Pathways to Climate Change Resilience Community Resource Collection:

A Guidebook for Canadian Communities

CANADIAN MODEL FOREST NETWORK

RÉSEAU CANADIEN DE FORÊTS MODÈLES

Pathways to Climate Change Resilience: A Guidebook for Canadian Forest-Based Communities

Community Resource Collection

This Guidebook and the accompanying Community Resource Collection has been crafted based on the idea that Canadian rural communities in forest settings want guidance in understanding and acting to reduce community impacts from the changing climate. Collecting information and existing tools into a useful framework has been the first step for this initiative.

The next step is to test and pilot this idea with Canadian forest-based communities. After these pilots, the Guidebook will be refined, with investments in graphics, pictures and possibly worksheets.

We encourage feedback on this guidebook. Please send comments or additional resources to the Lead Author – Cindy Pearce at cindypearce@telus.net

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Resource References

These resources are recommended as the most valuable to learn about Canadian rural forest-based community adaptation planning.

Resource Reference and Description	Weblink
Rural Climate Change Adaptation Program Websites	
Climate Change North The Northern Climate ExChange is a clearinghouse of climate change information for Northern Canada. The mandate is to provide independent information, develop shared understanding and promote action on climate change. They continue to host community adaptation planning projects.	www.taiga.net/nce
Columbia Basin Trust Communities Adapting to Climate Change Initiative This initiative supports communities of the Canadian Columbia Basin to increase their adaptive capacity and resiliency to climate change impacts at a community level. See Rural Community Adaptation Initiatives below for District of Elkford, City of Kimberley, Town of Rossland, Village of Kaslo & rural areas, and City of Castlegar projects.	http://cbtadaptation.squarespace.com/ http://www.cbt.org/Initiatives/Climate_Change/?Adapting_to_Climate_Change
Natural Resources Canada – Tools for Adaptation Adaptation tools include guidelines, methods and approaches to help people incorporate information about a changing climate in decision-making. The Division supported the review of existing decision-support tools in some sectors and the creation of several new ones.	http://adaptation.nrcan.gc.ca/tools/abosuj_e.php#risk

Rural Community Adaptation Initiatives	
Dawson Community Climate Change Adaptation Plan. 2009. A collaborative process that draws on the experience and knowledge of residents and integrates it with scientific expertise. The plan is primarily intended as a resource for community use and to support other planning and decision-making processes in the area. 100 p.	http://taiga.net/nce/adaptation/Dawson_Plan_Final.pdf For more information on the project: http://taiga.net/nce/adaptation/dawson.html#1b
District of Elkford Climate Change Adaptation Strategy. 2009. A community wide adaptation plan. Priority impact areas investigated in Elkford included: wildfire, water availability and flooding. Elkford will be the first community in BC to integrate climate change adaptation into their Official Community Plan. 81 p.	http://cbtadaptation.squarespace.com/elkford-bc/ Includes information on the process and reports

Adapting to Climate Change in Kimberley, BC. 2009. A community-wide adaptation plan. Priority climate impacts that were investigated included: water and forests, municipal infrastructure and tourism. 92 p.	http://cbtadaptation.squarespace.com/kimberley-bc/ Includes information on the process and reports
City of Rossland: Communities Adapting to Climate Change Initiative Final Report. 2010 A community-wide adaptation plan. Priority climate impacts investigated include: infrastructure, water, energy and food.	http://adaptationresources.pbworks.com/w/page/30730124/Final-reports
Kaslo / Area D Climate Change Adaptation Project. 2010 An adaptation plan prepared by a small community in partnership with rural residents. Climate change impacts on water availability and food security were explored.	http://adaptationresources.pbworks.com/w/page/30730124/Final-reports
City of Castlegar Climate Change Adaptation Plan. 2010 This community examined water provision, food security and infrastructure, including a PIEVC pilot on stormwater systems.	http://adaptationresources.pbworks.com/w/page/30730124/Final-reports

Canadian Community Adaptation Planning Guides See guides from international sources below	
Managing the Risks of Climate Change Adaptation – A Guide for Arctic and Northern Communities. 2010. Volumes 1 (63 p.) & 2 -Workbook and Case Studies (p.) This Guide 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. It 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.	http://ccrm.cier.ca/start_here.php
Regional Risk-based Guides for Canadian Local Governments Natural Resources Canada has commissioned a series of Guides using the Canadian Standards Association risk evaluation processes in climate change adaptation for the regions of Canada. The following guides are available. *Adapting to Climate Change: A Risk-Based Guide for Local Governments in BC.* 2010. DRAFT. Volumes 1 & 2. *Adapting to Climate Change: A Risk-Based Guide for Alberta Municipalities.* 2009. *Adapting to Climate Change: A Risk-Based Guide for Ontario Municipalities.* 2006.	http://adaptation.nrcan.gc.ca/tools/abosuj_php http://adaptation.nrcan.gc.ca/projdb/pdf/176b_e.pdf http://adaptation.nrcan.gc.ca/projdb/pdf/176a_e.pdf

Changing Climate - Changing Communities: Guide and Workbook for Municipal Climate Adaptation This guide and workbook provide guidance for municipal governments looking to create and integrate local climate change adaptation plans. It is a compendium of resources that provides a five-milestone framework to assist local governments with the creation of an adaptation plan to address the relevant climate change impacts in their community. ICLEI is beginning projects with a number of communities across Canada.	http://www.iclei.org/index.php?id=8708
Élaborer un plan d'adaptation aux changement climatiques/ **A Guide for Quebec Municipalities for Developing a Climate Change Adaptation Plan** This tool, produced by Ouranos for Quebec communities, discusses the need for adaptation and provides an overview of the expected climatic changes and impacts for Quebec as they relate to municipalities. The tool takes users through a process that results in the development of an adaptation plan.	http://ouranous.ca/media/publication/111_PlanadaptationCC-Guidemunicipalities-Ouranos.pdf

Canadian Climate Change Adaptation Resources for Municipalities These resources are helpful even though they reference larger municipalities most often	
CANADIAN COMMUNITIES' GUIDEBOOK FOR ADAPTATION TO CLIMATE CHANGE - Including an approach to generate mitigation co-benefits in the context of sustainable development. Environment Canada and UBC. 2008. This Guidebook builds on the rich experiences of researchers within Environment Canada's Adaptation and Impacts Research Division (AIRD) working with decision-makers on practical projects focused on climate change and sustainable development. It provides a process closely tied to on-going planning cycles to help decision-makers incorporate climate change science, impacts, adaptation and mitigation solutions into their sustainable development initiatives.	http://www.forestry.ubc.ca/LinkClick.aspx?fileticket=xsexCSatHjo%3D&tabid=2455&mid=5415&language=en-US
Municipal Resources for Adapting to Climate Change. Federation of Canadian Municipalities. 2009. The purpose of this resource is to provide information to Partners in Climate Protection members and other municipal officials about municipal adaptation initiatives and to provide resources for municipal officials who wish to undertake adaptation planning.	http://fmv.fcm.ca/files/Capacity_Building_-_PCP/PCP_Resources/Mun-Re-_Adapting-Climate-Change-e.pdf
Adapting to Climate Change : An Introduction for Canadian Municipalities. Natural Resources Canada. 2010 This book is an update and expansion of the document published in 2006 by the Canadian Climate Impacts and Adaptation Research Network (Mehdi, 2006) under the same title. It provides municipal decision-makers and staff with information to help them understand the need for climate change adaptation and how to put adaptation measures in place. The book also refers to other guides that can help municipalities identify and address risks and opportunities, and to case studies that illustrate how municipalities of varying sizes from across the country are taking action now.	http://adaptation.nrcan.gc.ca/mun/index_e.php

Sector-based Climate Change Adaptation	
Canadian Council of Forest Ministers Climate Change Adaptation Initiative The Canadian Council of Forest Ministers' (CCFM's) has identified climate change as a priority in their *Vision for Canada's Forests: 2008 and Beyond*. As part of a shared commitment to sustainable forest management, the CCFM is developing innovative approaches to mitigate the effects of climate change, and adapt to its impacts on Canada's forests.	http://www.ccfm.org/english/coreproducts-cc.asp
Engineers Canada Public Infrastructure Engineering Vulnerability Committee (PIEVC) The Vulnerability Committee was created to conduct engineering assessments of the vulnerability of Canada's public infrastructure to the impacts of climate change. Pilot case studies are ongoing. The PIEVC Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment can be very helpful if infrastructure is being examined in a community climate change adaptation initiative.	http://www.pievc.ca/e/index_.cfm http://adaptation.nrcan.gc.ca/projdb/pdf/211_e.pdf
Canadian Institute of Planners Municipal Case Studies - A joint study with Natural Resources Canada examined the planning process and climate change in five municipalities across the country. Rural community examples examined impacts on sea level rise in Graham Island, BC and southeastern New Brunswick coastal communities as well as northern communities. Planning for Climate Change website	http://www.cip-icu.ca/web/la/en/pa/FDD921FC64CB4439A096528BFD59E779/template.asp http://www.planningforclimatechange.ca/wwwroot/dsp_HomePage.cfm

International Adaptation Planning Guides	
Climate Change Impacts & Risk Management - A Guide for Business and Government. 2006. Australian Government. 75 pp. This is a guide to integrating climate change impacts into risk management and other strategic planning activities in Australian public and private sector organisations. The purpose of this Guide is to assist Australian businesses and organisations to adapt to climate change.	http://www.climatechange.gov.au/en/what-you-can-do/community/~/media/publications/local-govt/risk-management.ashx
UKCIP Adaptation Wizard A 5-step web-based tool that guides users in assessing vulnerability to current climate and future climate change, identifying options to address key climate risks, and developing a climate change adaptation strategy.	http://www.ukcip.org.uk/index.php?Itemid=273&id=147&option=com_content&task=view
Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. 2007. Snover, A.K., L.C. Whitely Binder, J. Lopez, E. Willmott, J.E. Kay, D. Howell, and J. Simmonds. 2007. Climate Impact Group, University of Washington, in association with and published by ICLEI - Local Governments for Sustainability, Oakland, CA. The purpose of this guide is to help decision-makers in local, regional or state governements to prepare for climate change by recommending a detailed, easy-to-understand process for climate change preparedness based on familiar resources and tools.	http://cses.washington.edu/cig/fpt/guidebook.shtml

Summaries of Technical Information on Climate Change Impacts	
From Impacts to Adaptation - Canada in a Changing Climate 2007. Through a primarily regional approach, this assessment discusses current and future risks and opportunities that climate change presents to Canada, with a focus on human and managed systems. It is based on a critical analysis of existing knowledge, drawn from the published scientific and technical literature and from expert knowledge.	http://adaptation.nrcan.gc.ca/assess/2007/index_e.php
Climate Change and Canada's Forests: From Impacts to Adaptation. 2009. Williamson, et. al. Sustainable Forest Management Network and Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB. 104 pp. Based on the work of the forestry authors of the recently released Canadian national assessment , this report summarizes the current state of knowledge of current and future impacts of climate change and its implications for forest management	http://nofc.cfs.nrcan.gc.ca/bookstore_pdfs/29616.pdf.
Climate Change and Forest Management in Canada: Impacts, Adaptive Capacity and Adaptation Options. A State of Knowledge Report. 2010. Johnston, M., Williamson, T., Munson, A., Ogden, A., Moroni, M., Parsons, R. Price, D. and Stadt, J. 2010. Sustainable Forest Management Network, Edmonton, Alberta. 54 pp. This report addresses both the impacts of climate change and the adaptive capacity of forest management, with somewhat more emphasis on the latter.	http://www.sfmnetwork.ca/docs/e/SOK_2010_Johnson.etal_%20Climate%20Change_En.pdf

Global Climate Change Impacts in the United States Summarizes the science and the impacts of climate change on the United States, now and in the future. It focuses on climate change impacts in different regions of the U.S. and on various aspects of society and the economy such as energy, water, agriculture, and health. It's also a report written in plain language, with the goal of better informing public and private decision making at all levels. See relevant regional and sector sectors.	http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts
Scientific Reports	
A framework for assessing vulnerability of forest-based communities to climate change. 2007. Williamson, T.B.; Price, D.T.; Beverly, J.; Bothwell, P.M.; Parkins, J.R.; Patriquin, M.N.; Pearce, C.; Stedman, R.C.; Volney, W.J.A. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Information Report NOR-X-414E.	http://bookstore.cfs.nrcan.gc.ca/detail_e.php?recid=12586640
Assessing potential biophysical and socioeconomic impacts of climate change on forest-based communities: a methodological case study. 2008. Williamson, T.B.; Price, D.T.; Beverly, J.; Bothwell, P.M.; Frenkel, B.; Park, J.; Patriquin, M.N. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Information Report NOR-X-415E. 136 pp.	http://bookstore.cfs.nrcan.gc.ca/catalog_e.php?Catalog=29156

International Guidance on Climate Change	
Intergovernmental Panel on Climate Change Fourth Assessment Report. 2007.	http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1

Community Examples

Examples of how rural communities have undertaken climate change adaptation planning are included in this section. One example of each assessment approaches is outlined in the guidebook. Portions of the tables in the reports are included to illustrate the decision processes used.

1. Impact Rating Example

☐ ***Hall Beach, Nunavut – Climate Change Adaptation Plan***. 2008. Christine Callihoo and Dan Ohlsen. http://www.climate-decisions.org/4_CaseStudy_Hall_Beach.htm

Purpose – Produce a Climate Change Action Plan with the community of Hall Beach to assist with decision-making at the local level through policy options, capacity building and identifying policy options.

Community description

Location – At the northwest tip of Melville Peninsula on the shores of Foxe Basin

Landscape – Tundra (Although this is not a forest-based community, this is the only current example of impact rating)

Population - ~650

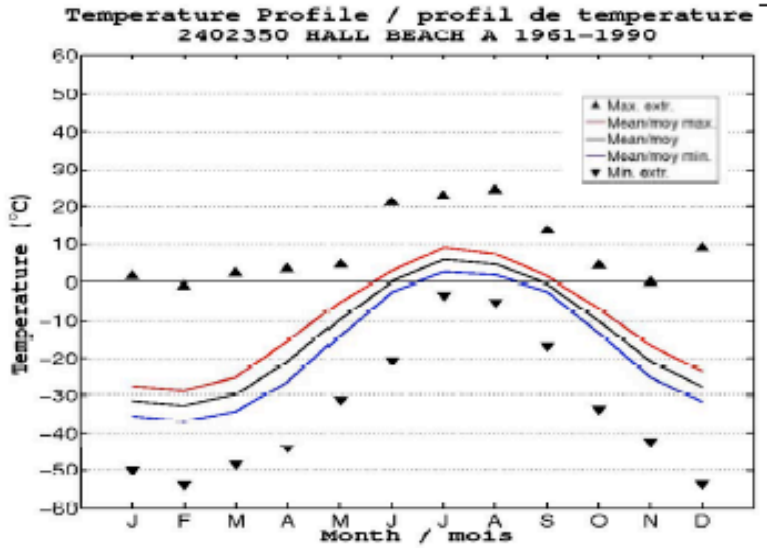
Community activities – Hunting, fishing, crafting

Community climate change adaptation objectives – See Table 1 below

Table 1: Objectives for the Hall Beach Climate Change Adaptation Action Plan	
Community:	• To protect and enhance community infrastructure • To improve transportation between Hall Beach, other communities and traditional hunting areas
Social:	• To protect human health and safety • To maintain cultural/northern traditions and knowledge
Environment:	• To protect the natural environment • To improve energy efficiency
Economic:	• To minimize the potential costs to the Hamlet for climate change impacts to the community • To minimize cost of required adaptations or mitigations

Temperature

This temperature profile provides monthly average **minimum**, **mean** and **maximum** temperature and also extreme minimum and extreme maximum temperature during the 1961-1990 reference period.



Precipitation

This precipitation profile provides the number of days of **rain** (light shade) and **snow** (darker shade) are indicated on a monthly basis, with the values averaged over the 1961-1990 reference period.

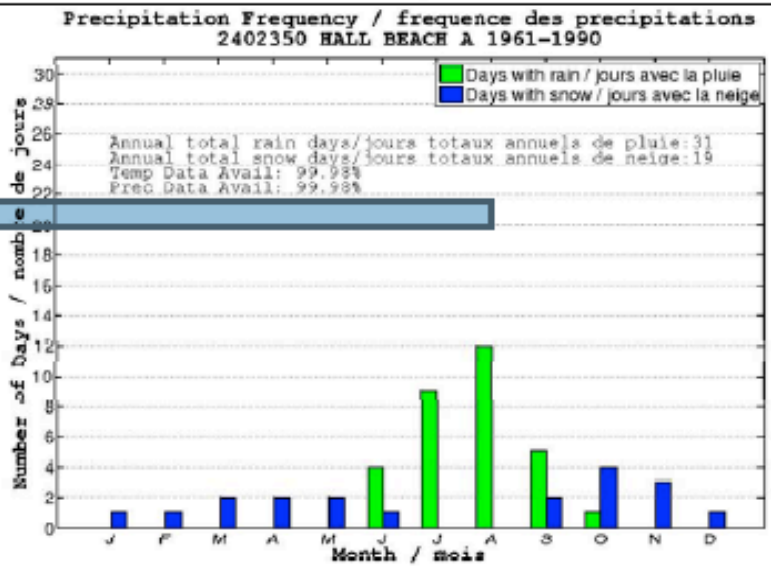


Figure 1: Temperature and Precipitation for Hall Beach based on historical records during the 1961 – 1990 reference period.

Source: Canadian Climate Change Scenarios Network website (http://www.ccsn.ca/index-e.html)

Climate profile

Figure 1 on the left shows the historical climate of Hall Beach.

Table 3 on the next page summarizes potential future climate information.

Table 3: Summary of Climate Change Scenarios for Selected Variables

Climate Variable	Focus Period	Range of Magnitude / Directions of Change	Summary of Projections
Temperature	Annual	+4 °C to +12 °C	• Generally projected to rise steadily over time, annually and for all seasons. • Most significant increases projected to occur in fall and winter. Greater uncertainty in these seasons.
	Fall Winter	+4 °C to +14 °C +7 °C to +19 °C	
Precipitation	Annual	+14% to +42%	• Generally projected to rise steadily over time, annually and for all seasons. • Most significant increases projected to occur in
	Fall	+11% to +62%	
			• Generally projected to rise steadily over time annually. • Yet seasonally projected to either rise or fall with the greatest uncertainty being in winter.
Wind Speed	Annual	+1% to +17%	
	Summe r Winter	- 14% to +7% - 4% to +46%	
			• Generally projected to decrease steadily over time, annually and for all seasons. • Most significant decreases projected to occur in spring and winter. Greater uncertainty in these seasons.
Sea Ice	Annual	- 240 kg/m^2 to - 170 kg/m^2	
	Spring Winter	- 400 kg/m^2 to - 260 kg/m^2 - 370 kg/m^2 to - 260 kg/m^2	

the basis of this summary and the specific focus periods selected
ignificant influence on local impacts.

Note: Long-term trends (i.e., the 2080 results) are used as
for each variable are those hypothesized to have a s

Table 5: Summary of Potential Climate Impact Assessment – Community Well-Being

Topic	Potential Climate Change Impact	Major Uncertainties	Rating
Travel Safety	Increased number of incidents due to increased storm frequency and general unpredictability of weather. Travel to Igloolik of particular concern.	• The potential magnitude and frequency of extreme weather events.	HIGH
Hunting Safety	Reduced hunting safety as a result of: • Later freeze-up and earlier break-up of sea ice, flow edge and lake ice. • Increased frequency and unpredictability of extreme weather (storms, blizzards).	• The potential magnitude and rate of change of ice freeze-up and break-up cycles. • The potential magnitude and frequency of extreme weather events.	HIGH

Impact rating process - The ratings shown in Table 5 below were assigned by the project team based on information provided by the community and research team along with available baseline data for the region. These ratings were confirmed by community participants.

Note that in this case it was not necessary to define what the ratings mean (eg. how many residents impacted, the level of impact, etc.).

The impact rating process was followed by an assessment of adaptive capacity using the framework below to determine how well enabled the community is to plan and implement climate change adaptation measures.

Figure 10: Elements of Adaptive Capacity

Action Plan

A portion of Table 6 below lists a sample of the actions from this plan.

Table 6: Action Plan Summary

Topic	Activity	Details	Responsibility
Shoreline Erosion	Research	Complete implementation of the coastal impact assessment: • historical air photo interpretation of shoreline stability • near-shore seabed mapping sounding and • final assessment of coastal change: processes, rates of change, areas at risk	NRCan team
		High-level feasibility study of technical options: Sea wall, breakwater, beach nourishment, etc.	GN: Community and Government Services
		High-level feasibility study of relocation options: Westward, new location to north, to Igloolik, etc.	GN: Community and Government Services
	Monitoring	Implement a program of local observations during storm surge events, including: • Event dates, times, and durations • Wave height, direction wave period • Maximum run-up level on beach and time • Photos from same point for each storm	HB CC Adaptation Committee (support from NRCan team)

2. Vulnerability Assessment

☐ ***Adapting to Climate Change in Kimberley, BC - Report & and Recommendations***. *2009.* I. Liepa. http://cbtadaptation.squarespace.com/kimberleys-process/

Purpose - To identify the range of potential climate change impacts the community might face in the future, assess local sensitivities and develop adaptation strategies. The project was built around three distinct phases titled: Learn, Share and Plan.

Community description

Location – Southeast corner of British Columbia, on the west side of the Rocky Mountain Trench

Landscape – Mountainous area with mixed conifer forests (pine, spruce, larch and others) and aspen with low elevation grasslands

Population - 6,000

Community economy – Nature-based, recreation and tourism (ski-hill, golf course and recreational property development), with forestry and agriculture in adjacent areas

Climate profile - Table 4 below shows the climate profile used in this project.

Table 4: Summary of Climate Analysis for Kimberley[20]

Variable	Historical climatology (1961-1990)*	Historical climatology (1980-2002)	Past trend	Future projection (2050s)^
Temperature – annual mean	5.0°C	5.4°C	+1.0°C to +3.0°C per century	7.6°C to 8.6°C (+2°C to +3°C warming)
Precipitation – annual total	463 mm	450 mm	+20% to +40% per century	+3% to +10% increase
Precipitation – winter				+1% to +13% increase
Precipitation – summer				-4% to -10% decrease
Snow	n/a	251 cm (snowfall)	n/a	-15% to 0%# (snowpack)
Streamflow			Shift of peak from May/June to April/May (1950-1995)	

* Based on Cranbrook 1961-1990 and difference between Cranbrook and Kimberley 1980-2002 climatologies
^Ranges based on 25th and 75th percentiles of projections from 30 GCM results unless otherwise noted
Range for surrounding area based on single regional climate model projection

Vulnerability assessment process - This project used different vulnerability/ adaptability screening tools to identify or validate key risks within the priority issue areas. The assessment of municipal infrastructure vulnerability followed the approach designed by Engineers Canada to assess community infrastructure.

Kimberley Infrastructure Vulnerability Screening Worksheet Sample

	Flooding	High Temperatur	Low Temperatur	Intense Rain	Drought	Ice Storm Accretion	Heavy Snow Event	Extreme Wind	Hail	Freeze/Tha w	Rain or Snow	Wildfire	General Notes
g) Mark Creek (in town, esp. near flume)	H			H							H		Creek rechannelizes quickly if obstructed

High Vulnerability – Based on best available judgment (engineering and operational), there is a high risk of reduced or limited performance and perhaps even failure of the element due to the indicated climatic factor. High vulnerabilities will require remedial action in the short-to-medium term (0-8 yrs). **Note**: A high vulnerability may also exist if there is insufficient information or too many unknowns to make a

Capacity & Vulnerability Work Sheet for: Flooding of Mark Creek

Possible Adaptive Actions		Challenges/Barriers	Recommended Actions
Review freeboard on Mark Creek as per 1999 Mark Creek Flood Study		No significant challenges or barriers.	Recommended
Review/update Emergency Flood Plan		No significant challenges or barriers	Recommended
Determine options for medium-long term replacement of concrete flume		No significant challenges or barriers	Recommended
City to develop strategy to acquire at-risk properties along affected areas.		No significant challenges or barriers.	Recommended
Update Flood Hazard mapping recommended storm event return rates		No significant challenges or barriers	Recommended
Obtain updated storm return event design standards for all municipal infrastructure		Availability of updated standards	Recommended - get from Infrastructure Canada
Adaptive Capacity (L-M-H):	L-M	**Vulnerability - No Action (L-M-H)**	H
Sensitivity (L-M-H):	H	**Vulnerability - With Action (L-M-H)**	L-M

Table 11: Recommended Actions to Reduce Risk of Flooding

ID	Action	Threat Reduction	Urgency	Priority	Lead/Champion
WF-20/ MI-24	Undertake a comprehensive flood hazard study for Kimberley, including further analysis of stream flow data for flood return frequency, digital elevation model, possible obstruction/blockage sites and weak/low points in the system.	M	H	M++	City
WF-17/ MI-21	Review 1999 Mark Creek Flood Study and subsequent report by Wildsight (2007) with respect to increasing freeboard upstream of flume	M	H	M+	City - Operations
WF-18/ MI-22	Review and update the Emergency Flood Plan described in the 1999 Mark Creek Flood Study	M	H	M+	City – Fire Chief

3. Risk assessment example

- ***Managing the Risks of Climate Change – A Guide for Arctic and Northern Communities Volume 2***. 2010. Centre for Indigenous Environmental Resources. http://ccrm.cier.ca/index.php

The Centre for Indigenous Environmental Resources (CIER) convened a workshop for representatives of a number of Arctic communities and 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 Arctic communities and what adaptation strategies should be considered to reduce the risks to acceptable levels. The example below uses the risk management process to develop adaptation strategies in the Yukon and Mackenzie areas.

Climate profile - The guide provides observed and projected trends in climate related factors shown on the right.

Changes	Yukon & Mackenzie District	
	1950 – 2000	2050
Mean Temp °C increase	2 to 2.2	3 to 6
Winter Temp °C increase	4 to 4.5	4 to 8
Growing Degree days	40 to 60/decade	40 to 60/decade
Heating Degree days	-80/decade	-80/decade
Frost days change in numbers	0 to -1/decade	0 to -1/decade
Precipitation Total % increase	2 to 5	Up to 15
Annual Snow % change or mm/yr	-2 to +45 mm/yr	Up to 15%
Glaciers & Ice Sheets	North America Arctic – 450 km³ loss (1 Accelerated loss to 2050	
Sea Ice	1978 – 2003 -5.6% / decade late summer	
Sea Level Rise	1.8 to 3 mm/yr Subsiding crustal movement on coast	.2 to .6m 2100 Some estimates 1 m
River Flows % change	+7	+12 to 30% mainly April to July
Intense Winter Storms increase	Increase in numbers of intense (8% (195	
Rain intensity change in Days >10mm or %	+ve but small	+5 to 10% 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

Risk assessment process - The group focused on increased precipitation as a hazard. As shown to the right, they identified seven potential risks, documented the events or results from these risks, and completed a preliminary risk assessment.

The group then did a more detailed assessment of the risks by rating the probability/frequency and consequences. The results for more snow accumulation are provided in the tables on the next page.

The combination of the likelihood and consequences of the six assessed risks that were then evaluated in the matrix on page 21. The risk perceptions of those who might be affected could also be evaluated at this stage.

TABLE 2: Preliminary Hazard and Risk Scenario Assessment

HAZARD: INCREASED PRECIPITATION			
RISK	EVENT OR RESULT	FREQUENCY	CONSEQUENCE
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)

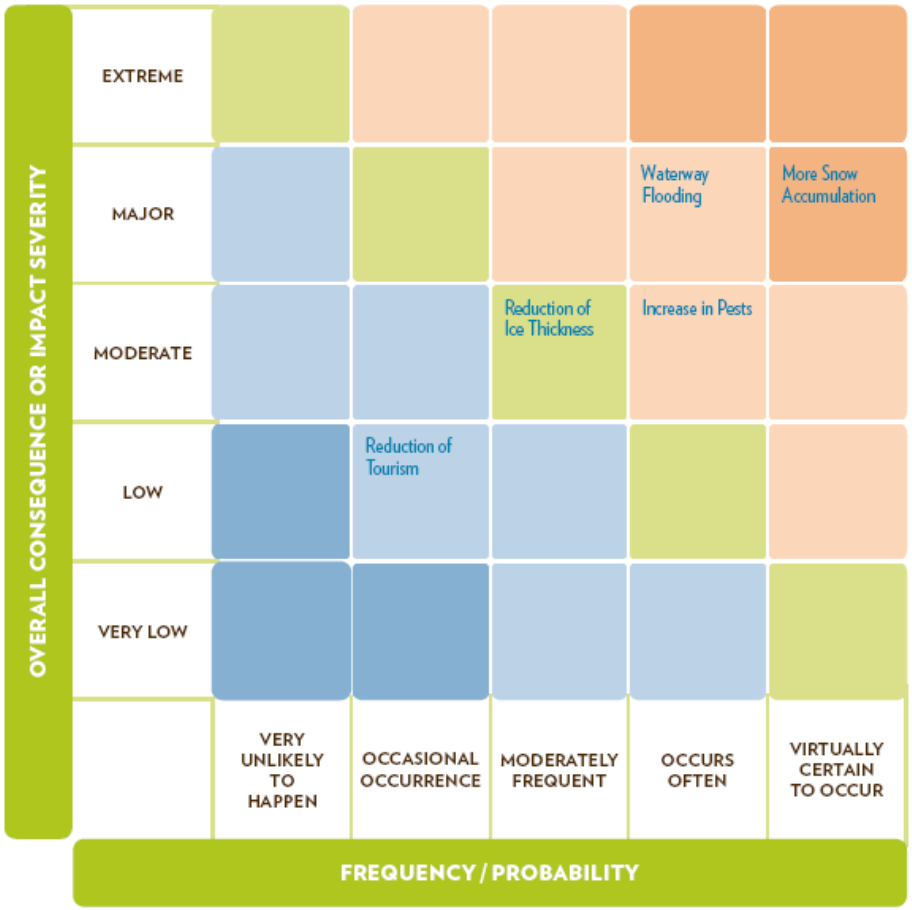
TABLE 3-1: Estimates of Frequency of Risks Associated with Increased Precipitation

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

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

Action Plan - The group then prepared Table 5 below showing the risk controls or adaptation measures needed to lower risks resulting from high snow accumulation. It appeared that this risk could be reduced to a manageable and acceptable level.

A final plan would include prioritization of the control measures.

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	

4. Combined assessment example

☐ ***Dawson Climate Change Adaptation Plan***. 2009. Dawson Adaptation Project Team. http://www.taiga.net/nce/adaptation/Dawson_Plan_Final.pdf

Community description
Location – Confluence of the Klondike and Yukon Rivers in the Yukon

Landscape – Taiga/boreal and discontinuous permafrost zones

Population – 1,300

Community economy – Seasonal mining, tourism, regional government centre

Climate profile – Climate information is included in a 32 page Appendix D Past Trends and Future Projections for Dawson City Yukon Territory and available at http://taiga.net/nce/adaptation/dawson.html#1b.

Assessment process - During the first part of the planning process the project team worked with residents to understand how they may be affected by climate change. This was crafted into a *vulnerability scenario* for the community. The community vulnerability scenario was then distilled into a *list of consequences* that climate change may have for residents (See Table 5.1.1 on the right).

Each consequence was evaluated based on a *risk assessment framework*. This framework evaluates consequences of climate change based on three predetermined characteristics of resilience. Resilience, in this context, is defined as the ability of the community to maintain its functions in the face of internal and external change.

Table 5.1.1: Regional Vulnerabilities

Ref #	Vulnerability Type	Climate Change Consequence
R.1	Forest Fire	Increased frequency of forest fires alters the biodiversity of the region and shifts natural cycles. Increased frequency of forest fires changes forest composition. Loss of biomass shifts migration patterns. Migration patterns shift when animals become disoriented by smoke or fire.
R.2		Fire damage to vegetation alters the availability of food for herbivores.
R.3	Wildlife and Changes to Biodiversity	Viability of white spruce declines.
R.4		Aspen leaf miners are favoured by climate change and increasingly exert a negative effect on individual aspen; reducing the proliferation of aspen.
R.5		Displacement of old species as new species move pole-ward. Diffusion of invasive species populations through region. Established invasive species proliferate due to warming temperatures. New invasive species are introduced through new agricultural experiments and land uses (e.g. use of exotics to landscape downtown core).
R.6		Established vegetative norms shift as the treeline moves.
R.7		Warming climate conditions favours established invasive species, altering local species mix.
R.8		Changing blooming times negatively affect some insect populations as timings fall out of sync.
R.9		Shifting climate conditions alter the hibernation period of trees and wildlife.

For the purposes of this plan, resilience was characterized by:

- the ability of the community to respond to each consequence,
- the severity of the consequence, and
- the likelihood of the event.

Priorities were determined based on the relative ranking of each consequence. Table 5.2.5 below illustrates a sample of the outcomes of this process.

Action plan - For each set of consequences the team prepared suggested adaptations and lead partners to take action.

Table 5.2.5: Community Consequences of Seasonal Weather Changes

Ref #	Consequence	Community Resilience			Priority
		Level of Impact	Likelihood	Adaptive Capacity	
SW.1	Increased incidence of extreme events characterized by high wind and precipitation leading to damage (property, infrastructure, and agriculture).	Medium / High	High	Low	Medium /High
SW.2	Increased snowfall potentially leads to a need for snow clearing in outlying areas and added isolation for some residents.	Medium	Low/ Medium	High	Low

Chapter 1. Get Prepared

1.1 Community Climate Change Adaptation Routes

Examples, Benefits and Downsides

Common Routes	Description	Examples	Potential Benefits	Potential Downsides
A. Community learning events	Community members share observations of climate changes & impacts and learn about past climate trends and future projections. Some discussion of impacts and actions	• Public presentations • Meetings with local government and interested groups	• Respects local knowledge and introduces climate science information • Requires the least resources	• Does not include detailed review of impacts and risks and does not identify actions to increase resilience
B. Climate Adaptation 'Quick Start'	Combines community learning with a workshop to explore possible impacts, identify priority risks/ vulnerabilities and adaptation actions.	• As above plus a community workshop with focus groups to document current and potential future impacts and actions	• Expands community knowledge of impacts • Identifies actions for highest priority impacts and promotes mainstreaming into decisions	• Not a thorough analysis so may miss important risk or vulnerabilities, and actions
C. Mainstream into major decisions and plans				
Major community decision/investment	Climate resilience is examined and considered for a specific community decision having long-term implications	• Water, sewer or road rehab/new construction • New construction/major renos of buildings (e.g. schools, recreation centre)	• Ensures climate resilience is included in the most relevant community decisions • The community learns about climate resilience for a specific topic as an introduction for wider scale future planning	• Climate resilience may be overlooked in other decisions • Does not 'mainstream' climate resilience thinking in all aspects of community life

Continued on next page

Common Routes	Description	Examples	Potential Benefits	Potential Downsides
Sector climate change adaptation plan	A segment of the community examines climate resilience for a specific environmental, social or economic sector	• Tourism sector plans • Community infrastructure plans	• Time and efforts focused on a specific sector • More in depth study and understanding of impacts and priority risks/opportunities	• Does not 'mainstre climate resilience thinking in all aspe of community life
Broad community plan	Climate resilience is included in a broad community planning process as one of the topics the community learns about and considers in decisions	• Official Community Plan (e.g. Elkford, BC) • Community Action Plan (e.g. Revelstoke, BC)	• Builds on existing process • Mainstreams climate information into community decisions • Efficient for community involvement	• Climate change m get overlooked in t midst of all the oth challenges • May not be enoug resources to fully assess climate ch impacts
D. Community climate change adaptation plan	A separate process focused on climate resilience that covers relevant environmental, social and economic topics with broad community involvement	• Kimberley, Rossland, Castlegar, Kaslo & Area, BC • Dawson City, NWT • Whitehorse, Yukon	• More effort can be focused on climate change resilience and adaptation challenges for a community	• Requires the most resources • May require extra effort to integrate results into ongoin community plans/decisions

How-To Guidance

Common Route	Guidebook Chapters & Resources	Community Activities	Timeframe, Funding & Expertise Estimates	Outcomes
A. **Community learning**	1. Get Prepared – Project team 2. Learn about Climate Change – Climate Profile 3. Chart & Scan Impacts & Opportunities – Impact Checklist 4. Watch, Learn & Refine – Citizen Science Programs	• Public presentation • Meetings with interested groups and local government • Media coverage	2 months & $2-5,000 • Time/funds for organizer • Travel costs (and time if not academic or government) for climate science & adaptation experts	• Increased awareness and knowledge about local climate change • Initial understanding of impacts and possible actions
B. **Climate Adaptation 'Quick start'**	As for Community Learning plus: 1. Impact charting and Initial Scan 2. Plan & Act – Action Options Checklist	As for community learning plus: • 1 day community workshop • Community Climate Change Background summary	3 months & $5-10,000 • Time to research and prepare the summary • Additional travel costs for climate and adaption experts and costs for technical experts	As for community learning plus: • Expands community knowledge of impacts • Identifies actions for priority impacts and promotes mainstreaming into decisions
C. **Mainstream in community plans & decisions**	As for Community Learning plus: analysis and decisions within another process (e.g. infrastructure decisions, sustainability plan, etc.) 1. Detailed identification of impacts 2. Decide priorities – Detailed analysis of vulnerability/risks & opportunities 3. Plan & Act – Decisions and action	As for community learning plus: Additional impact assessment, vulnerability/risk analysis and decisions would be done within the specific process with or without a community role.	Depends on the type of process • Climate experts should be involved in assessing impacts, vulnerability/ risk and actions	As for community learning plus: • Strengthens existing processes • Climate change is integrated into ongoing decisions

	4. Specific monitoring and reporting			

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Common Route	Guidebook Chapters & Resources	Community Activities	Timeframe, Funding & Expertise Estimates	Outcomes
D. Climate Adaptation Plan	As for Mainstream covering all aspects of community life including infrastructure, safety, economy and quality of life within a single process	As for 'Quick start' plus: • Focus group workshops to explore impacts, priorities and actions • Community workshop to review recommended actions	12 months & $30-70,000+ • Time to research and write plan • Additional coordination time and travel costs	As for 'Quick start' plus: • Detailed analysis and understanding of impacts, priorities and actions • Priority actions across most aspects of community life

1.2 Community Climate Lens Questions

Questions	Think about	Why this Information is Important
What changes in climate and the local environment are being observed?	Climate – seasonal temperature, rainfall, snowfall, wind storms, growing season Environment – biodiversity, forests, water resources, aquatic & coastal ecosystems, sea level	Begins the sharing of local knowledge about climate and environmental change observations
How are these changes affecting the community?	Community infrastructure (buildings, water, sewer, emergency response), transportation, energy, communications, health, recreation and economic/business sectors -Note specific groups or organizations who have been most affected	Helps to define possible topics for an action plan and community members and organizations who might need to be involved
How has the community responded to changing climate? What else might be done?	What individuals, families, governments, and firms are doing to cope with current climate events and other environmental changes Note the timing of any extreme events in the past 10 years (e.g. floods, droughts, windstorms, heavy rains) and how well the community coped.	Begins to describe the community's ability to adapt and possible adaptation actions Extreme events help identify climate conditions that have been difficult for the community to adapt to
Will a changing climate make it difficult/impossible to achieve the community's objectives?	Community vision and objectives If the community doesn't have a vision, consider possible environmental, social, economic and cultural objectives	Begins to define objectives for planning and the linkages to changing climate

1.3 Climate Resilience Action Planning Questions

Questions	Think About	Why this Information is Important
Has recent weather and climate exposed vulnerabilities or opportunities that should be looked at first as priorities?	Extreme events that have strained the community's ability to cope Longer term changes that may change community life	May define an important priority to be addressed in the short term
Are there planning processes underway already that should include climate change?	Examples: Official Community Plans, community development plan, health and wellness plan. If yes, should/can climate change be added to the factors that are considered in these plans?	May identify opportunities to 'mainstream' climate change into current processes
Are there challenges facing the community that may make it difficult to focus resources on climate resilience actions? **What are the community assets that can be focused on addressing these challenges?**	Timeframe of challenges/ barriers? Can the community identify any solutions/resources/strengths that can be leveraged in the adaptation process?	Identifies challenges and solutions to engaging the community and accessing resources at this time
If the community decides to go forward • **What geographic area should be included?**	The settled area only? The area within the local government boundary? And the immediate surrounding area? Or a larger area that community members work and play within (ie. watershed, regional boundary)?	Affect the planning topics and priorities, as well as who should be involved
• **What else is changing that might need to be**	Population change, land use changes, economic changes (ie. no longer forestry-	Helps to define non-climatic factors that may need to be

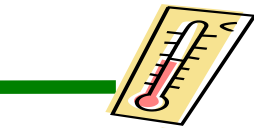
considered?	based due to business changes)	factored into climate resilience decisions

1.4 Climate Change Adaptation Potential Funding Resources

Geographic scope/Options	Information
National	
Federation of Canadian Municipalities Green Municipal Fund	Provides below-market loans and grants as well as education and training services to support municipal initiatives that improve air, water and soil quality, and protect the climate. http://gmf.fcm.ca/Home/
Engineers Canada	May support pilot studies of climate risks to rural infrastructure www.pievc.ca
Regional Climate Change Adaptation Collaboratives - Sources of information about potential regional funding options	
Maritimes	No contact identified
Quebec	Ouranos - Consortium on Regional Climatology and and Adapation to Climate Change (Quebec) http://www.ouranos.ca
Ontario	Ontario Centre for Climate Impacts and Adaptation Resources - a university-based resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation. http://www.climateontario.ca/
Prairies	Prairie Adaptation Research Collaborative - Purpose is to advance climate change adaptation decision-making in relevant policy areas and lead to the development of targeted policies and other instruments. http://www.parc.ca/rac/
BC	Purpose is to help BC communities adapt to climate change and its impacts. Delivered through the Fraser Basin Council. http://www.fraserbasin.bc.ca/programs/bcrac.html
Northern	In development

Geographic scope/Options	Information
Provincial Governments	
Newfoundland & Labrador	No contacts identified
Nova Scotia	Climate Change Adaptation Fund http://www.climatechange.gov.ns.ca/content/adaptation_fund
PEI	No contacts identified
New Brunswick	No contacts identified
Quebec	No contacts identified
Ontario	Adapting to Climate Change http://www.ene.gov.on.ca/environment/en/category/climate_change/STDPROD_078898.html
Manitoba	Climate and Green Initiatives http://www.gov.mb.ca/conservation/climate/index.html Manitoba Climate Change Action Fund http://www.gov.mb.ca/conservation/climate/mb_doing/action_fund.
Saskatchewan	SaskAdapt http://www.parc.ca/saskadapt/introduction
Alberta	Climate Change Adaptation Framework http://www.srd.alberta.ca/MapsFormsPublications/Publications/ClimateChangeAdaptationFramework.aspx
BC	Climate Action Secretariat http://www.env.gov.bc.ca/cas/adaptation/strategy.html
Yukon	Climate Change Secretariat http://www.environmentyukon.gov.yk.ca/monitoringenvironment/climate_change_secretariat.php
NWT	Climate Change Impacts and Adaptation http://www.enr.gov.nt.ca/_live/pages/wpPages/climate_change.aspx

Provincial & regional organizations	
Maritimes	None identified
Quebec	Ouranos - Consortium on Regional Climatology and and Adapation to Climate Change (Quebec) http://www.ouranos.ca
Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and the Clean Air Partnership	Distributes resources and host events designed to help Ontario communities adapt to climate change http://www.climatechange.gov.ns.ca/content/adaptation_fund
Manitoba	Climate Change Connection http://www.climatechangeconnection.org/
Saskatchewan	None identified
Alberta	None identified
BC	Columbia Basin Trust Communities Adaptation to Climate Change http://www.cbt.org/Initiatives/Climate_Change/?Adapting_to_Climate_Change Resources North Association – Climate Change Initiative http://www.resourcesnorth.org/rna/379/climate+change+initiatives Fraser Basin Council. http://www.fraserbasin.bc.ca/programs/bcrac.html
Northern	Climate Change North - Northern Climate Exchange www.taiga.net/nce



Chapter 2. Learn about Climate Change

2.1 Climate Information Resources

Historical climate data	
National Climate Data and Information Archive	climate.weatheroffice.ec.gc.ca/Welcome_e.html
Future climate projections and climate scientists	
Canadian Climate Change Scenarios Network	cccsn.ca (check Network/Regional Sites) The Localizer which provides future projections for community locations across Canada - http://atlantic.cccsn.ca/?page=viz-localizer
Pacific Climate Impacts Consortium (PCIC) See Plan2Adapt under Tools	http://pacificclimate.org/
Prairie Adaptation Research Collaborative (PARC)	http://www.parc.ca/index.htm (Click ARCIms datasets)
Ouranos – Consortium on Regional Climatology and and Adapation to Climate Change (Quebec)	http://www.ouranos.ca
Technical specialists with climate expertise	
Provincial governments	Contact environment and natural resource agencies
Local and provincial universities and colleges	Contact geography, environment, natural resource, and other land related departments

2.2 Common Measures of Historical Climate Change

Temperature

Measure	Observation/calculation
Minimum	Usually measured near dawn
Maximum	Usually measured in the afternoon
Average or mean	Usually the average of measured minimum and maximum temperature
Extreme minimum or maximum	The lowest and highest recorded values within a defined time period (eg. daily, monthly, seasonally, annually or over a defined period)

Precipitation

Measure	Observation/calculation
Rainfall	Amount of precipitation falling as rain (millimeters-mm)
Snowfall	Amount of precipitation falling as snow (centimeters-cm)
Precipitation	Total precipitation: rainfall plus snowfall converted to equivalent amount of rain (mm)
Snowpack / snow depth	Depth of snow on ground (cm)
Snow water content / snow water equivalent	Amount of water in snowpack (kg/m^2, mm)

2.3 Example Community Climate Change Profile

Community Examples for more climate profiles.

Seasonal notes - Spring snowfall is projected to decline by 54% (-14 to -73%) by the 2050s

Growing degree days - A measure of heat energy for plant growth. Calculated as the number of days that the mean daily temperature exceeded 5°C multiplied by the number of degrees above that threshold.

NA - Not Available

Normals for Other Communities for comparison

Community	Annual temperature 'normal' 1961-1990	Annual total precipitation 'normal' 1961-1990
Osooyoos	10 °C	340 mm
Castlegar	8.3 °C	732 mm
Grand	7.6 °C	471 mm

Climate Change Profile for Castlegar, BC

Climate element	Recent climate 'normals' Airport station 1961-1990	Past trends in the Basin 1913-2002	Projected future change In the Central Kootenays (compared to 1961-1990) By 2020s	By 2050s	By 2080s
ANNUAL					
Average temperature	8.3 °C	+1.4°C	+0.6 to +1.3	+1.2 to +2.8	+1.7 to 4.4
Average precipitation - total (mm)	731.9	+26%	0 to +6%	-2% to +9%	+2 to +11%
- rainfall	533.2	+32%	Not available	Not available	Not available
-snowfall	224.6	-6%	-1 to -11%	-3 to -18%	-3 to -36%
Frost-free days	120	NA	+8 to 19	+16 to 36	+21 to 57
Growing degree days*	2038	NA	+90 to 240	+219 to 513	+320 to 900
SUMMER (June to August)					
Average temperature	18.6°C	NA	+0.8 to +1.8	+1.6 to +3.3	+2.2 to 6.0
Average precipitation - rainfall (mm)	50	NA	-6 to -12%	-2% to -20%	+1 to -30%
WINTER (December to February)					
Average temperature	-2.1°C	NA	+0.3 to +1.7	+0.9 to +3.3	+1.4 to 4.8
Average precipitation - total (mm)	74.9	NA	-2 to +11%	-2% to +17%	+2 to +24%
- rainfall (mm)	25.5	NA	NA	NA	NA
- snowfall (cm)	57.4	NA	+3 to -13%	+2 to -18%	-4 to -35%

Additional Climate Properties for Community Climate Change Profiles

Community interests	Climate property
Summer heat stress	Summer extreme temperatures and no. of days >30 ^{o}C
Winter snow for skiing	Annual snowfall and snowpack
Frozen roads and ice bridges	Fall, winter and spring monthly number of days <0 ^{o}C
Agriculture crops	Growing degree days and frost free days (noting that in some areas water shortages may limit agriculture potential)

2.5 Example Graphs of Climate Variability and Change

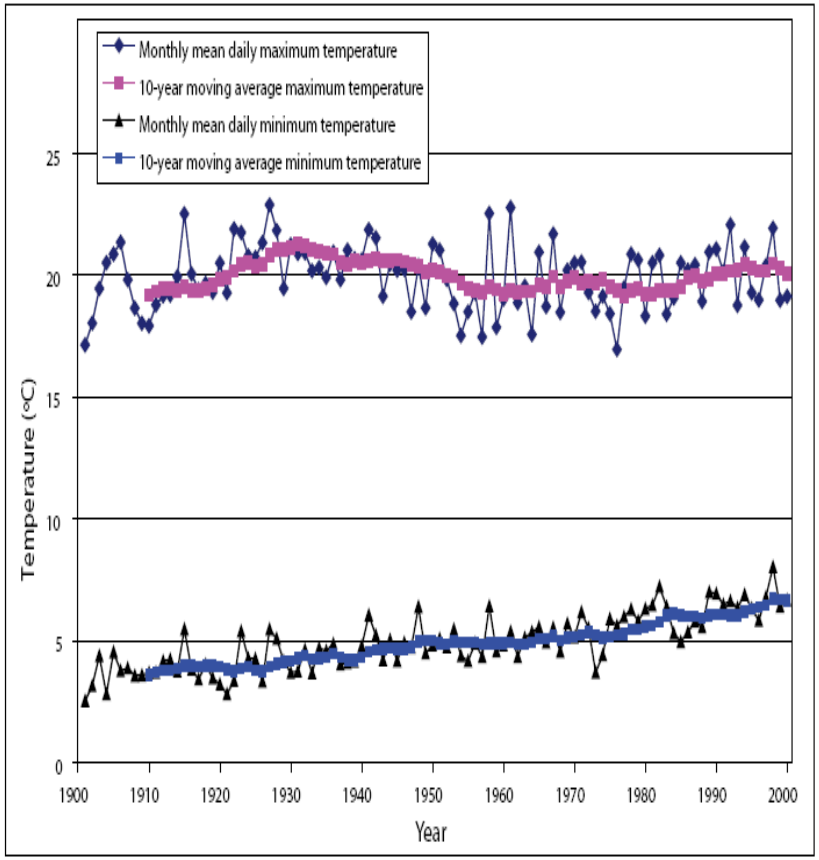


Figure 12. Summer monthly mean temperatures in the Vanderhoof region, 1901–2000.

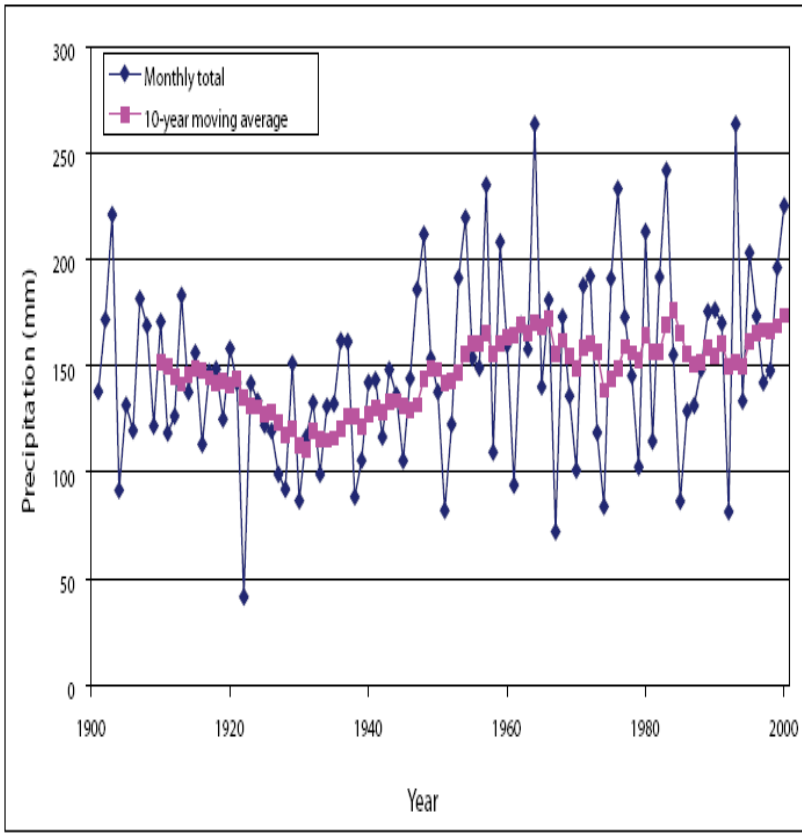


Figure 8. Summer monthly precipitation in the Vanderhoof region, 1901–2000.

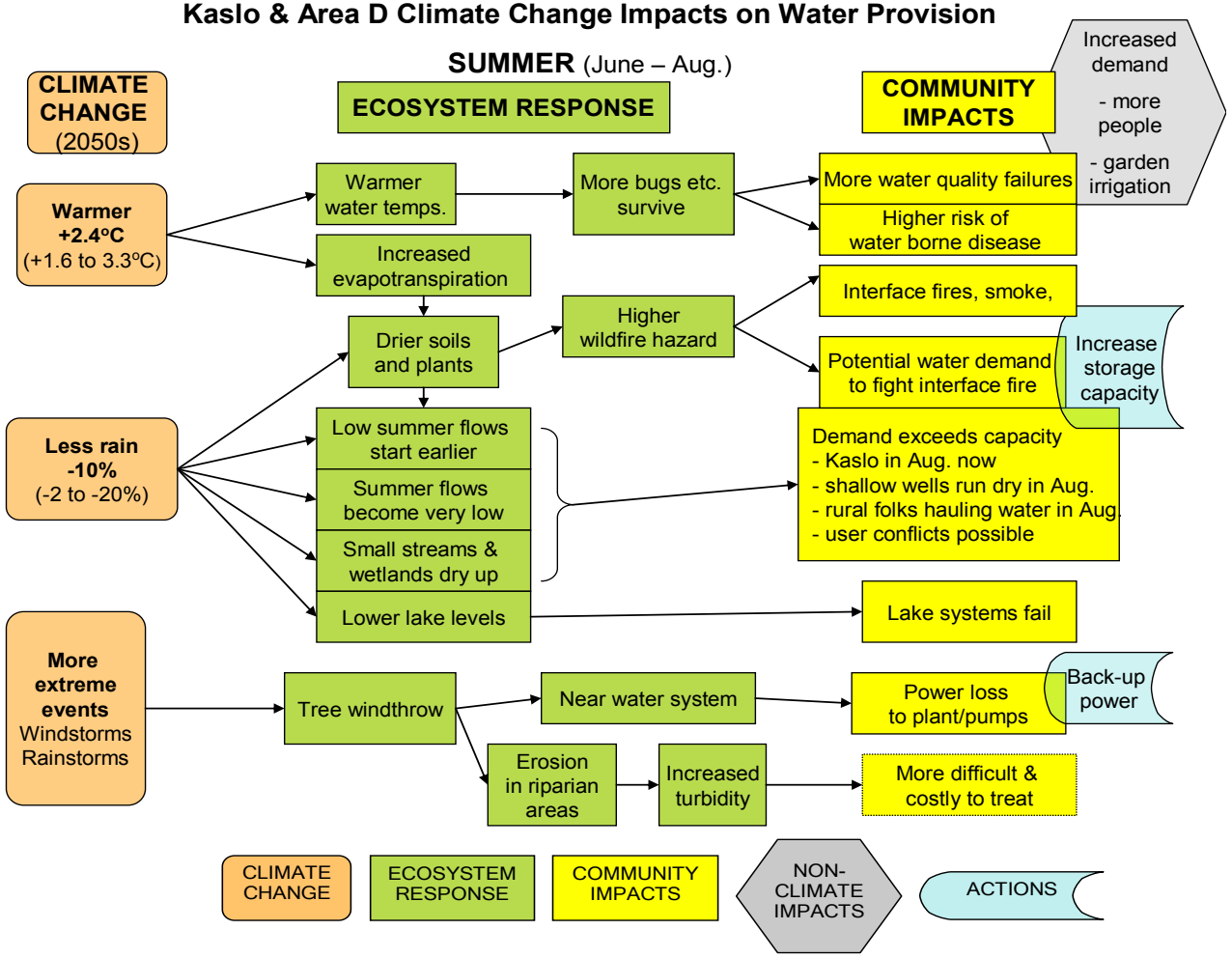
Note to reader: The thin black lines show the year-to-year variability in temperature and precipitation. The thick lines show the 10 year moving averages. Note the increase in minimum summer temperature over the century (bottom line on the graph on the left). The average precipitation on the right shows the dry years during the 1930s (the 'dirty '30s), and the increases and declines since the 1960s.

Chapter 3. Chart & Scan Impacts & Opportunities

3.1 Impact and Opportunity Chart Examples

The basic information for four seasonal charts was created during a 1.5 hour workshop with twelve individuals including elected officials, planners, public works manager, gardeners, farmers,and water and forestry specialists.

Kaslo & Area D Climate Change Impacts on Water Provision



3.2 Checklist 1 Key Messages from Climate Change and Canada's Forests: From Impacts to Adaptation (2009)

Extreme weather

- ❑ The frequency and intensity of extreme weather and climatic events, such as thunderstorms and windstorms, hailstorms, intense precipitation events, drought, heat waves, and abnormally warm winters, are likely to increase.
- ❑ Relatively large increases in the risks associated with extreme weather are possible as early as 2030.
- ❑ Increased drought frequency and intensity will be a concern in areas that are already dry.

Insects and disease

- ❑ There is a potential for an increase in the area, duration, and intensity of infestations of spruce budworm, spruce bark beetle, forest tent caterpillar, and large aspen tortix.
- ❑ It is likely that the status of some insects will change from relatively harmless to severely disruptive.
- ❑ There will be increased uncertainty about the timing and degree of major insect outbreaks.
- ❑ It is possible that the mountain pine beetle will spread to boreal forest regions, with the possibility of periodic outbreaks in jack pine forests.

Wildfires

- ❑ Climate change will increase the annual area of forest burned
- ❑ There will be regional variation in the degree to which climate change affects fires, with higher increases expected in the western and northern portions of Canada than the eastern portions
- ❑ Increases in the frequency and intensity of forest fires will be a leading agent of change in Canada's forest ecosystems
- ❑ The length of the fire season will likely increase.

Forest regeneration and Growth

- ❑ There is the potential for growth to increase in more northerly areas with relatively cold and moist climates and for growth to decrease in southern areas that are relatively hot and dry.
- ❑ Local plants are finely adapted to an area's current climate so future climate change may place these plants under some stress unless they are able to adjust, adapt or migrate as climate niches shift.
- ❑ It will be difficult to predict growth and yield from forests over the long term because historical conditions will not match future conditions.

Ecosystem dynamics and migration

- ❑ Climatically suitable habitats for most species will move north and increase in elevation.
- ❑ The rate of movement in climatically suitable habitats will considerably exceed the ability of individual species to migrate.
- ❑ The rate of movement in climatically suitable habitats will considerably exceed the ability of individual species to migrate.
- ❑ Forest areas will convert to grasslands at current forest-grassland transition zones.
- ❑ The range of species that are adapted to hot and dry climates will expand into areas that are currently occupied by species that are more suited to cooler and moister climates.
- ❑ Increases in disturbances will mean that early succession species may be favoured, that old-growth stands will become less common and the average age of forests will decrease.
- ❑ There is the potential for growth to increase in more northerly areas with relatively cold and moist climates and for growth to decrease in southern areas that are relatively hot and dry.

SUMMARY from Canada in a Changing Climate: From Impacts to Adaptation 2007

Streams and lakes

- Increased flow and frequency of peak runoff events due to storm events and changes in snow accumulation and snowmelt timing – leading to flooding, channel instability and degradation of aquatic and riparian habitats.
- Longer and more frequent low flow events – leading to degradation or loss of aquatic habitats and reduced water availability for human uses
- Earlier spring run-off due to less snow.
- Changes in glacier dominated systems leading to initial modest increases in summer flows, followed by substantial reductions in summer flows and reduced water availability.
- Shortened ice seasons on lakes, rivers and wet sites, with thinner ice cover, is likely especially in the north.
- Complex interactions can be expected, with uneven distribution of changes and impacts.

Water table and drought

- Warmer temperatures and increased evaporation are likely to result in lower water tables, lower lake levels and droughts.
- Water shortages can be expected.

Water quality

- Increased steam and lake temperatures are likely to result in altered aquatic habitats (ie. increased algae growth) and reduced water quality.
- Increased landslides, windthrow and/or channel instability can change sediment levels which degrade aquatic habitats and water quality.

Transportation, tele-communications and energy infrastructure

- More frequent and intense storms, wildfires and flooding as well as melting ice are likely to disrupt the extensive road, tele-communications and energy networks to remote communities.

Water supply & storm/wastewater systems

- Increased shortages in domestic water supplies are expected in drier years.
- Intense rain events are likely to create ‘flash floods’ when they overwhelm stormwater systems.
- Wastewater systems located in valley bottoms may be susceptible to flooding.

Buildings

- Flood events, wildfires and intense windstorms may threaten buildings.
- Buildings designed for colder climates may need to be retrofitted for warmer summers especially schools, elder care facilities and hospitals.

Community safety

- More frequent intense rain, hail, ice and snow storms; greater intensity, more frequent and larger wildfires; and an increase in seasonal flooding will likely disrupt essential services, forcing evacuations and damaging property.

Forest economy

- Changes to disturbance patterns, forest growth, regeneration success and species composition is expected to reduce merchantable volume in some regions and impact long-term timber supply.
- The most significant impacts will occur where changes in timber supply occur over a short time period.
- Rethinking sustainable forestry objectives and practices in light of changing climates will likely be necessary.
- Forest companies are likely to continue to experience shorter winter-harvest seasons, road stability challenges from extreme rainfall events and disrupted summer seasons from high fire hazards and wildfires.
- Salvage operations to recover timber damaged during wildfires and storm events and by insects and disease are expected to continue to disrupt planned harvesting and milling in some regions, making it difficult for mills to meet customer demands.

Community health

- Increases in extreme heat, physical hazards from extreme weather events, water shortages and air pollution are likely to increase.
- Access to health services and critical food and medical supplies may be disrupted by extreme weather events, flooding and wildfires.
- Changes in water quality and the potential for the distribution of infectious diseases are expected.
- Individuals may experience symptoms of post traumatic stress disorder after emergencies resulting from changing climates.

Nature-based cultural activities

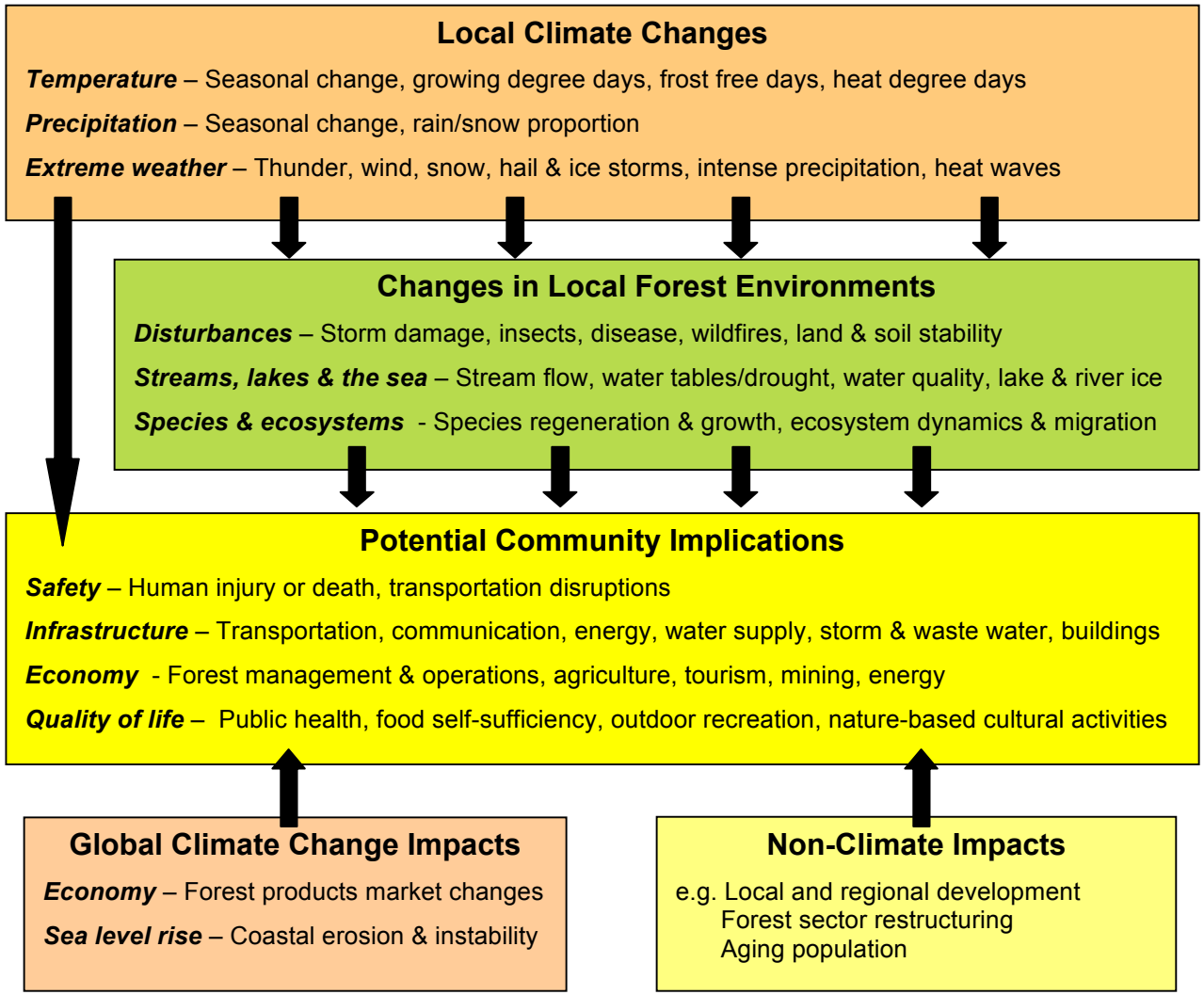
- Opportunities to gather berries, mushrooms, roots and other materials from the forest can be expected to shift with changing climates, with some benefits and some losses.
- Stark, visible changes in forest ecosystems from the expected wildfires, insect and disease outbreaks and storms may weigh heavily on individuals who cherish intact, healthy forest ecosystems.

Outdoor recreation

- An overall positive effect on summer activities is likely because of longer seasons and higher temperatures.
- Winter activities will likely decrease due to shorter seasons. Changing snow conditions may also impact activities.
- Changing habitat conditions are likely to result in shifts in wildlife and fish species, particularly those that are already endangered or at risk, with changing hunting and fishing opportunities that may alter historical subsistence uses.
- Restricted access to forest areas may occur due to safety risks from wildfires, flooding and extreme storms.

3.3 Checklist 2 - Summary of Potential Implications for Rural Forest-Based Communities

Potential Implications for Forest-based Communities



3.4 Example Initial Scan of Priority Climate Change Risks and Opportunities

Potential impacts	Initial Priority			Community Process/ Initiatives	Community Interest	Info/ Support/ Funding	Next Steps Priority/ Initial Actions
	1A. Immediate threat? 1B. Long time to act? 1C. Investment planned?	2. High value at stake?	Priority				
Intense rain causes flooding and highway damage that closes the main access route. A new bridge is being planned across the main river crossing	Yes to all 3	Yes - community safety	High - Town has been cut off twice in the past 2 years	None	High	Could work with provincial agency; may be part of emerg plan	High priority for this assessment - involve provincial staff

Initial Priority Screening Questions

1A. Is there an **immediate threat** based on current climate conditions?

1B. Does responding to the threat involve **long-term** investments or contracts, lengthy implementation or substantial costs?

1C. Is a **major investment** being planned now?

2. Is a **high value at stake** if a wrong decision is made?

If YES to both questions - This is a high priority that should be assessed in detail and action taken

If NO to either question - This is a lower priority that can be monitored and reassessed in the future

Chapter 4. Decide Priorities

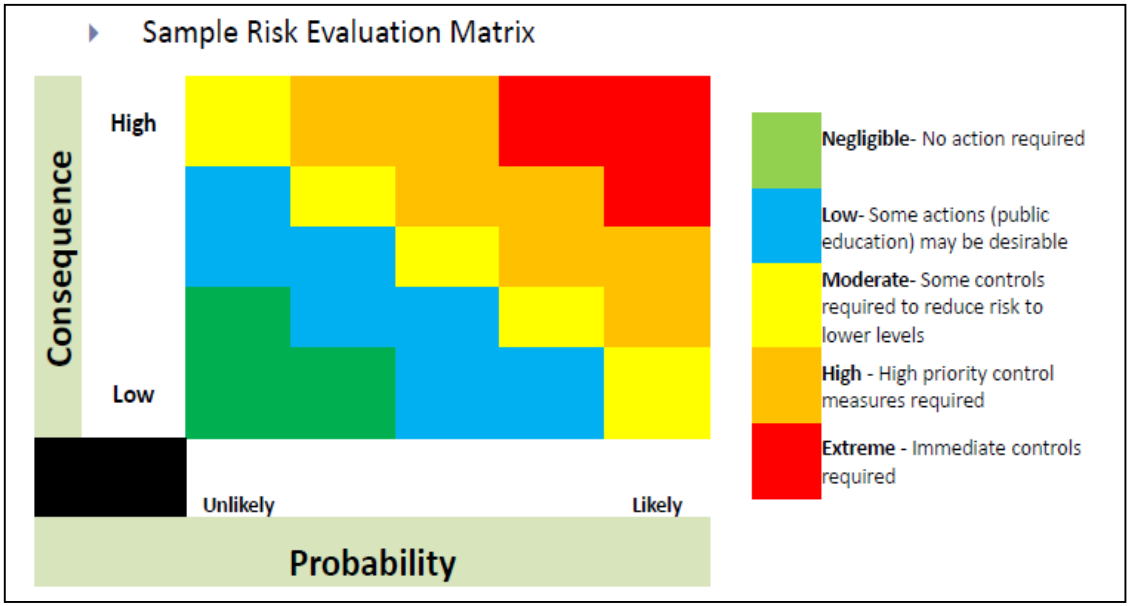
4.1 Climate Vulnerability Rating Definitions and Resources

Exposure & Sensitivity Result in Impacts		Adaptive Capacity		Vulnerability Rating
Will the projected climate changes and the characteristics of the area create an impact that will affect the area in important ways?	and	*Can actions be taken to adjust to this climate change impact?*	Results in	*How significant are the 'weak spots' in the community as the climate changes?*
IPCC definitions - **Exposure** - The character, magnitude, and rate of climate change and variation a system is exposed to. **Sensitivity** - The degree to which a system is affected, either adversely or beneficially, by climate variability or change. **Impact** - The adverse and beneficial effects of climate change on natural and human systems		**IPCC definition** - The ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.		**IPCC definition** - The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change.

Changing Climate Changing Communities
Worksheet 7
(http://www.iclei.org/index.php?id=8708) and
Preparing for Climate Change – A Guidebook for Local, Regional and State Governments
Chapter 8
(http://cses.washington.edu/cig/fpt/guidebook.shtml

4.2 Risk Rating Definitions and Resources

Current risk controls	effects	Consequences	and	Probability/ Frequency	and	Risk Perception	=	Risk Rating
What are we doing now to reduce this risk?		*How large might the loss be from this impact?*		*How likely is it that the consequences will occur and/or how often?*		*How is the potential risk viewed by those who may be affected, or who might affect the risk?*		*Which clima impacts are most import to act on to reduce risks*
Ongoing actions intended to reduce the frequency and/or severity of impact		Outcome or impact of an event in relation to the achievement of objectives		Chance of occurrence or the number of occurrences per unit of time		The significance assigned to risks by those who might be affected, or who might affect the risk		Relative lev of risk



Natural Resources Canada ***Adapting to Climate Change - A Risk-Based Guide for Local Governments*** for Alberta, BC and Ontario – See weblinks in Resources section of the Community Resource Collection

Managing the Risks of Climate Change – A Guide for Arctic and Northern Communities *(*http://ccrm.cier.ca/index.php)

Engineers Canada **Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment** (Note – Although titled 'vulnerabilit'y assessment, a risk rating approach is used.) http://adaptation.nrcan.gc.ca/projdb/pdf/211_e.pdf

Chapter 5. Plan & Act

5.1 Adaptation Action Options for Canadian Forest-based Communities

✓ Local & Regional Governments	
Local governance	❑ Mainstream climate change including projected warming, changes in precipitation and increased frequency and intensity of extreme events, in all community decisions and plans. ❑ Use updated storm event return intervals in design and construction of all new infrastructure. ❑ Create a community plan to guide decisions toward sustainability and climate resilience. Review and revise at least every 5 years. ❑ Update safety factors in codes, operating standards and maintenance/monitoring schedules to reflect the changing climate, especially more frequent extremes. ❑ Maintain close communications with adjacent local and regional governments and with the provincial government to collaborate on climate resilience priority actions and to share new information.
Emergency preparedness	❑ Create a robust emergency preparedness plan(s) for wildfire, flooding and severe storms with early warning advisory systems, evacuation plans and community disaster response plans. Test this plan frequently in mock-up scenarios with all partner organizations. ❑ Urge households to have an emergency plan and a 3 day emergency cache. ❑ Urge businesses to have emergency plans. ❑ Prepare for temporary transportation, energy supply and communications disruptions. ❑ Prepare and implement a Community Wildfire Protection Plan[1], including encouraging property owners to Firesmart[2] their properties. ❑ Augment local firefighting capacity if needed, with enhanced number of firefighters, training and equipment. ❑ Regularly monitor areas at risk of landslides for signs of instability.

[1] See https://ground.hpr.for.gov.bc.ca/cwpps.htm and http://www.communitiescommittee.org/pdfs/cwpphandbook.pdf

[2] See Partners in Protection information at http://www.partnersinprotection.ab.ca/products.php

Land use and development	❑ Do not permit development, including community infrastructure, in areas susceptible to flooding or landslides now and into the future. ❑ Require developments to anticipate extreme stream flows and incorporate adequate buffers and appropriate structures to channel flows. ❑ Require storm water infiltration on-site in new developments. ❑ Require that new developments be Firesmart[2]. ❑ Promote local food production by encouraging retention of high quality agriculture lands, providing land for community gardens and permitting goats, hens bees and greenhouses.
Buildings	❑ Revise design guidelines for new builds and renovations to withstand new climate conditions such as more variability in snowfalls and to reduce overheating, basement flooding, fire risk and extreme event damage. ❑ Identify and address climate change threats to local government buildings.
Roads and transportation	❑ Expect increased pavement deterioration from more freeze/thaw cycling and heat waves. Use different asphalt mixes, or repair with cobbles. ❑ Anticipate and plan for shorter seasons for frozen winter roads. ❑ Anticipate and plan for disruptions in transportation routes into/out of the community due to storms, wildfires, flooding and landslides, with a particular eye to health care and access to necessary supplies.
Storm water infrastructure	❑ Reduce paved area when possible to reduce runoff and potential for flooding. ❑ Establish and maintain green space to absorb storm water and reduce the potential for flash floods. ❑ Regularly monitor storm water infrastructure and clear debris, especially in areas that have become blocked in the past, and during peak stream flows and extreme storms.

Water supply and infrastructure	❑ Firesmart water supply sources and infrastructure (including power lines). ❑ Ensure rapid fire suppression in community watersheds. ❑ Protect and restore riparian areas next to streams to reduce erosion during high flows and moderate water temperatures during heat waves. ❑ Flood-proof water supply infrastructure if needed. ❑ Install back-up power if needed in case of power interruptions from storms or wildfires. ❑ Have a plan for alternative drinking water supply, particularly if a wildfire occurs in the community watershed. ❑ Increase maintenance to identify and repair damage from increased sedimentation and freeze-thaw cycles. ❑ If water supply is or will be limited, implement water conservation measures (eg. education, leakage repair, watering restrictions/drought plan, metering water use with increasing costs for increased use, requiring low flow toilets/showers/taps), increase knowledge about local water supplies with flow monitoring or aquifer mapping, and explore options to increase storage. ❑ Step-up water quality monitoring during times of peak and very low steam flows, and during heat waves.
Sewer system	❑ Flood-proof sewage treatment infrastructure if needed. ❑ Install back-up power if needed in case of power interruptions from storms or wildfires.
Energy & communications	❑ Encourage energy and communications providers to ensure their infrastructure is resilient to wildfires, floods, extreme winds and storms.
Health	❑ Develop heat wave and wildfire smoke advisory and refuge plans in cooperation with health care providers, with particular attention to susceptible individuals. ❑ Consider adequacy of mosquito management in light of the potential for increased vector borne diseases

Parks and recreation	❑ Firesmart forested areas. ❑ Regularly inspect and remove hazard trees or branches in forested areas. ❑ If water supply is limited, reduce water use by improving soil water retention, xeriscaping, planting native vegetation that will withstand projected climate changes and reducing irrigated areas. ❑ Plant a diversity of species to minimize impacts of pest outbreaks. ❑ Monitor vegetation for pest outbreaks and take action to reduce impacts. ❑ Monitor for and remove invasive species, especially alien species. ❑ Expect a longer outdoor recreation season.
Monitoring, information and education	❑ Educate community members about climate change impacts and needed actions. ❑ Encourage businesses to assess climate risks to their operations[3]. ❑ Use seasonal forecasts to understand potential demands on community services. ❑ Encourage community members to participate in citizen science monitoring, including schools, community groups, businesses and households. ❑ Continue to learn about climate change, impacts and adaptation actions. Facilitate ongoing learning within the community (eg. through the media, by hosting forums to provide updated information etc). ❑ Support staff to become better informed about climate change, impacts and actions. ❑ Support community learning about growing food locally.

[3] See *Adaptation – An Issue Brief for Business* http://www.wbcsd.org/DocRoot/iMn5EtG4bkjxQNLfU9UZ/Adaptation.pdf

√ Businesses, Community Organizations & Households	
Emergency preparedness	❑ Businesses & Community Organizations - Create and test a robust emergency plan. ❑ Households - Be prepared for emergencies with a household emergency plan and a 3 day cache.
Transportation & Communications	❑ Anticipate disruptions from extreme weather events and wildfires.
Buildings	❑ Firesmart properties to reduce risks from wildfires. Consider installing sprinklers. ❑ Firesmart electrical and communication lines, and remove overhead hazards that may damage lines in storms. ❑ If on a sewer system, install a backflow valve and slope land away from buildings to reduce flooding impacts. ❑ If electricity powered pumping is required during flood events, install a back-up power source. ❑ Reduce summer heating by building orientation and planting trees. ❑ Use permeable surfaces for walkways and driveways to increase water percolation on site.
Water conservation	❑ Install low flow toilets, showerheads and taps. ❑ Conserve water by reducing lawn areas that needs watering by using drought tolerant turf species, having a smaller lawn or not watering. ❑ Collect water in rain barrels/cisterns, or recycle grey water for watering plants, gardens and landscaped areas.
Food security	❑ Community organizations & businesses – Support community food security initiatives such as community gardens, farmers markets, community supported agriculture, community composting, local food production and local processing. ❑ Households – Grow your own food and compost

Monitoring, information and education	❑ Use seasonal forecasts to understand potential impacts on business operations and community life. ❑ Join citizen science monitoring programs where existing monitoring programs don't provide needed information. ❑ Continue to learn about climate change, impacts and adaptation actions. Businesses should assess potential climate risks to their operations[3].

4

Forest property owners

Forest planning	❑ Mainstream climate change in all aspects of forest planning and decisions including growth and yield estimates, long term timber supply estimates, annual plans, operational plans and infrastructure decisions. ❑ Be prepared for salvage logging more frequently to recover trees damaged by pests, wildfire, drought and extreme weather events. ❑ Shorten rotation length to reduce risks if feasible. ❑ Plan for variable timber supply. ❑ Maintain communications with neighbours to explain changes in practices in light of climate change. ❑ On public lands, engage the public in a dialogue about the impacts of climate change on forest conditions and valued attributes, including the possible need to revise long-term management plans.
Safety	❑ Have procedures in place for safety actions such as stop-work, etc. in anticipation of increased frequency of extreme storms, higher stream peak flows, heat waves, wildfires or avalanches.

[4] See *Climate Change and Canada's Forests* at http://nofc.cfs.nrcan.gc.ca/bookstore_pdfs/29616.pdf

Wildfire	❑ Have a high level of preparedness with fire fighting tools & communications protocols in place for swift fire suppression. ❑ Anticipate the need to stop harvesting in extreme fire hazard conditions. ❑ Plan for wildfire rehabilitation, including salvage logging and drainage infrastructure improvements to avoid damage during increased peak flows.
Forest health	❑ Monitor pest and forest conditions closely and anticipate increased damage if possible. Stay informed about pest activities on nearby lands. ❑ Reforest with a diversity of species and manage for a range of age classes, when ecologically feasible, to minimize impacts of each pest. ❑ Monitor for and remove invasive species, particularly alien species.
Transportation	❑ Build ditches, culverts and bridges large enough to handle increased stream flows from heavy rains and rain on snow or frozen ground events. ❑ Plan for increased on-site inspections during storm events, and increased road maintenance from storms, changes in precipitation and increased freeze/thaw cycling. ❑ Anticipate shorter hauling seasons as roads are frozen for shorter and intermittent periods as the climate warms.
Harvesting	❑ Anticipate shorter harvesting seasons as the ground thaws earlier, freezes later and has more frequent freeze/thaw cycles. Consider using low ground pressure logging equipment.
Markets	❑ Develop markets and products for changing wood quality and size.
Reforestation	❑ Consider planting/seeding species and with seed stock suited to possible future climate conditions[5]. ❑ Emphasize micro-site planting/seeding to improve survival and growth on sites that are prone to flooding or drought.

[5] See *Vulnerability ofVulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation: An Overview for Policy Makers and Practitioners* at http://www.ccfm.org/pdf/TreeSpecies_web_e.pdf

Monitoring, information and education	❑ Use seasonal forecasts to understand potential impacts on operations. ❑ Join citizen science monitoring programs where existing monitoring programs don't provide needed information. ❑ Continue to learn about climate change, impacts and adaptation actions[6].

Forest-based Tourism

Safety	❑ Have procedures in place for safety actions such as no-go, etc. in anticipation of increased frequency of extreme storms, higher peak stream flows, heat waves, wildfires or avalanches. ❑ Increase education and information for independent travelers about local weather-based safety risks such as wildfires, flooding, landslides and avalanches
Infrastructure	❑ Anticipate potential flooding, reduced water supply and reduced snow at low elevations when deciding where to locate long-term infrastructure. ❑ Implement water conservation practices where water supplies are expected to decline over time. ❑ Anticipate and plan for disruptions in transportation into/out of the community due to storms, wildfires, flooding and landslides.
Activities	❑ Anticipate longer spring and fall seasons and warmer summers, with more variable weather conditions. ❑ Anticipate more variable snowpacks, especially in areas where winter temperatures often hover around zero.
Monitoring, information and education	❑ Use seasonal forecasts to understand potential impacts on operations. ❑ Join citizen science monitoring programs where existing monitoring programs don't provide needed information. ❑ Continue to learn about climate change, impacts and adaptation actions.

[6] See Canadian Council of Forest Ministers Climate Change Initiative http://www.ccfm.org/english/coreproducts-cc.asp

Chapter 6. Watch, Learn & Refine

6.1 Citizen Science Monitoring Programs

Canada	
Nature Watch - http://www.naturewatch.ca/english/ FrogWatch - http://www.naturewatch.ca/english/frogwatch/bc/intro.html IceWatch - http://www.naturewatch.ca/english/icewatch/ PlantWatch - http://www.naturewatch.ca/english/plantwatch/ WormWatch - http://www.naturewatch.ca/english/wormwatch/	**NatureWatch** is a series of ecological monitoring programs that encourage you **to become a** citizen scientist**.** **NatureWatch** lets you learn about the environment while gathering the information scientists need to monitor and protect it. Data collected through **NatureWatch** is being used to add to our knowledge of the effects of climate change and other impacts on biodiversity.
North America	
Audubon Society's Christmas Bird Count http://birds.audubon.org/christmas-bird-count	From December 14 through January 5 tens of thousands of volunteers throughout the Americas take part in an adventure that has become a family tradition among generations. Families and students, birders and scientists, armed with binoculars, bird guides and checklists go out on an annual mission - often before dawn. For over one hundred years, the desire to both make a difference and to experience the beauty of nature has driven dedicated people to leave the comfort of a warm house during the Holiday season. Each of the citizen scientists who annually braves snow, wind, or rain, to take part in the Christmas Bird Count takes an enormous contribution to conservation.

From the National Phenology Network – Phenology Observation Programs http://www.usanpn.org/participate/other-programs	
eBird	eBird is a real-time, online checklist program that has revolutionized the way that the birding community reports and accesses information about birds. The program was started by the Cornell Lab of Ornithology and National Audubon Society to give the public general access to information on bird abundance and distribution at a variety of spatial and temporal scales.
GLOBE Phenology	Phenology is one of the fields of investigations in the Global Learning and Observations to Benefit the Environment (GLOBE) program and is dedicated to the education of primary and secondary students in the area of science. GLOBE provides many project ideas, scientific measurement protocols and learning materials to help teachers and students become engaged in monitoring and conducting inquiry-based investigations in phenology as well as in atmosphere, soils, hydrology, and land cover.
Hummingbird Monitoring Network	The Hummingbird Monitoring Network is a science-based, project-driven, nonprofit organization dedicated to the conservation of hummingbird diversity and abundance throughout the Americas. The network relies on a mix of professionals and citizen scientists to monitor hummingbirds.
JellyWatch	JellyWatch monitors jellyfish, red tide, squid, and other unusual marine activity. Marine biologists use this information to help to develop a better understanding of the ocean.
Journey North	Journey North engages students in a global study of wildlife migration and seasonal change. K-12 students share their own field observations with classmates across North America.
Operation RubyThroat	Operation RubyThroat is a student and citizen science project that monitors Ruby-throated Hummingbirds (Archilochus colubris) and their behavior, distribution, and migration throughout all ten countries of North and Central America.
The Great Sunflower Project	People all over the US and Canada can enlist to observe their bees and sunflowers. Participants plant sunflowers in their gardens, observe bee visiting them, and provide resources for bees.

Possible Opportunities to develop in Canada	
Community Collaborative Rain, Hail & Snow Network *Because every drop counts* http://www.cocorahs.org/	CoCoRaHS is a unique, non-profit, community-based network of volunteers of all ages and backgrounds working together to measure and map precipitation (rain, hail and snow). By using low-cost measurement tools, stressing training and education, and utilizing an interactive Web-site, our aim is to provide the highest quality data for natural resource, education and research applications.