming decades.

To assist in the use of this Guide a brief summary of the key findings, in these thousands of pages, are provided in this Annex.

RECENT TRENDS

Determination of trends in climatological conditions has been somewhat difficult because of limited observational data in these regions, especially at stations with long consistent records. Local traditional knowledge can be important as well in assessing changes. Nevertheless, since the mid-60s, when atmospheric greenhouse gases began to dominate long-term climate change, the whole circumpolar region north of 60°N warmed at an average rate of 0.4°C per decade (1966–2003).

The rate of warming was greater in Canada than on the Russian side of the Arctic. However, a cooling trend in previous decades (1946–1965) was particularly evident on Baffin Island, but this changed to a warming trend about 1990. The net result was a slightly negative temperature trend values from 1950 to 2000 as shown in Table A1 in eastern Arctic. Throughout these regions, warming has been greatest in winter and spring but is evident in all seasons. Aboriginal hunters have also detected and reported the warming trend.

Precipitation measurements are very difficult in the Arctic where much of the precipitation is snow and often occurs with high winds. As measured, precipitation in all seasons has increased since 1966 in the eastern Arctic and Yukon where precipitation is already greatest in the Arctic. A decline in precipitation in all seasons was observed in most of northern NWT. Overall in the circumpolar region north of 60°N, a precipitation increase of about 2% per decade was recorded from 1966 to 2003. The amount of precipitation occurring as snow has declined somewhat.

In marine areas, a most important feature is the presence of sea ice for much of the year. A contraction of the area covered at the end of the melt season (Aug–Sept.) has been recorded with estimates of the rate of change ranging from 3 to 5.6% per decade. IPCC 2001 suggests a 40% decline in ice thickness.

ANNEX 1: Climate Change Projections for the Arctic & the North *continued*

Sea level rise reflects the global experience of an average 1.8mm/yr rise since 1961, but an acceleration to 3.1mm/yr has occurred since 1993. However, the relative sea level change is also affected by whether the shoreline land is rising due to postglacial isostatic rebound, as in much of the Arctic, or subsiding. Subsiding areas are on the Beaufort seacoast, including the western edge of the Archipelago, and narrow bands on eastern Devon and eastern Baffin Islands. Sea level rise is becoming a significant concern in these areas of subsiding shorelines, with melting permafrost and less protective shore ice. With upper estimates of sea level rise now about 1 metre this century, many other low lying coastal areas will experience increasing erosion and flooding.

On the land areas in the Arctic islands, glaciers have retreated and ice cover reduced. Many small lakes and ponds have dried up with increased summer evaporation under higher temperatures. In some areas thawing permafrost has made surface waters into groundwater.

These trends, since the mid-60s, reflect not just the effects of increased greenhouse forcing but also the climate pattern called the Arctic Oscillation that is closely linked to the North Atlantic Oscillation (AO/NAO), as well as the Pacific Decadal Oscillation (PDO). The AO was in a warm phase from 1989 to 1994 and accelerated the warming over that period. Since 1994, there have been several short-term phase reversals, but continued warming from greenhouse forcing.

PROJECTIONS FOR THE FUTURE

In most cases changes experienced in the north in the past few decades are expected to accelerate as greenhouse gases accumulate in the global atmosphere.

Warming in most of the North has been greater and is projected to be greater in future than in most of the rest of the world. This is mainly because of an important feedback. Once greenhouse gas induced warming begins to melt snow and ice, which reflect most of the sun's energy, the exposed water and land absorb much more of that heat energy, augmenting greatly the direct greenhouse effect.

Some of the Atmosphere/Ocean General Circulation Models (AOCGM) used to project climate changes into the future have been shown to be able to reasonably produce current climate in the Arctic. Three models (U.K, German, Japanese) and two Regional models did a good job of simulating observed temperatures. None replicated precipitation patterns satisfactorily.

In general, the models project for 2050 a 3°C to as much as a 5°C temperature increase in Western areas and 3°C to 4°C in eastern regions for median GHG emission and concentration projections. For high estimates of GHG concentrations, appearing increasingly likely, annual temperature increases in the western archipelago and extreme northern Territories could be in the range of 10 to 12°C, but about 4°C in eastern Arctic. Winter and autumn changes are projected to be greatest.

In general, precipitation increases are projected to be 15% in western areas and 10% in eastern areas with a median projected increase in greenhouse gases although these estimates are less reliable than those for temperature. With high GHG increases, the precipitation increases could be 30 to 40% in much of the Territories and western Arctic, but about 10% in the east. Increases in freshwater flow from rivers are expected to increase, by 12 to 20% for the Mackenzie River, for example.

ANNEX 1: Climate Change Projections for the Arctic & the North *continued*

Over the next 50 years, the active layer in cold thick permafrost could increase from 0 to 50% depending on local circumstances. In Yukon and much of southern NWT where permafrost is warmer than -2°C on average, much of this permafrost will thaw or continuous permafrost will become discontinuous by 2050. This has important implications for landslides, buildings, pipelines and for surface and groundwater resources.

STORMINESS, EXTREMES AND FIRES

The Canadian GCM (CGCM2) projects an increased frequency of severe winter storms north of 60°N, suggesting more frequent blizzard conditions. An analysis of severe cold season precipitation events at Iqaluit over the 1955–1996 period, indicates that high atmospheric moisture content and low pressure systems from the south were most important for severe events. However, not all heavy precipitation is snow. On June 7–8, 2008, at Pangnirtung, high temperatures (13°C) and heavy rain produced devastating flash floods.

The area burned by forest fires in the two Territories has been rising along with average temperatures. Lightning sparks some 80% of forest fires. The length of the fire season in the Territories is expected to increase by up to 50 days this century.

Inuit knowledge has been combined with instrumented observations to determine an increase in dangerous wind speeds at Kanngiqtugaapik (Clyde River).

SOME IMPACTS TO CONSIDER

1. Coastal erosion has been severe on Territorial northwestern shores, especially near Inuvik. This is due to sea level rise, increased storminess with less protective shore ice, land subsidence and permafrost thaw all likely to continue.
2. The geographical ranges and species composition of both terrestrial and aquatic ecosystems are changing.
3. Climate change effects on thawing of permafrost are often augmented by clearing of vegetation and heat of new structures to compound problems of design and maintenance of buildings, roads, pipelines, etc.
4. Reduction of sea ice has made easier Arctic shipping and access to potential mineral and fossil fuel resources. These provide both economic opportunities on the one hand and potential social and environmental problems for local populations on the other.
5. In areas served by winter roads, especially in the Territories, the length of the safe travel season is shortening.
6. Increasing threats of forest fires, especially in the Yukon and in the Mackenzie basin require action by forest agencies to reduce risks, and preparedness by emergency managers in communities that may be in the potential path of major fires.
7. In the face of rapid snowmelt, combined with intense rains in spring and summer, communities susceptible to flash flooding should review and improve their drainage facilities and remove vulnerable buildings and facilities from locations likely to be affected.
8. Reduction of sea ice and increased frequency of blizzards need to be taken into account by hunters and travelers.

ANNEX 1: Climate Change Projections for the Arctic & the North *continued*

9. Decreases in mean and maximum depths of winter snow cover have been observed in the past 4 decades and are likely to continue affecting vegetation and important foraging mammals (barren ground caribou, muskox) and migration patterns
10. Changes in marine species distribution and northern movement of ice-edge species like ringed seals and polar bears, as well as changes in fish species, will require adaptive management strategies by coastal communities.

In summary the following Table A1 gives observed trends in climate-related factors from 1950 to 2000, and projected trends to 2050.

ANNEX 1: Climate Change Projections for the Arctic & the North *continued*

TABLE A1: Observed & Projected Trends in Climate-related Factors

Changes	Yukon & Mackenzie District		Western Arctic		Eastern Arctic	
	1950 – 2000	2050	1950 – 2000	2050	1950 – 2000	2050
Mean Temp °C increase	**2** to **2.2**	**3** to **6**	**1.5** to **2**	**4** to **6**	Slightly negative but positive since 1990	**3**
Winter Temp °C increase	**4** to **4.5**	**4** to **8**	**1** to **2**	**6** to **8**	**0** to **1**	**4** to **6**
Growing Degree days	**40** to **60**/decade	**40** to **60**/decade	**20**/decade	**20**/decade	**−20** to **+20**/decade [1]	**−20** to **+20**/decade [1]
Heating Degree days	**−80**/decade	**−80**/decade	**−40** to **−60**/decade	**−40** to **−60**/decade	**+60**/decade [1]	**−60**/decade [1]
Frost days change in numbers	**0** to **−1**/decade	**0** to **−1**/decade	**−1** to **−3**/decade	**−1** to **−3**/decade	**+1** to **−3**/decade	**−3**/decade
Precipitation Total % increase	**2** to **5**	**Up** to **15**	**15** to **25**	**10** to **30**	**15** to **25**	**10** to **15**
Annual Snow % change or mm/yr	**−2** to **+45** mm/yr	**Up** to **15%**	**+2** mm/yr	**20%**	**−1** to **+1** mm/yr	**15%**
Glaciers & Ice Sheets	**North America Arctic – 450 km³ loss (1960 – 1998)** Accelerated loss to 2050					
Sea Ice	**1978 – 2003 −5.6%** / decade late summer: multi-year ice **−6.7%**/decade					
Sea Level Rise	**1.8** to **3** mm/yr Subsiding crustal movement on coast	**.2 to .6**m 2100 Some estimates 1 m	**1.8** to **3** mm/yr Subsiding crustal movement	To 2100 **.2** to **.6m** Some estimates 1m	**1.8** to **3** mm/yr Rising crustal movement	**.2** to **.6m** by 2100 Some estimates 1m
River Flows % change	**+7**	**+12** to **30%** mainly April to July		**+19** to **20%**	**−10%**	**+10%**
Intense Winter Storms increase	Increase in numbers of intense (8% (1950 – 2000)) and Projected Intense storms by 2050: **+8%** to **15%**					
Rain intensity change in Days >10mm or %	**+ve** but small	**+5** to **10%** P20 yr to 10 yr return period	**2** to **6** days per decade	**+10** to **13%** P20 yr to 10 yr return period	**+ve** but small	**+15%** P20 yr to 10 yr return period
Permafrost thaw	Ground T change **0.3** to **0.5°C**/decade	**−30%** of area in South region	Thickening of surface melt layer.			

Note 1 *– negative trends became positive after 1990, Eastern Arctic*

ANNEX 1: Climate Change Projections for the Arctic & the North *continued*

REFERENCES

Abdaleti, W., et al., 2004. *Elevation changes of ice caps in the Canadian Arctic Archipelago*, J. Geophys. Research 109, P04008, doi:10.1029/2003 JF000045.

Arctic Climate Science Committee, 2005. *Arctic Climate Impact Assessment*, Cambridge University Press, 1035p.

Cohen, S.J., Ed., 1997. *Mackenzie Basin Impact Study, Final Report*, Environment Canada and University of B.C., 372p.

Dery, S.J., et al., 2005. *Characteristics and trends of river discharge into Hudson, James and Ungava Bays, 1964 – 2000*, J. of Climate 18.14:2547-2557.

Furgal, C. and T.D. Prowse, 2008. *Northern Canada, in From Impacts to Adaptation: Canada in a Changing Climate, 2007,* eds. D.S. Lemmen, et al., NRCan, Government of Canada, Ottawa p. 57 – 118.

Gascon, G., 2008. *Major cold-season precipitation events at Iqaluit, Nunavut: MSc. Thesis, Dept. of Atmospheric and Oceanic Sciences*, McGill University 23-07-2008.

Gearheard, S., et al., 2009. *Linking Inuit knowledge and meteorological station observations to understand changing wind patterns at Clyde River, 2008*. –submitted to Climate Change.

Intergovernmental Panel on Climate Change: Climate Change 2007: WGII, Vulnerability, Impacts and Adaptation, Cambridge University Press.

International Arctic Science Committee, 2005. *Arctic Climate Impact Assessment*, Cambridge University Press, 1042 pp.

Johannessen, O.M., L. Bengston, et al., 2004. *Arctic climate change, observed and modeled temperature and sea ice variability*, Tellus 56A.4:328-341.

Kharin, V.V., F. W. Zwiers, X. Zhang, and G.C. Hagerl, 2007. *Changes in temperature and precipitation extremes in the IPCC ensemble of global coupled model simulations*, J. of "Climate 20.8:1419-1444.

Kochtubajda, B., et al., 2006. *Lightning and fires in the Northwest Territories and responses to future climate change*, Arctic 59.2:211-221, (June 2006).

Lambert, S.J., 2004. *Changes in winter cyclone frequencies and strengths in transient enhanced greenhouse warming simulations using two coupled models*, Atmosphere-Ocean 42.3:173-181.

Lemmon, D.S, et al., Eds., 2008. *From Impacts to Adaptation: Canada in a Changing Climate 2007*, NRCan, Ottawa, 448p.

McBean, G., et al., 2005. *Arctic climate past and present: in Arctic Climate Impact Assessment*, Cambridge University Press, U.K., p. 22 – 60.

McCabe, G.J., et al., 2001. *Trends in Northern Hemisphere surface cyclone frequency and intensity*. J. of Climate 14.12:2765-68.

Roberts, and R.E. Stewart, et al., 2008. *On the occurrence of freezing rain and ice pellets over the eastern Canadian Arctic in 2008*, Atmospheric Research: 93 – 109.

Woo, M-K, and R. Thorne, 2003. *Streamflow in the Mackenzie Basin, Canada*, Artic 56.4:328-340.

Wrona, F.J., et al., 2005. *Freshwater ecosystems and fisheries: in Arctic Climate Impact Assessment*, Cambridge University Press, U.K., p353 – 452.

Zhang, X. et al., 2001. *Temperature and precipitation trends in Canada during the 20th Century*, Atmosphere-Ocean 38:395 – 42

ANNEX 2: Risk Communications & 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.

ANNEX 2: Risk Communications & Perceptions *continued*

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 × 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 × Consequence × 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.

ANNEX 2: Risk Communications & Perceptions *continued*

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.

ANNEX 2: Risk Communications & Perceptions *continued*

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.*

ANNEX 2: Risk Communications & Perceptions *continued*

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 imple-mentation 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.

ANNEX 2: Risk Communications & Perceptions *continued*

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.

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.

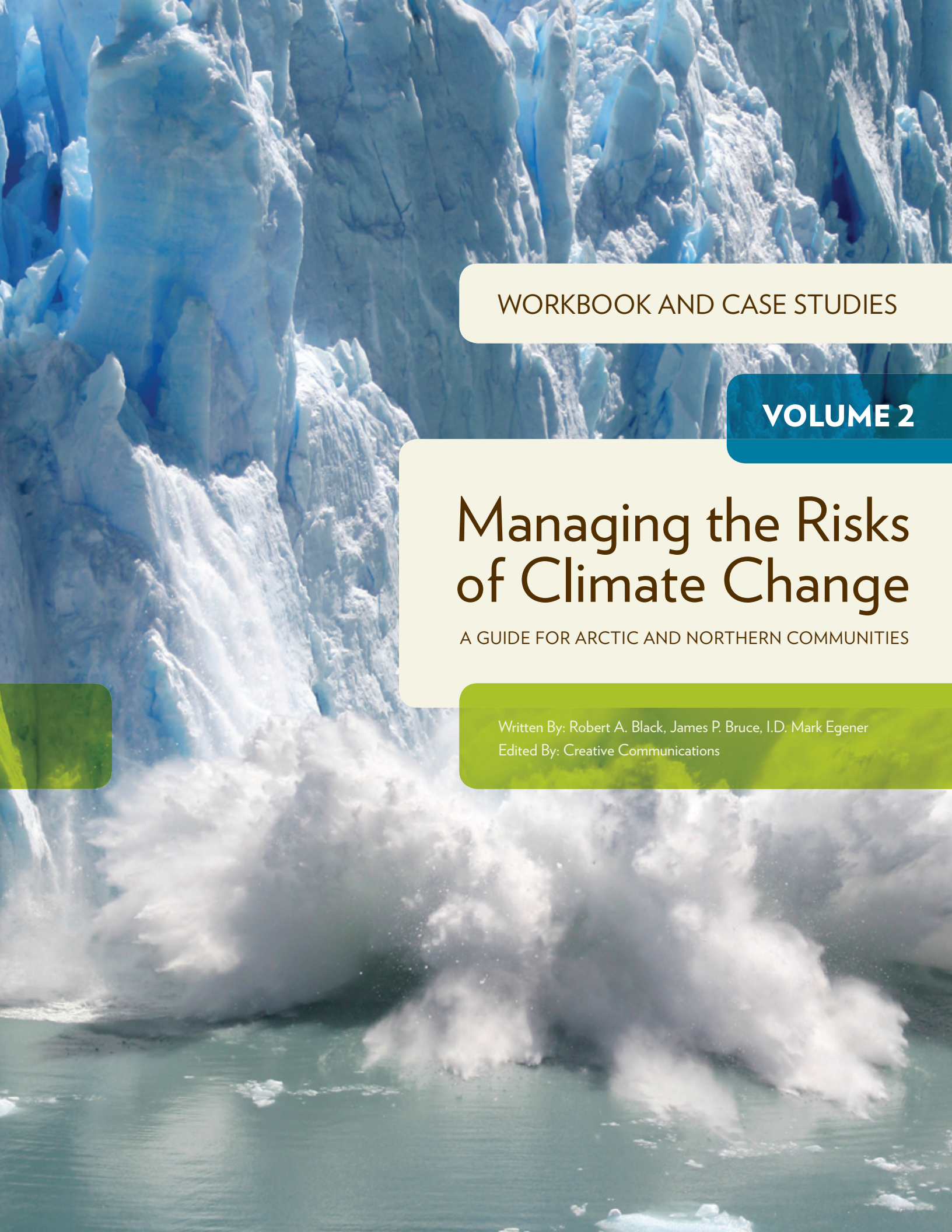
ANNEX 2: Risk Communications & Perceptions *continued*

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)



WORKBOOK AND CASE STUDIES

VOLUME 2

Managing the Risks of Climate Change

A GUIDE FOR ARCTIC AND NORTHERN COMMUNITIES

Written By: Robert A. Black, James P. Bruce, I.D. Mark Egener
Edited By: Creative Communications

TABLE OF CONTENTS

CENTRE FOR INDIGENOUS
ENVIRONMENTAL RESOURCES

ACKNOWLEDGEMENTS

Volumes 1 and 2 of this Guide were developed by Summit Enterprises International (S.E.I.) Inc. and authored by Dr. James P. Bruce and I.D. Mark Egener with assistance from Robert A. Black. Volume 1 of this Guide was edited by Creative Communications. The authors are indebted to the participation by representatives of Arctic communities and the territorial governments whose insights and assistance greatly improved the quality of the Guide. We thank Guppy Graphic Design for their design work on the Guides and Ron Mongeau for the use of his photos from Pangnirtung.

The Government of Canada through Indian and Northern Affairs Canada's Climate Change Adaptation Program generously provided the financial support that made the development of these Guides and the companion website possible.

The project to create these guides and the companion website was facilitated and managed by the Centre for Indigenous Environmental Resources. Please contact Shaunna Morgan at smorgan@cier.ca for any questions or comments on these Guides.

1 Introduction

INTRODUCTION

The Centre for Indigenous Environmental Resources (CIER) convened a workshop for representatives of a number of Arctic communities and the territorial governments to consider the projected climate change impacts over the next 20 to 30 years. The objective of the workshop was to understand which impacts will create the greatest risks to the Arctic communities and what adaptation strategies should be considered to reduce the risks to acceptable levels.

The meeting participants decided to consider the impacts in three general geographic areas:

- THE EASTERN ARCTIC,
- THE WESTERN ARCTIC, AND
- THE YUKON/MACKENZIE REGION

The following examples illustrate the use of the risk management process to develop adaptation strategies in these three geographic areas.

2

Case Studies: Arctic and Northern Communities

EASTERN ARCTIC

Members of the CIER workshop breakout group for the Eastern Arctic discussed the climate projections for their region and listed the following as the ones of principal concern:

- Permafrost thaw particularly from the perspective of community planning,
- Species migration,
- Shoreline erosion,
- Food security and potable water availability,
- Food security from the perspective of access to harvesting areas,
- Longer dry seasons including dust and health issues,
- Unpredictable weather changes and seasonal changes,
- Impact on traditional knowledge being passed on, and
- Natural resources exploration

The group decided to consider permafrost thaw as a detailed example because it is one of the most important impacts facing many of their communities over the next 20 to 40 years.

EASTERN ARCTIC *continued*

STEP 1: GETTING STARTED

The group, in defining the risk problem considered the following management implications of permafrost thaw:

- Community planning - areas for new development,
- Erosion,
- Water flow,
- Municipal infrastructure (i.e. roads, reservoirs and sewage lagoons),
- Building instability (i.e. residential, commercial, institutional),
- Water delivery and other municipal services,
- Raising awareness of consequences,
- Developing best practices in communities (i.e. Snow removal),
- Maximizing green spaces and recreation, and
- Possible relocation of buildings and population, among other factors.

They considered that the following would be the principal stakeholders who should be involved or informed about the analysis of the problems. The ones marked with an asterisk (*) would be on the project team:

- Territorial government,
- Elders,*
- Hunters & Trappers Organizations (HTOs),
- Municipality (Council, SAO*, engineering staff, Planning*),
- Church officials,
- Permafrost scientists/research institutions,
- Canadian Standards Organization,
- Private Sector (ie: Contractors, NTI),
- Health officials,
- INAC,
- Engineering institute,
- Home owners,
- Water board.

As part of their initial considerations the group had the following thoughts about communicating with stakeholders:

- Meet with community leaders (municipal council, elders, HTOs),
- Use radio stations for announcing and consulting, - try to get leaders to participate in radio and community outreach initiatives, and
- Ensure that information is translated in appropriate languages (includes posters and communication tools).

The group decided that it had enough information to move on to the next step.

EASTERN ARCTIC *continued*

STEP 2: PRELIMINARY ANALYSIS

The risk scenario for permafrost thaw was developed:

A. Land for development (shortage of land)
- Monitoring and assessment
  - → soil analysis
  - → site inspection
  - → identify hot spots
  - → geotechnical sampling
- Full analysis too costly for many communities

B. Infrastructure
- Roads
- Water
- Sewage
- Airstrips
- Water reservoir
- Dump sites
- Bridges
- Culverts

C. Cemeteries, historical/cultural sites
- Historical structure or cultural sites
- Moving of cemetery due diligence

D. Water
- River patterns-ponds disappearing
- Drainage patterns

E. Land slides (erosion)
- Could cause moving of parts of community

F. Building instability
- Housing
- Buildings

G. Mine development /tailings
- Containment of contaminants

EASTERN ARCTIC *continued*

TABLE 2: Preliminary Hazard and Risk Scenario Assessment (Step 2)

HAZARD :							
RISK	EVENT OR RESULT	FREQUENCY			CONSEQUENCE			COMMENTS
Permafrost Thaw	Land for Development	1	2	(3)	1	2	(3)	Greater Analysis/Inspection
	Infastructure	1	2	(3)	1	2	(3)	Same as above
	Historical and Cultural sites and cemeteries	(1)	2	3	1	(2)	3	Geotechnical/Accessibility
	Drainage Patterns	1	2	(3)	1	2	(3)	More Culverts
	River Patterns	1	(2)	3	1	2	(3)	Geotechnical
	Land Slumps	1	(2)	3	1	2	3	Community Planning
	Building Instability	1	2	(3)	1	(2)	3	New Practices
	Mining Development: Containment of Contaminants	1	(2)	3	1	2	(3)	None

FREQUENCY
1. Unlikely To Occur
2. Moderately Frequent Occurrence
3. Almost Certain To Occur

CONSEQUENCES
1. Low
2. Moderate
3. High

After doing the preliminary analysis the team found that they needed further data for Step 3 particularly in the following areas:

- Updated information on construction techniques
- Installation of monitoring equipment to monitor temperature of the ground, conditions of permafrost
- Feasibility of creating relationships with various research institutes working on the subject.

After recording all their information in the risk library, the group decided to move to Step 3.

EASTERN ARCTIC *continued*

STEP 3: RISK ESTIMATION

In this step the group considered both:

- Gradual thawing of the permafrost
- Episodic/extreme occurrence of a rapid permafrost thaw.

TABLE 3-1: Estimates of Frequency or Probability of Risks

PROBABILITY OR FREQUENCY					
Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Land for Development					X
Infrastructure				X	
Historical and Cultural Sites and Cemeteries		X			
Drainage Patterns				X	
River Patterns			X		
Land Slumps			X		
Building Instability					X
Mining Development Containment of Contaminants		X			

EASTERN ARCTIC *continued*

TABLE 3–2: Estimates of Consequences of Risks (Permafrost thaw overview)

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	
Very Low			X				X				
Low											
Moderate		X									
Major	X					X				X	X
Very Severe				X	X			X	X		

EASTERN ARCTIC *continued*

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
Permafrost Thaw	Impacts on Infrastructure	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Very Low Private Sector - Very Severe +-
	Cultural and Historical Sites and Cemeteries	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Moderate Private Sector - Low NTI - Moderate
	Rivers Changing Courses	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Very Severe Private Sector - Very Severe
	Drainage Patterns	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Major HTO - Major Private Sector - Moderate
	Land Slumps	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Major Private Sector - Moderate +-
	Building Instability	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Moderate Private Sector - Very Severe +-
	Containment of Contaminants	Municipal Council - Very Severe Territorial Government - Very Severe Residents - Very Severe HTO - Very Severe Private Sector - Very Severe +-

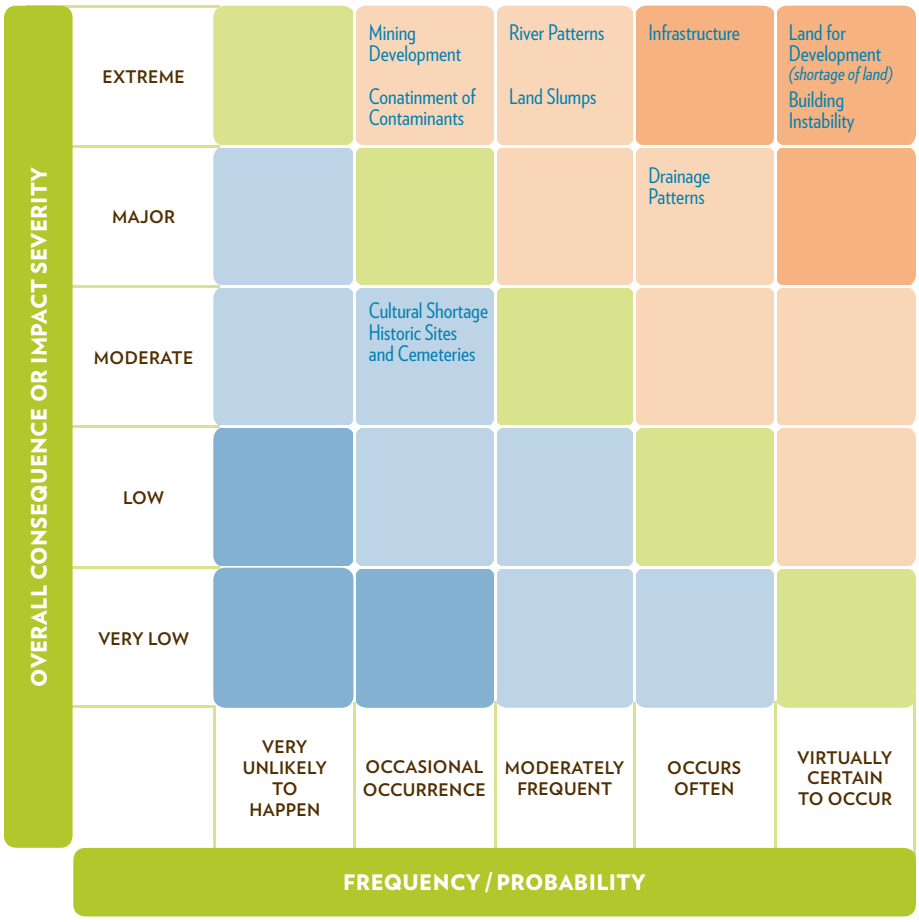
After thoroughly discussing their estimates of probability and consequences, the group agreed that there was a consensus among the members for the first round of the risk management process.

EASTERN ARCTIC *continued*

STEP 4: RISK EVALUATION

The group considered the overall consequences and probability of the various risks associated with permafrost thaw and produced the overview chart below:

TABLE 4: Risk Evaluation Matrix (Step 4)



EXTREME RISK:
Immediate controls required

HIGH RISK:
High priority control measures required

MODERATE RISK:
Some controls required to reduce risks to lower levels

LOW RISK:
Controls not likely required

NEGLIGIBLE RISK:
Scenarios do not require further consideration

The evaluation chart clearly indicated to the group the urgent need to consider adaptation measures or risk controls for the highest priority risks from permafrost thaw: creation of shortages of land for development, building instability, infrastructure damages, changes to river flow patterns, land slumps and changes to land drainage patterns.

The group was comfortable that a consensus existed among its members and it was decided to advance to Step 5.

Before doing so the group discussed the need for a dialogue with the key stakeholders, particularly the Council, HTOs and their prime contact in the Territorial government.

All documents used or copies of them including meeting and discussion notes were stored in the risk library.

EASTERN ARCTIC *continued*

STEP 5: RISK CONTROLS AND ADAPTATION DECISIONS

The group now considered the risk controls or adaptation measures needed to lower the higher risks due to permafrost thaw from Step 4 to acceptable or manageable levels.

After discussions with the readily available technical representatives the chart below was developed (only the two highest risks were used in this section of the example):

TABLE 5: Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
Shortage of Land for Development	Produce Geotechnical Reports	5-10 years	High	High	High	Geotechnical analysis is necessary for land use planning and it must be included in community planning and zoning by-laws Effective but slow
	Community Hazard Maps	5-10 years	High	High	High	
	Amend Development Plans and By-Laws	5-10 years	High	High	High	
	Require New Development Permits	5-10 years	High	High	High	
Building Instability	New Development Standards and Building Practices Monitoring	5-10 years	High	High	High	Examine new technologies in circumpolar regions Effective but slow
	Retrofitting Technologies	Immediate	Med	High	High	
	Monitoring of Soil	Immediate	Med	High	High	

The group agreed that all factors considered would bring risks to manageable and acceptable levels.

There would be a requirement for considerable discussion with and provision of information to all key stakeholder groups, and particularly the territorial and federal governments recognizing that funding assistance would be needed for the technical studies and experts assistance would be required.

The group completed the storing of information in the risk library and decided to move onto Step 6.

STEP 6: IMPLEMENTATION AND MONITORING

For the purposes of this example, the group was tasked to prepare a report for consideration by Council. The findings of the study were documented and recommendations drafted for Council to consider including the urgent needs to begin geotechnical studies and produce hazard maps.

WESTERN ARCTIC

Members of the CIER workshop breakout group for the Western Arctic discussed the climate projections for their region.

The group decided to consider permafrost thaw because it is one of the most serious concerns in the Western Arctic and especially in the community of Tuktoyaktuk.

WESTERN ARCTIC *continued*

STEP 1: GETTING STARTED

The group selected the Project team to include:

- Community Planner (Team Leader),
- Elder,
- Youth,
- Land Administration/Regional Government, and
- Readily available resource person/people.

- Stakeholders:
  - → Hamlet Council and Senior Administrative Officer,
  - → Inuvialuit Land Administration
  - → Tuktoyaktuk Community Corporation,
  - → Hunters and Trappers Council
    - Local businesses,
    - Homeowners,
    - Federal government - Indian and Northern Affairs Canada, Environment Canada, Natural Resources Canada, and
    - GNWT - Industry, Tourism and Investment, Municipal and Community Affairs, Dept of Transportation.

The time-frame for completing an overview study, including briefings to Council and key stakeholders was two weeks.

The group decided to keep careful records of all information they received, all documents that they created including meeting notes in a special file set up for the risk management study.

The group decided that it had enough information to move to the next step.

WESTERN ARCTIC *continued*

STEP 2: PRELIMINARY ANALYSIS

A risk scenario for permafrost thaw was developed:

TABLE 2: Preliminary Hazard and Risk Scenario Assessment (Step 2)

HAZARD: PERMAFROST THAW				
RISK	EVENT OR RESULT	FREQUENCY	CONSEQUENCE	COMMENTS
Slumping	Loss of cultural assets	1 (2) 3	1 (2) 3	Includes: historical items, archaeological finds, culturally significant items, etc.
	Loss of fresh water habitat	1 2 (3)	1 (2) 3	
	Foundation failure	1 2 (3)	1 2 (3)	
	Land travel	1 (2) 3	1 (2) 3	
	Loss of vegetation	1 (2) 3	1 2 (3)	
Surface Water	Change in quality	1 2 (3)	1 2 (3)	
	Change in quantity	1 2 (3)	1 2 (3)	
	Change in location	1 2 (3)	1 (2) 3	(More info is needed to determine the consequences of location changes)
Seabed and Shoreline Erosion	Loss of land	1 (2) 3	1 2 (3)	Shoreline erosion could be considered a separate hazard under the broader issue of climate change, with a distinct set of risks and vulnerabilities related to a combination of contributing factors. However, in the context of this hazard (permafrost), shoreline erosion is a distinct and potential catastrophic risk on its own.
Pingos	Deterioration	(1) 2 3	1 (2) 3	
	Cultural/economic	(1) 2 3	1 (2) 3	
Land Availability	Loss of land for future use	1 2 (3)	(1) 2 3	
Contaminants	Sumps	1 2 (3)	(1) 2 3	There are already remediation processes in place.
	Soil	1 2 (3)	(1) 2 3	

WESTERN ARCTIC *continued*

The group narrowed the risk scenario to two risks (shown on page 17 under "Event or Result" in orange) and considered them over the next 20 years:

- Slumping and the impact on foundations, and
- Changes, especially reduction, to surface water.

The group included several images to illustrate slumps and pingos

Land slump due to unstable ground resulting from permafrost melting
Photo: D. Downing/GNWT

Coastal Erosion in Tuktoyaktuk
Photo: PWNHC

Collapsed pinge
Photo: D. Downing/GNWT

The group was satisfied with their preliminary analysis, stored their data in the risk information library and decided to proceed to the next step.

WESTERN ARCTIC *continued*

STEP 3: RISK ESTIMATION

The group made more considered estimates of the frequency and consequences of their selected risks and how stakeholders may perceive them as shown in the tables below

TABLE 3-1: Estimates of Frequency or Probability of Risks

PROBABILITY OR FREQUENCY					
Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
Slumping – foundation failure					X
Surface water change (Loss of quantity)			X		

WESTERN ARCTIC *continued*

TABLE 3-2: Estimates of Consequences of Risks: Surface Water Quantity Loss

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	
Very Low	X		X	X	X	X		X			
Low		X									X
Moderate									X	X	
Major							X				
Very Severe											

TABLE 3-2: Estimates of Consequences of Risks: Infrastructure Failure (Slumping)

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	
Very Low	X							X	X		
Low		X	X		X					X	X
Moderate				X							
Major						X	X				
Very Severe											

WESTERN ARCTIC *continued*

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
Permafrost melt - slumping	Foundation failure	Gnwt - Very Serious Business Owners - Serious Public Housing Occupants - Very Serious Private Home Owners - Very Serious Hamlet - Very Serious ILA - Serious TCC - Serious Government Of Canada - Serious
Permafrost melt - surface water	Quantity change	Hamlet - Very Serious GNWT - Very Serious HTC - Serious Private Businesses - Low Government Of Canada - Moderate Community Members - Very Serious ILA - Very Serious

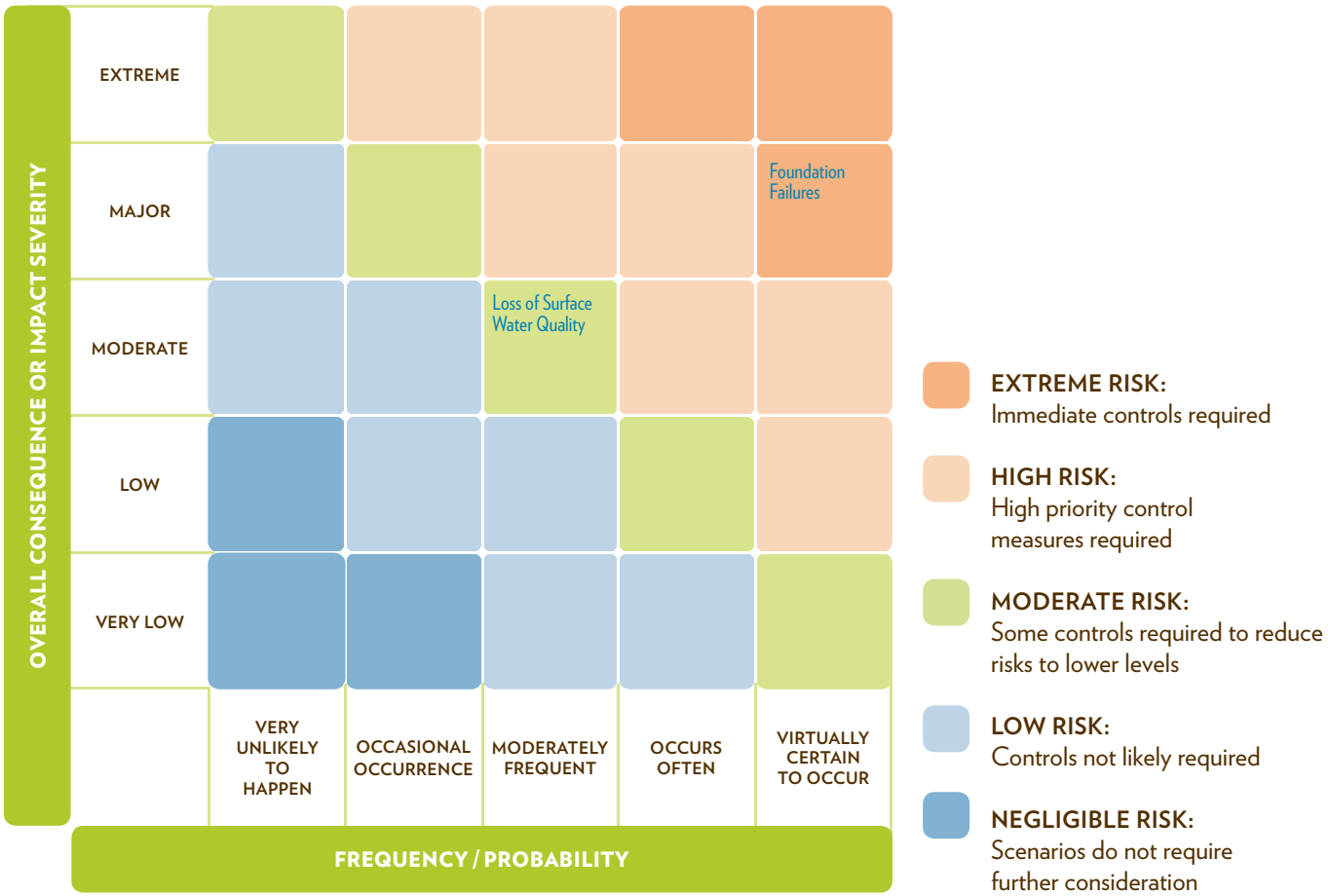
The group discussed their estimates of probability and consequences, and agreed that there was a consensus among the members for the first round of the risk management process.

WESTERN ARCTIC *continued*

STEP 4: RISK EVALUATION

The group considered the overall consequences and probability of the various risks associated with permafrost thaw and produced the overview chart below:

TABLE 4: Risk Evaluation



The evaluation chart indicated to the group the need to consider adaptation measures or risk controls for the highest priority risk from permafrost melt, foundation failures.

The group was comfortable that a consensus existed among its members and it was decided to advance to Step 5.

Before doing so the group discussed the need for a dialogue with the key stakeholders, particularly the Hamlet Council, Inuvialuit Land Administration, the Tuktoyaktuk Community Corporation and contacts in the Territorial government.

All documents used or copies of them including meeting and discussion notes were stored in the risk library.

WESTERN ARCTIC *continued*

STEP 5: RISK CONTROLS AND ADAPTATION DECISIONS

The group now considered the risk controls or adaptation measures needed to lower the risks due to permafrost melt from Step 4 to acceptable or manageable levels.

After discussions with the readily available technical representatives the chart below was developed:

TABLE 5: Risk Controls and Adaptation Measures

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
Foundation Failure (slumping)	Ensure infrastructure inspections occur regularly	Ongoing	Low	High	High	Check report completed by DPW
	Review and update (if necessary) building codes	Ongoing	n/a	High	High	Ensure that climate change is being considered; reaffirm needs with senior government
	Soil Classification/ permafrost mapping	One-time; within two years	High	High	Moderate	Would determine where ice is located under surface
	Research and communicate information about new and adaptive infrastructure technologies and best practices	Ongoing	Low	Moderate	High	
	Create new and/or more access to gravel source	Ongoing	High	High	Variable	Remedial treatments for domestic foundations
	Increase operation, maintenance and repair of foundations	Ongoing	Moderate	High	High	Increase Operations and Maintenance funding
	Implementing appropriate new technologies and/or building codes	As possible	TBD	High	Moderate	Would depend on the technology being implemented
Loss of Quantity (surface water)	Select future water source(s)that consider climate change effects	As needed	Low	High	High	Observations from community members are to be considered
	Research possibility of retaining existing water source	Immediate	Moderate	High	High	
	Monitor effect of changing quantity on ecosystems	Ongoing	Moderate	TBD	TBD	Focus on flow and connectivity; consider local observations. Must include a presentation of scientific knowledge
	Review and rehearse existing emergency preparedness plan for water supply	Ongoing	Low	High	High	

WESTERN ARCTIC *continued*

STEP 5: RISK CONTROLS AND ADAPTATION DECISIONS

The group agreed that all factors considered could bring risks to manageable and acceptable levels.

There would be a requirement for considerable discussion with and provision of information to all key stakeholder groups, and particularly the territorial and federal governments recognizing that funding assistance would be needed for the technical studies and experts assistance would be required.

The group completed the storing of information in the risk library and decided to move onto Step 6.

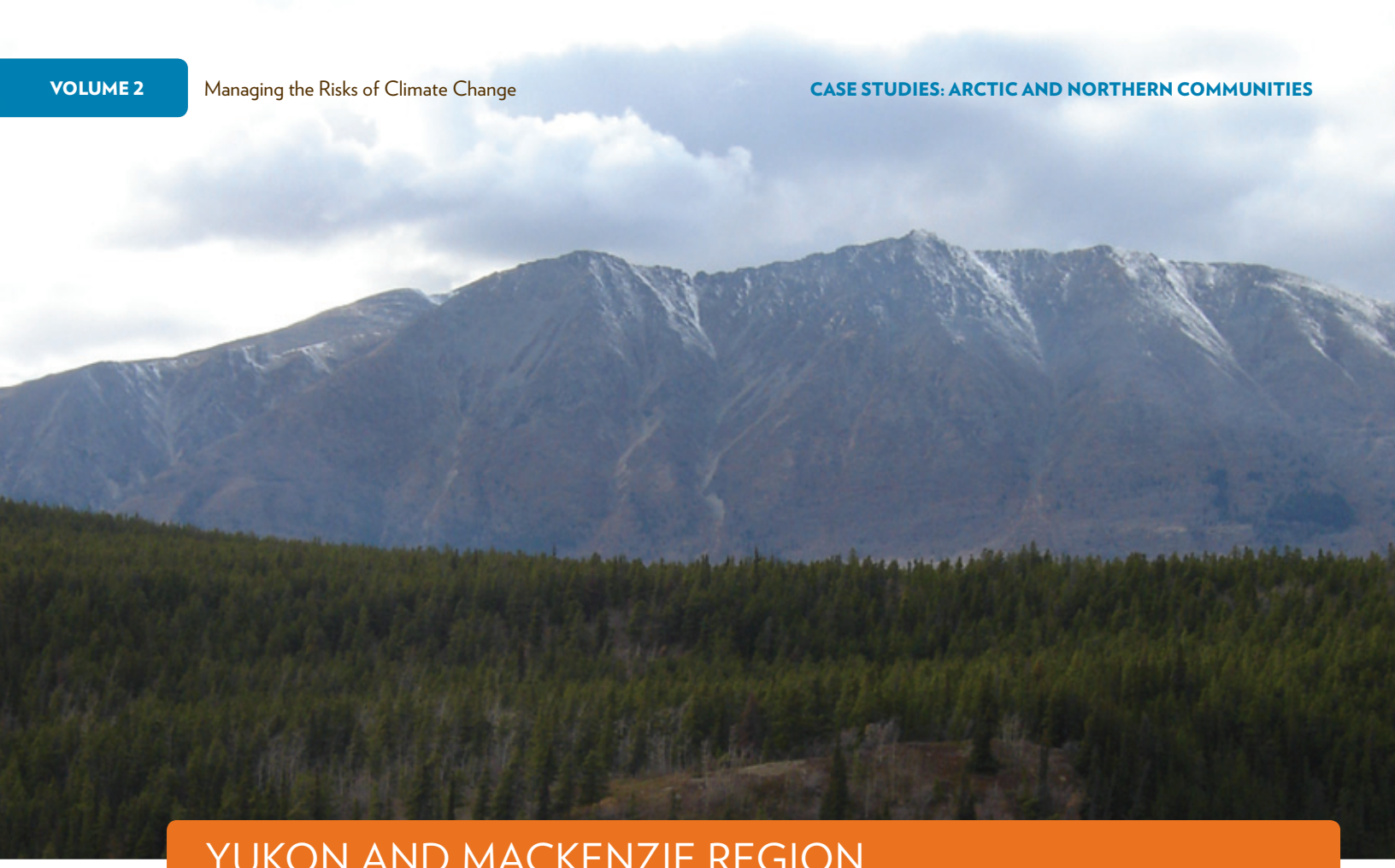
STEP 6: IMPLEMENTATION AND MONITORING

For the purposes of this example, the group was tasked to prepare a report for consideration by the Senior Administrative Officer and Council.

- Prioritization of risk control measures would be included in the report
- Inclusion of monitoring and results reporting
- Provision for a review every 5 years

The findings of the study were documented and recommendations drafted for the Hamlet Council to consider.

Stakeholder information sessions were included in the recommendations.



YUKON AND MACKENZIE REGION

Members of the CIER workshop breakout group for the Yukon/Mackenzie region discussed the climate projections for their region.

YUKON AND MACKENZIE REGION *continued*

STEP 1: GETTING STARTED

The group discussed the risks presented by climate change in their region over the next 25 to 40 years and selected increased precipitation for examination because it was one of the most serious hazards for this area of the Arctic.

The Project team included:
- Community Planner (Team Leader),
- Elder,
- Land Administration/Regional Government representative, and
- A readily available technical resource person from the community.

The group considered that the following would be the principal stakeholders who should be involved or informed about the analysis of the problems. The ones mark with an asterisk would be on the project team:
- Territorial government,
- Elders,
- Hunters & Trappers Organizations (HTOs),
- Municipal Council, SAO, engineering staff,
- Permafrost scientists/research institutions,
- Standing Offer Contractors
- Health officials,
- INAC,
- Homeowners,

As part of their initial considerations the group considered communicating with stakeholders:
- Meet with community leaders,
- Develop a community outreach plan, and
- Ensure that information is translated in appropriate languages (includes posters and communication tools).

The group decided that it had enough information to move on to the next step

YUKON AND MACKENZIE REGION *continued*

STEP 2: PRELIMINARY ANALYSIS

The risk scenario for increased precipitation was developed:

TABLE 2: Preliminary Hazard and Risk Scenario Assessment

HAZARD : INCREASED PRECIPITATION					
RISK	EVENT OR RESULT	FREQUENCY		CONSEQUENCE	COMMENTS
More Snow Accumulation	• Human Mobility • Animal Mobility & Health • Building Loads • Cost of Snow Removal	1 2 (3)		1 2 (3)	
Waterway Flooding	• Roads Washed Out • Community Flooding • Bank Erosion • Degradation of Fish Habitat • Water Potability Reduction	1 2 (3)		1 2 (3)	
Reduction of Ice Thickness	• Reduced Human Mobility • Safety • Reliance on other Transportation Modes	1 (2) 3		1 (2) 3	
Reduction in Tourism	• Less Income • More reliance on traditional income sources	(1) 2 3		1 (2) 3	
Increase in pests	• Mosquitoes & Black flies (West Nile, Ticks) • Tree pests	1 2 (3)		1 (2) 3	
Increased cost for Infrastructure	• Building Costs • Road Costs • Water treatment systems	1 2 (3)		1 (2) 3	
Socio-Economic Implications	• Change in Traditional Practices • Increased Health Issues • Availability of Traditional Foods • Reduction in reliability of Traditional Knowledge	1 2 (3)		1 2 (3)	

Because the group did not have sufficient time in the workshop to consider all of the risks in this scenario, they decided to consider the one that they assessed as the highest risk (shown above in orange) for further study:

After recording all their information in the risk library, the group decided to move to Step 3.

YUKON AND MACKENZIE REGION *continued*

STEP 3: RISK ESTIMATION

In this step the group considered in more detail the likelihood and consequences of the risks they had selected from table 2.

TABLE 3-1: Estimates of Frequency of Risks Associated with Increased Precipitation

PROBABILITY OR FREQUENCY					
Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur
More Snow Accumulation					X
Waterway Flooding				X	
Reduction of Ice Thickness			X		
Reduction in Tourism		X			
Increase in Pests				X	

TABLE 3-2: Estimates of Consequences of Risks
Risk Scenario #1: More Snow Accumulation

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low	X						X	X	X				
Low													
Moderate		X								X			
Major			X	X		X							
Very Severe					X						X	X	X

YUKON AND MACKENZIE REGION *continued*

TABLE 3–2: Estimates of Consequences of Risks
Risk Scenario #2: Waterway Flooding

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low							X						
Low													
Moderate									X	X			
Major	X		X		X	X		X					
Very Severe		X		X							X	X	X

TABLE 3–2: Estimates of Consequences of Risks
Risk Scenario #3: Reduction of Ice Thickness

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low	X						X	X	X	X			
Low				X									
Moderate	X				X								
Major		X				X							
Very Severe			X								X	X	X

YUKON AND MACKENZIE REGION *continued*

TABLE 3-2: Estimates of Consequences of Risks - Risk Scenario #4: Reduction in Tourism

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low	X	X		X			X	X	X	X			
Low						X					X	X	X
Moderate			X										
Major					X								
Very Severe													

TABLE 3-2: Estimates of Consequences of Risks - Risk Scenario #5: Increase in Pests*

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low													
Low	X							X	X				
Moderate		X		X	X		X						
Major			X			X				X	X	X	X
Very Severe			X										

*The impact of pests on forests and consequent implications for increased forest fires were considered by the group.

The group discussed their estimates of probability and consequences, and agreed that there was a consensus among the members for the first round of the risk management process.

They did not have time to consider the stakeholders' perception of the risks and decided to do that at the end of the next step.

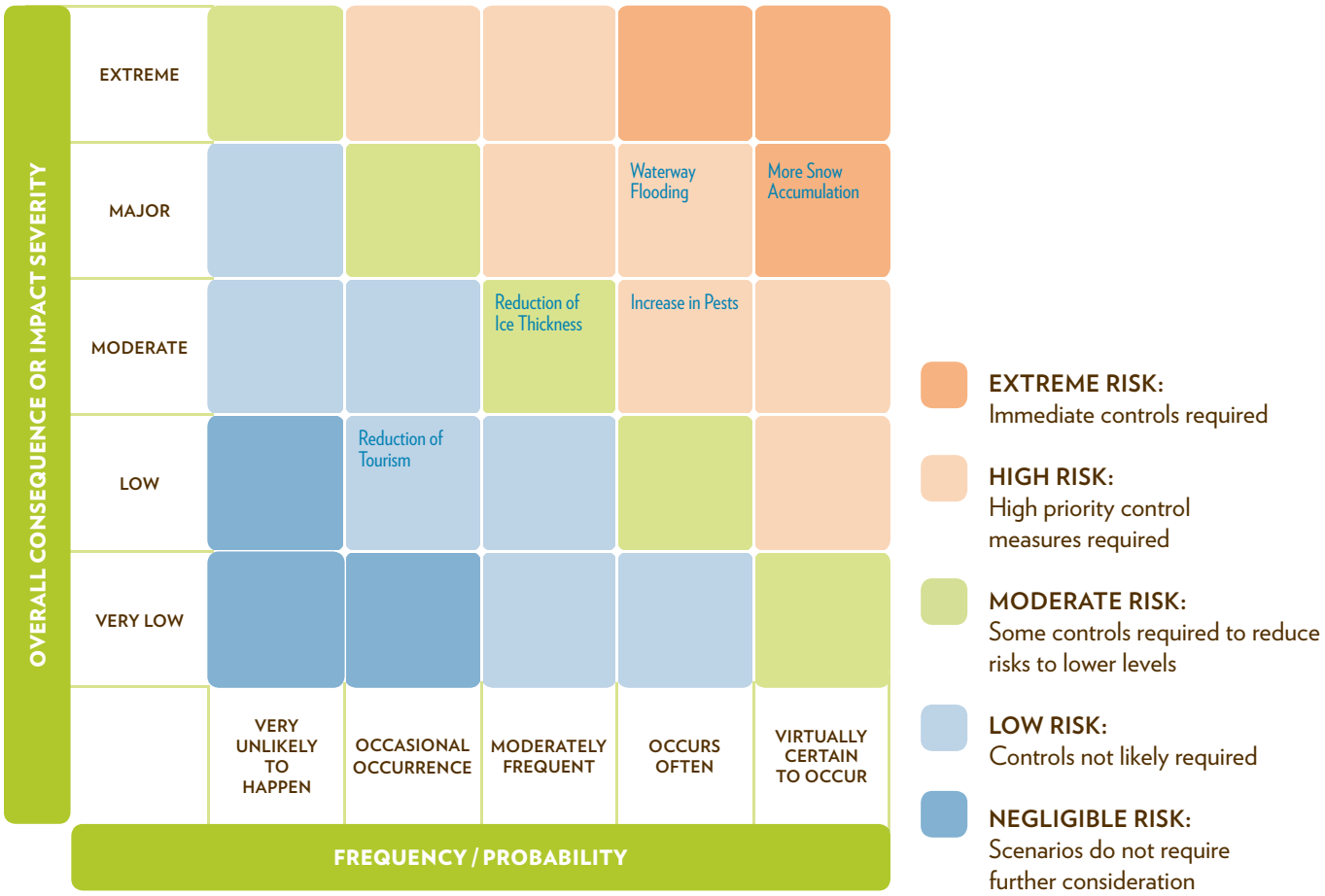
The group ensured that the documents, notes and other records were saved in the risk library.

YUKON AND MACKENZIE REGION *continued*

STEP 4: RISK EVALUATION

The group considered the overall consequences and probability of the various risks associated with increased precipitation and produced the overview chart below:

TABLE 4: Risk Evaluation Matrix (Step 4)



The evaluation chart indicated to the group the need to consider adaptation measures or risk controls for the highest priority risks from increased precipitation: snow accumulation.

The group was comfortable that a consensus existed among its members and it was decided to advance to Step 5.

Before doing so the group discussed the need for a dialogue with the key stakeholders, particularly the Council, and contacts in the Territorial government.

All documents used or copies of them including meeting and discussion notes were stored in the risk library.

YUKON AND MACKENZIE REGION *continued*

STEP 5: RISK CONTROLS AND ADAPTATION DECISIONS

The group now considered the risk controls or adaptation measures needed to lower the risks due to high snow accumulation to acceptable or manageable levels (note: time shortages precluded them from considering adaptation measures or risk controls for other risks from Step 4).

TABLE 5: Risk Controls and Adaptation Measures for More Snow Accumulation

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation
More Snow Accumulation	Enhanced Snow Removable Capability	Long	High	High	Marginal	
	Prioritize Roads to be Cleared	Short	Low	High	Good/Better	
	Review Building Codes	Short	Low	High	Very Good	
	Prioritize Buildings for Upgrading	Med	Med	High	Good	
	Structural Upgrading	Long	High	High	Marginal	
	Clearing Important Wildlife Routes	Short	Med	High	High	
	Monitoring Wildlife Health & Harvest Control	Short	High	Medium	Medium	• Higher acceptability if joint process • Politically sensitive
	Food Drops to Wildlife	Short	High	Medium	Medium	
	Resource Sharing	Short	Low	High	High	

The group agreed that all factors considered could bring this particular risk to a manageable and acceptable level.

There would be a requirement for considerable discussion with and provision of information to all key stakeholder groups, and particularly the territorial and federal governments recognizing that funding assistance would be needed for the technical studies and experts assistance would be required.

The group completed the storing of information in the risk library and decided to move onto Step 6.

YUKON AND MACKENZIE REGION *continued*

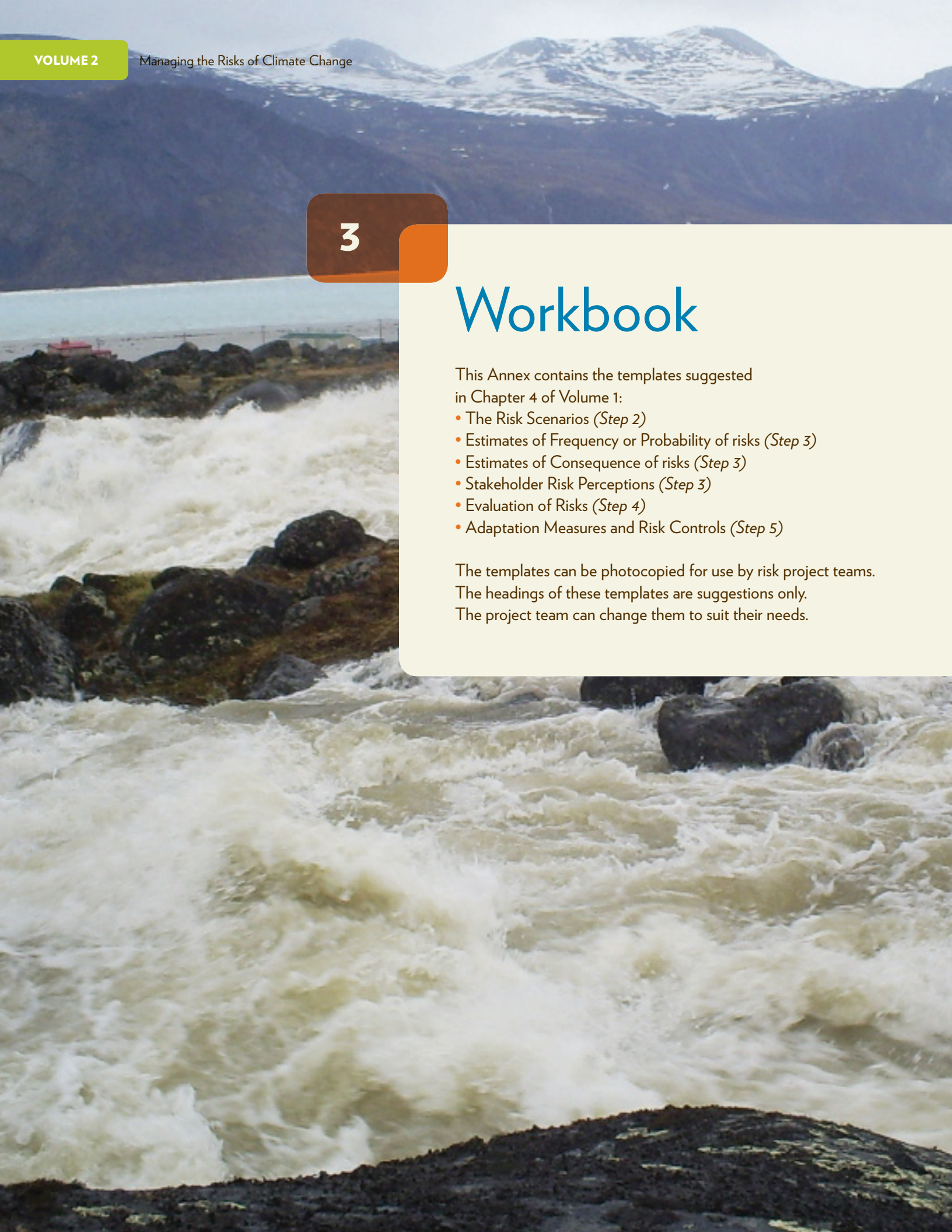
STEP 6: IMPLEMENTATION AND MONITORING

For the purposes of this example, the group was tasked to prepare a report for consideration by the Council.

- Prioritization of risk control measures would be included in the report
- Inclusion of monitoring and results reporting
- Provision for a review every 5 years

The findings of the study were documented and recommendations drafted for the Hamlet Council to consider.

Stakeholder information sessions were included in the recommendations.



3

Workbook

This Annex contains the templates suggested in Chapter 4 of Volume 1:

- The Risk Scenarios *(Step 2)*
- Estimates of Frequency or Probability of risks *(Step 3)*
- Estimates of Consequence of risks *(Step 3)*
- Stakeholder Risk Perceptions *(Step 3)*
- Evaluation of Risks *(Step 4)*
- Adaptation Measures and Risk Controls *(Step 5)*

The templates can be photocopied for use by risk project teams. The headings of these templates are suggestions only. The project team can change them to suit their needs.

TABLE 2: Preliminary Hazard and Risk Scenario Assessment (Step 2)

HAZARD : INCREASED PRECIPITATION				
RISK	EVENT OR RESULT	FREQUENCY	CONSEQUENCE	COMMENTS
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	
		1 2 3	1 2 3	

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

TABLE 3.1: Estimates of Frequency or Probability of Risks (Step 3) (Use as many rows as needed)

PROBABILITY OR FREQUENCY					
Event	Very Unlikely to Happen	Occasional Occurrence	Moderately Frequent	Occurs Often	Virtually Certain to Occur

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

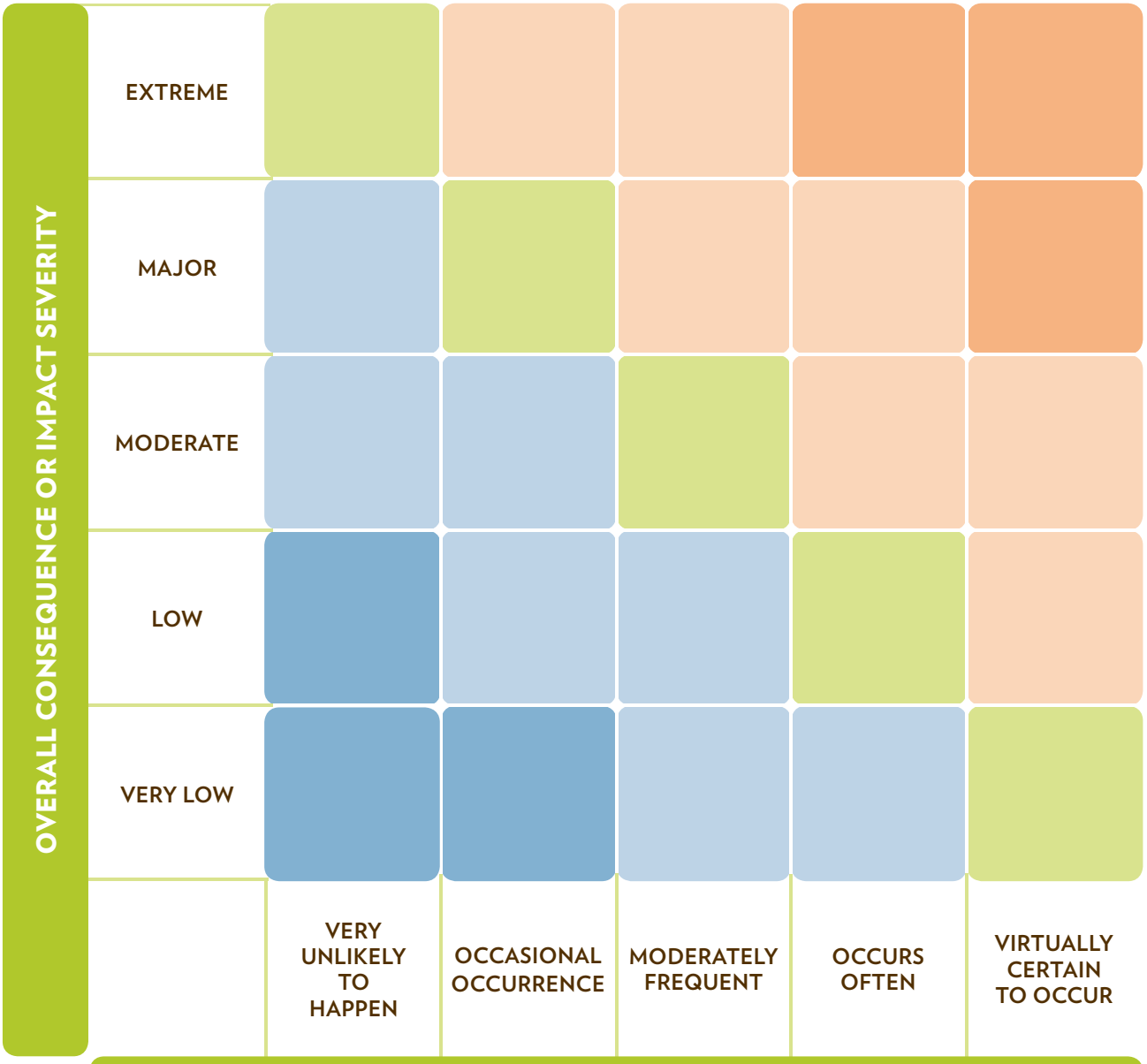
TABLE 3-2: Estimates of Consequences of Risks - Risk Scenario

IMPACT	Social Factors			Economic Factors			Environmental Factors				Cultural Aspects		
Degree	Health & Safety	Displacement	Loss of Livelihood	Property Damage	Financial Impact	Impact on Community Finances	Air	Water	Land	Eco-systems	Traditional Foods	Traditional Medicine	Traditional Lifestyle
Very Low													
Low													
Moderate													
Major													
Very Severe													

TABLE 3–3: Suggested display for stakeholders and risk perception (Step 3).

Climate Factors (Hazards)	Risk Scenarios - Aspects of Hazards and Risks to Community	Stakeholders and Perception of Risk

TABLE 4: Risk Evaluation Matrix (Step 4)



EXTREME RISK: Immediate controls required

HIGH RISK: High priority control measures required

MODERATE RISK: Some controls required to reduce risks to lower levels

LOW RISK: Controls not likely required

NEGLIGIBLE RISK: Scenarios do not require further consideration

TABLE 4: Risk Evaluation Matrix (Step 4)

Risk	Control or Adaptation Measure	Time Frame	Cost	Effectiveness	Acceptability	Comment / Evaluation