CLIMATE CHANGE RISK ASSESSMENT

City of Sault Ste. Marie

2020

CLIMATE RISK INSTITUTE

Climate Risk Institute

251 Laurier Ave. W.
Suite 700
Ottawa, ON
K1P 5J6
Canada

The Climate Risk Institute would like to thank City of Sault Ste. Marie for their participation in the Northern Climate Change Network and the risk assessment workshops. This initiative is offered through the Municipalities for Climate Innovation Program, which is delivered by the Federation of Canadian Municipalities and funded by the Government of Canada.

The climate risk workshops were hosted and organized by the Climate Risk Institute (CRI) with support from City staff. CRI works to select and tailor datasets, apply analytical tools, and interpret results to identify opportunities and prioritize options for building climate resilience into policy, programs, strategy, planning and operations. For more information on CRI, please visit: www.climateriskinstitute.ca.

This workshop was part of the Northern Climate Change Network (NCCN), which is being led by CRI. The NCCN links five northern Ontario municipalities to advance adaptation planning and risk assessment, and to provide peer-to-peer training and network building.

About the workshops

Climate Risk Institute, in cooperation with the City, completed two workshops to identify and assess risks associated with climate change. During these workshops, participants from a range of City departments, in addition to external agencies, were engaged to identify and assess a number of climate change risks as they relate to the City's assets, operations and services and the lives and livelihoods of residents in the city and region.

The workshop participants were primarily City of Sault Ste. Marie staff with representation from the following departments: Environmental; Engineering, Risk Management, Community Development and Enterprise Services; Public Health; Emergency Services. The Algoma Public Health Unit, Conservation Authority and Ontario Ministry of Natural Resources and Forest also attended.

Workshop #1: In the first workshop, participants had the opportunity to discuss the impacts of climate change on corporate operations, plans, and programs for the City of Sault Ste. Marie; share observations on past or recent climate change impacts in their departments; and hear about tools and case studies related to municipal climate change risk assessment. The workshop included a presentation and discussion of historical and projected climate trends for the SSM region, facilitated discussions of the potential impacts of climate change on municipal operations, environment, and people, and information on approaches to assess climate risks and reduce vulnerability. Participants participated in a risk identification exercise, outlining a number of different climate-related risks for the community and the corporation.

Workshop #2: During the second workshop, participants reviewed climate change data and trends presented in workshop #1, as well as the list of climate risks that were identified. Participants in workshop #2 were then provided with a guidance and detailed ranking matrices so that they could identify the likelihood and potential consequence of each risk. These risks were then compiled in a risk register database for reference.

Results of these risk assessment workshops are highlighted in this report.

Contents

Understanding Climate Change

Climate is the average weather for a particular region and time period (usually taken over a 30-year time period); climate change is the change in those long-term weather patterns and temperatures. Global warming is one measure of climate change, namely the rise in average global temperature.

The primary cause of climate change is rising Carbon Dioxide (CO2) concentrations in the atmosphere. The concentration of CO2, among other greenhouse gases, is increasing due to anthropogenic (human-caused) emissions, mainly from the burning of fossil fuels.

Prior the industrial revolution, CO2 concentrations in the atmosphere had remained stable at approximately 280 ppm for thousands of years: the sources of emissions were balanced by the removal of carbon from atmosphere (i.e. carbon sinks). In 2020, concentrations of CO2 exceed 415 ppm. This increase has caused global average temperatures to rise by nearly 1°C. In Canada, average temperatures have already increased by 1.7°C, double the magnitude of global warming.[1] In Canada, and around the world, these measured changes have already led to changes in extreme weather and impacts to both human systems and ecosystems.

Globally, scientists and policy-makers established a goal of preventing dangerous levels of climate change, defined as keeping global average temperature rise to well below 2°C, with efforts to achieve a goal of 1.5°C.[2] To meet this objective, annual global emissions must decrease rapidly and reach net-zero (i.e. sources of greenhouse gases are balanced by sinks) near mid-century. Canada has committed to being net-zero emissions by 2050, in support of this objective.[3]

Unfortunately, there remains a gap between current emissions reductions pledges and the objective of keeping global temperatures to as far below 2°C as possible. The current suite of policies and emission reductions pledges, globally, is expected to result in global temperature increases of over 2.2°C and up to 4.1°C (see Figure 1). [4]

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[1] Canada's Changing Climate Report. Government of Canada. 2019. https://changingclimate.ca/CCCR2019/
[2] UNFCCC Paris Agreement. https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement
[3] Getting to zero: Canada Plans to hit net-zero emissions by 2050. Canadian Institute for Climate Choices. https://climatechoices.ca/getting-to-zero-canada-plans-to-hit-net-zero-emissions-by-2050-whats-next/
[4] Climate Action Tracker. https://climateactiontracker.org/

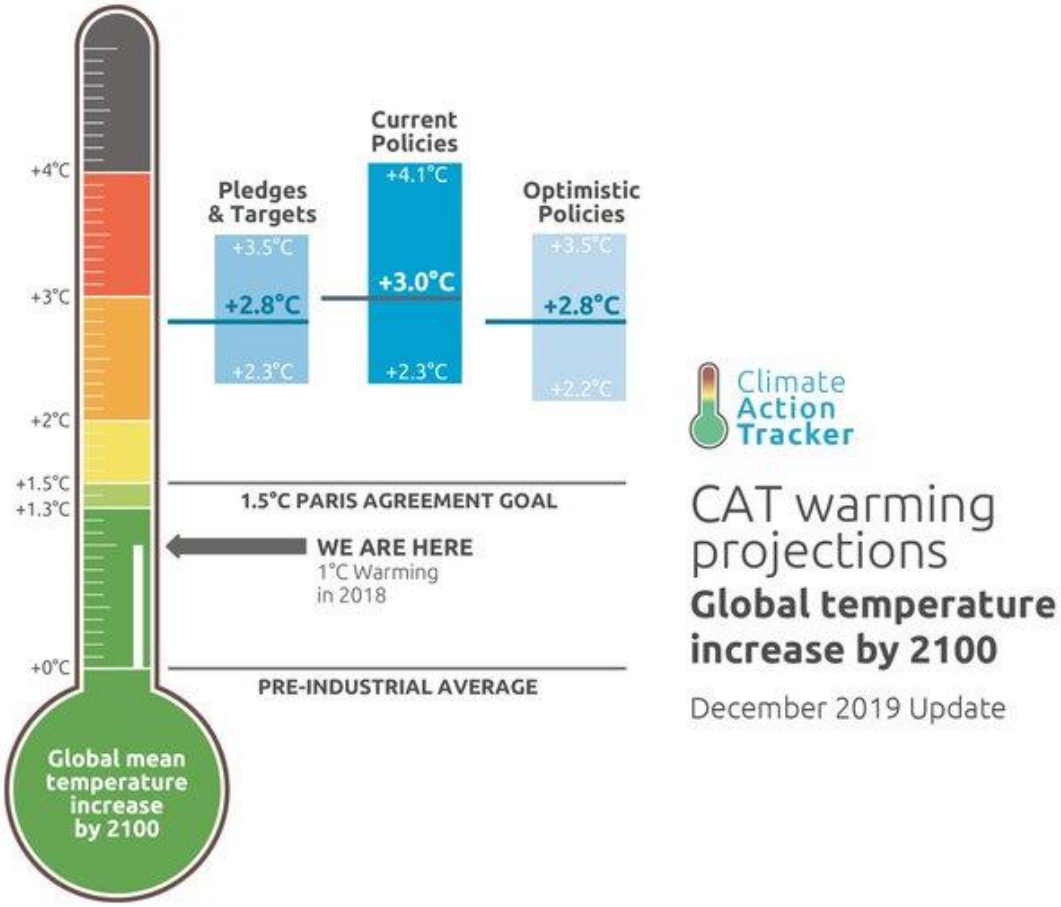


Figure 1: Warming projections for the 21st century. Climate Action Tracker

Climate change risk assessment and adaptation

Canadians are already feeling impacts of climate change. This is driving a need for climate change risk assessment and adaptation planning. Communities are increasingly seeking to build resilient social, economic and infrastructure systems to ensure that they can minimize or avoid negative impacts and are positioned to take advantage of any relative opportunities.

At a current global average temperature of less than 1C, impacts of regional and global climate change are already having an impact on business, health, and infrastructure in Canada. With current international pledges and actions on emissions reductions, global temperatures are anticipated to rise by 3-4°C by 2100. As global temperature continues to climb, the frequency and severity of climate change impacts – to food systems, biodiversity, ecosystems, and human health for example - is expected to rise.

The relationship between average values and extreme events is shown below (See Figure 2).[5] As average values in key climate variables increase due to human contributions to climate change, the frequency and magnitude of extremes (droughts, forest fire, extreme rainfall events, and heat events) will increase.

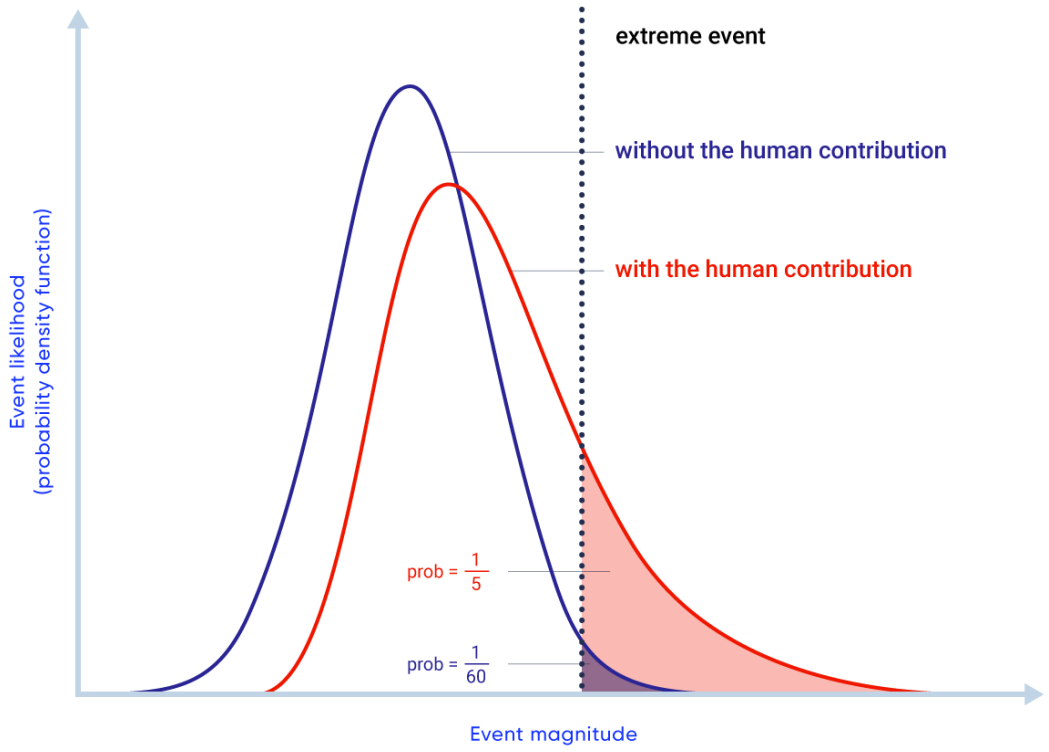


Figure 2: Hypothetical illustration of event attribution (Source: CCCR 2019).

Canadian communities are seeing the impact of increasing extremes. This can been seen by the number of events for which Canadian provinces and territories have applied through Public Safety Canada for Disaster Financial Assistance Arrangements (DFAA), which has increased steadily over previous decades. The increasing trend in number of events is driven primarily by weather related disasters; three-quarters of all financial aid through DFAA is in response to flooding events. In the period between 2009 and 2016, DFAA provided more recovery funding than the total distributed since the program inception in 1970.[6]

[5] Chapter 4, Figure-4.21. Canada's Changing Climate Report. Government of Canada. 2019. https://changingclimate.ca/CCCR2019/.
[6] 2016-2017 Evaluation of the Disaster Financial Assistance Arrangements. Government of Canada. https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/vltn-dsstr-fnncl-ssstnc-2016-17/index-en.aspx

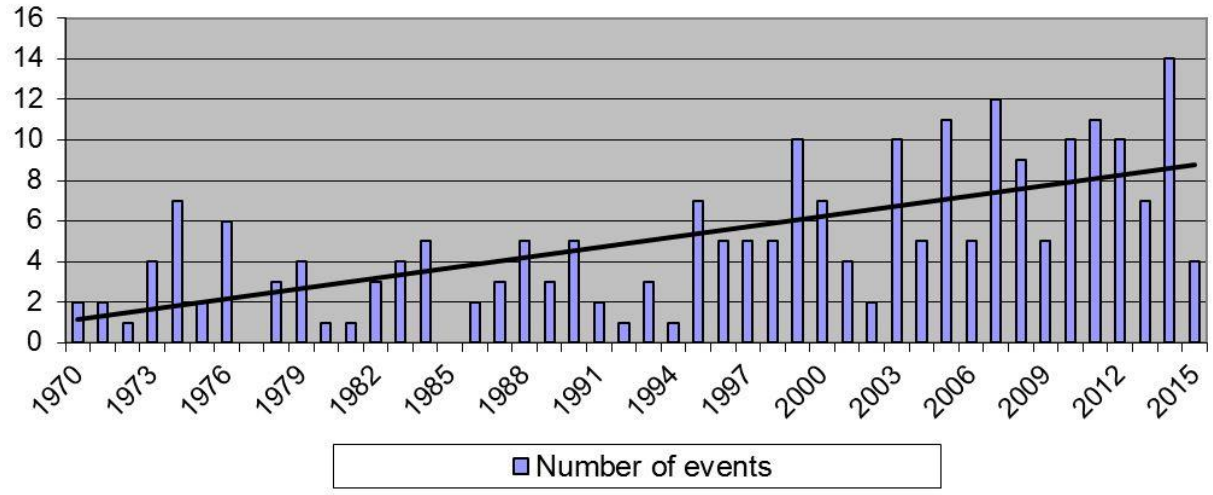


Figure 3: The number of disaster events in Canada is increasing.

Across Canada, municipalities, engineers, farmers, health-care providers and others are already responding to impacts of climate change, and are assessing and planning for current and future climate risk. According to the Insurance Bureau of Canada and National Institute of Building Science, each $1 invested in proactive adaptation and resilience will yield $6 return in future averted losses.[7]

Building resilience and managing risk in relation to climate change will be an ongoing challenge in coming years and decades. However, opportunities exist to build resilience, protect public infrastructure and services, and ensure that communities thrive in the coming decades. Measures to build resilience and adapt to climate change can have significant financial benefit. A recent study found that conservation and restoration of natural infrastructure – wetlands, ponds, and vegetated areas – provides a significant financial benefit for municipalities by providing stormwater management services, avoiding flood losses, reducing engineered infrastructure, and maintaining water quality. These benefits are in addition to other co-benefits including protecting habitat and biodiversity, improving aesthetics in communities.[8]

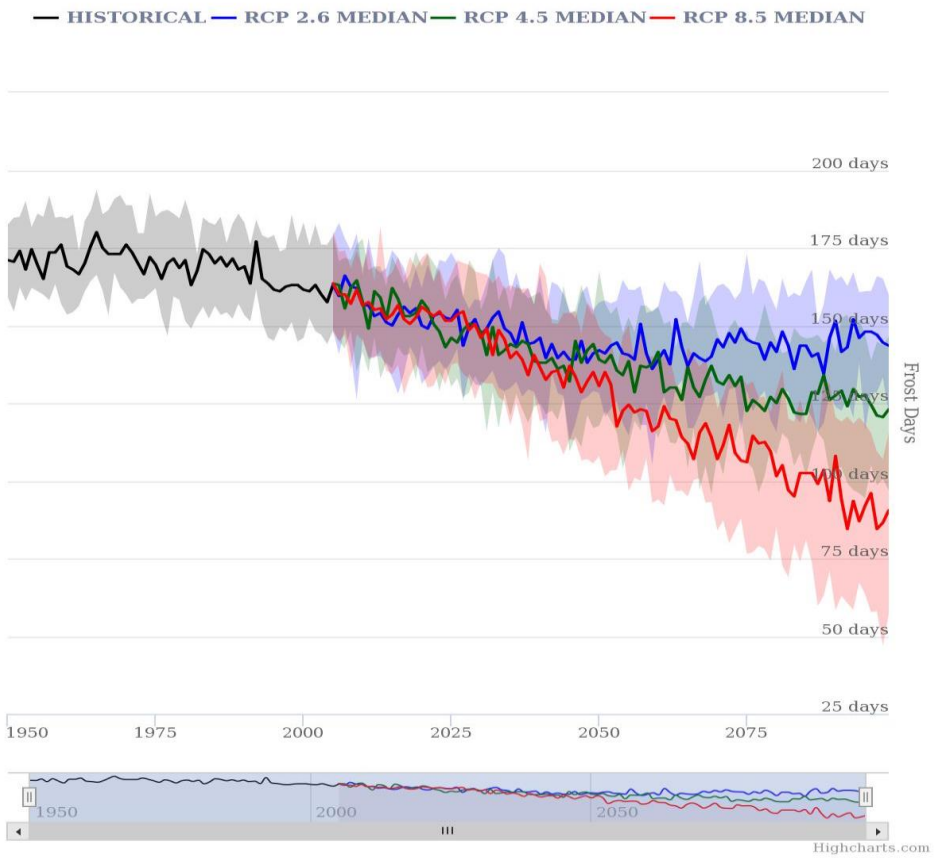
[7] Multihazard Mitigation Council. (2017). *Natural Hazard Mitigation Saves 2017 Interim Report: An Independent Study*. Principal. National Institute of Building Sciences, Washington.

[8] Moudrak, N., Feltmate, B., Venema, H., Osman, H. 2018. Combating Canada's Rising Flood Costs: Natural Infrastructure is an underutilized option. Prepared for Insurance Bureau of Canada. Intact Centre on Climate Adaptation, University of Waterloo http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf

Climate change in the Sault Ste. Marie Region

In Canada, the average annual temperature has increased 1.7°C since 1950 – double the global magnitude – with seasonal warming being very pronounced in the winter. Average precipitation has shifted towards more rain and less snow, with a decrease in snow accumulation.

For SSM, the annual number of frost days is currently 160 days/year, and that number is projected to drop to 125-150 days/year by mid-century under all emissions scenarios, and would continue this trend and drop to less than 100 days by late century under under higher emissions scenarios.



Average temperature increase is anticipated to lead to an overall decrease in the number of freeze/thaw cycles. However, this decrease would be concentrated in the shoulder seasons (October, November, March, April and May) and SSM would experience an increase in freeze-thaw events during winter (January, February) – meaning more mid-winter melts (See Figure 4). The number of cold and extreme cold days will significantly decrease in the coming decades.

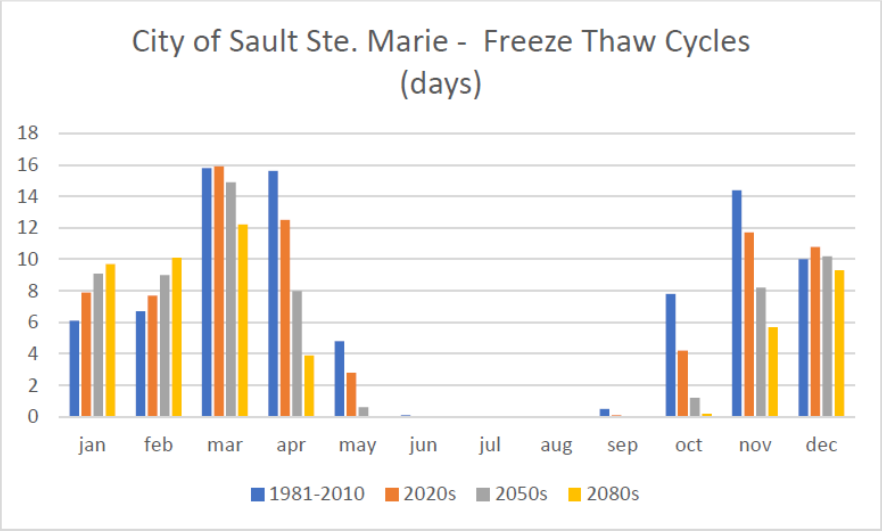


Figure 4: Projected seasonal changes to freeze-thaw cycles.

SSM will also experience increases in a number of heat-related indicators including: frequency of days exceeding 30°C, increase in maximum temperature, and increase in the frequency of 'tropical' nights (where temperature remains above 20°C). Under all climate change scenarios, the number of days exceeding 30°C will climb from a baseline of 3-4 days per year to 15-20 by mid-century. In high emissions scenarios, SSM could see 40-50 days per year over 30°C.

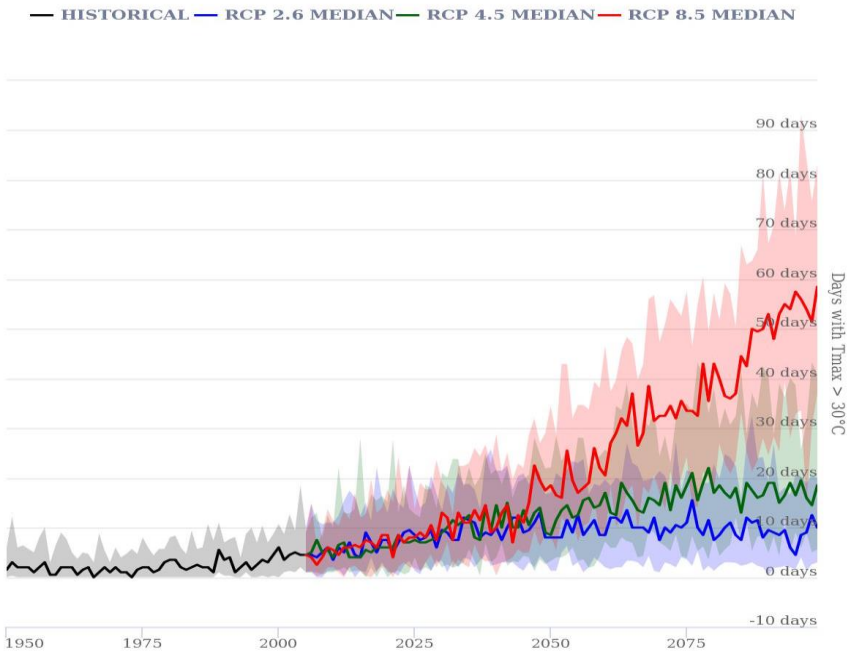


Figure 5: Projected increases in number of days with temperature above 30˚C.

Maximum daytime temperatures experienced in the region are currently 30-32°C range; this is projected to rise to 32-34°C by 2050s and 35-39°C by 2080s.

Key precipitation variables will also shift in the Sault region. While annual precipitation totals will climb by 8-11% in coming decades, annual snowfall totals (and snowfall as a fraction of total precipitation) will decrease. Baseline snowfall amounts of 240cm per year are projected to decline to less than 200cm by 2050s and will continue to decrease to 150cm by 2080s. Additionally, changes in precipitation are not uniform across the seasons, with increases occurring in spring, winter and fall offset by summer declines (see Figure 6).

Combined with higher temperatures and evaporation rates, water availability (precipitation minus potential evaporation) will decrease in summer. The number of days with high rainfall totals (>40mm) is also projected to increase.

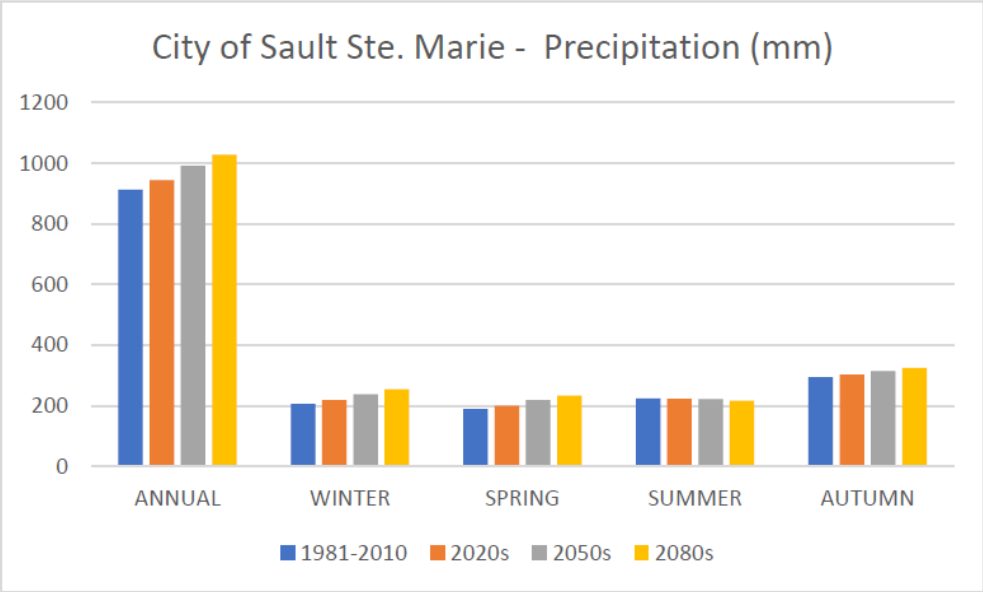


Figure 6: Projected change in seasonal precipitation patterns.

Extreme weather and climate change have led to observed impacts in SSM region already. Projected changes across multiple climate variables (Table 1 below), will increase the scale of these impacts and absent adaptation measures could further stress infrastructure, city operations and residents in the SSM region.

A summary of the local change is outlined below (Table 1).

Table 1: Current and Projected Climate Indicators in SSM Region

	Baseline	2020s	2050s	2080s
Annual mean temperature			Increase by 3.C	Increase by 5.8°C
Annual mean precipitation			Increase by 8%	Increase by 11%
Annual snowfall (cm)	244	223	193	148
Annual precipitation (mm)	912	939	982	1015
Days >30°C	3.9	8.6	19.4	42.0
Days < -25°C	5.2	3.3	1.4	0.2
Days > 40mm rain	0.6	0.7	0.8	0.8
Frost free days year	199	223	252	279
Growing degree days	1712	1970	2368	2915
Water budget (mm)	379	384	371	307

Regional Climate Impacts

Health

Climate change is and will have an impact on human health and health systems. According to the Canadian Medical Association: "The life of every child born today will be profoundly affected by climate change, with populations around the world increasingly facing extremes of weather, food and water insecurity, changing patterns of infectious disease, and a less certain future. Without accelerated intervention, this new era will come to define the health of people at every stage of their lives."[9]

The range of health impacts relate to climate change include: asthma and cardiovascular disease caused by increasing air pollution, heat related illnesses and deaths, and injuries, fatalities and mental health impacts caused by extreme weather events (see Figure 7).[10]

In order to address these impacts, climate change has been added to Public Health Standards in Ontario, and health units across the province have been scaling up their climate change knowledge and capacity. Beginning in 2019, the Algoma Health Unit joined a consortium of seven northern health units through the Public Health Agency of Canada (PHAC) to participate in health vulnerability and adaption assessments for the north. The large-scale project will look at the impacts to public health, with specific focus on those who may be particularly at risk (e.g. children, elderly, indigenous, etc.).

Canadian Medical Association. 2019

From warming temperatures in the north to wildfires, heat waves and flooding, many Canadians are experiencing the effects of climate change first-hand. Health care professionals see the impact on patients' health, including heat-related conditions, cardiorespiratory illnesses, infectious disease outbreaks and post-traumatic stress disorder.

[9] Lancet Countdown: Tracking Progress on Health and Climate Change. 2019. https://www.lancetcountdown.org/2019-report/

[10] The Lancet Countdown on Health and Climate Change Policy brief for Canada. 2019.

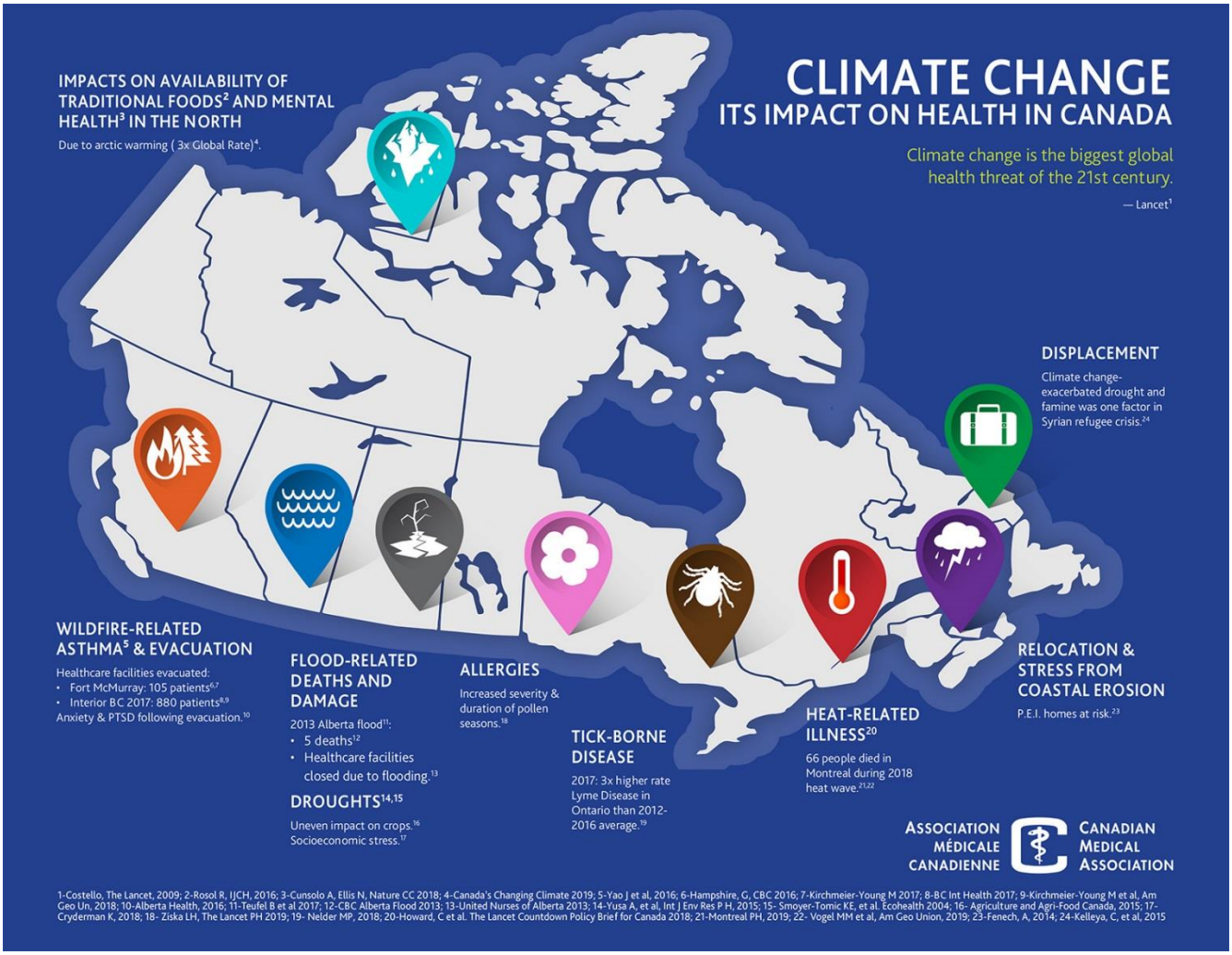


Figure 7: Examples of impacts of climate change on health ad health systems in Canada. Source: Canadian Medical Association.

Forests

Overall, climate change will add stress to an already-stressed ecosystem. When it comes to forest fires, warmer/drier conditions, an increase in pests/diseases, and less winter snow cover is putting more stress on Ontario forests. Forest fires are expected to increase in the future, with fire season length increasing in duration (see Figure 8). In addition to experiencing increasing fire risk regionally, northern Ontario can still be affected by western forest fires as smoke can travel across the country and impact air quality thousands of kilometers away.

Climate change has been recognized in Ontario's Biodiversity Strategy as one of the greatest challenges and threats facing biodiversity (Ontario Biodiversity Council, 2011). Warming temperatures will continue to cause habitat limitation, fragmentation, loss and decline. Changes in regional bioclimate will alter the timing and composition of species. Also, native species will migrate, where possible, to remain within a familiar bioclimate, and non-native and invasive species will find opportunities for expansion.

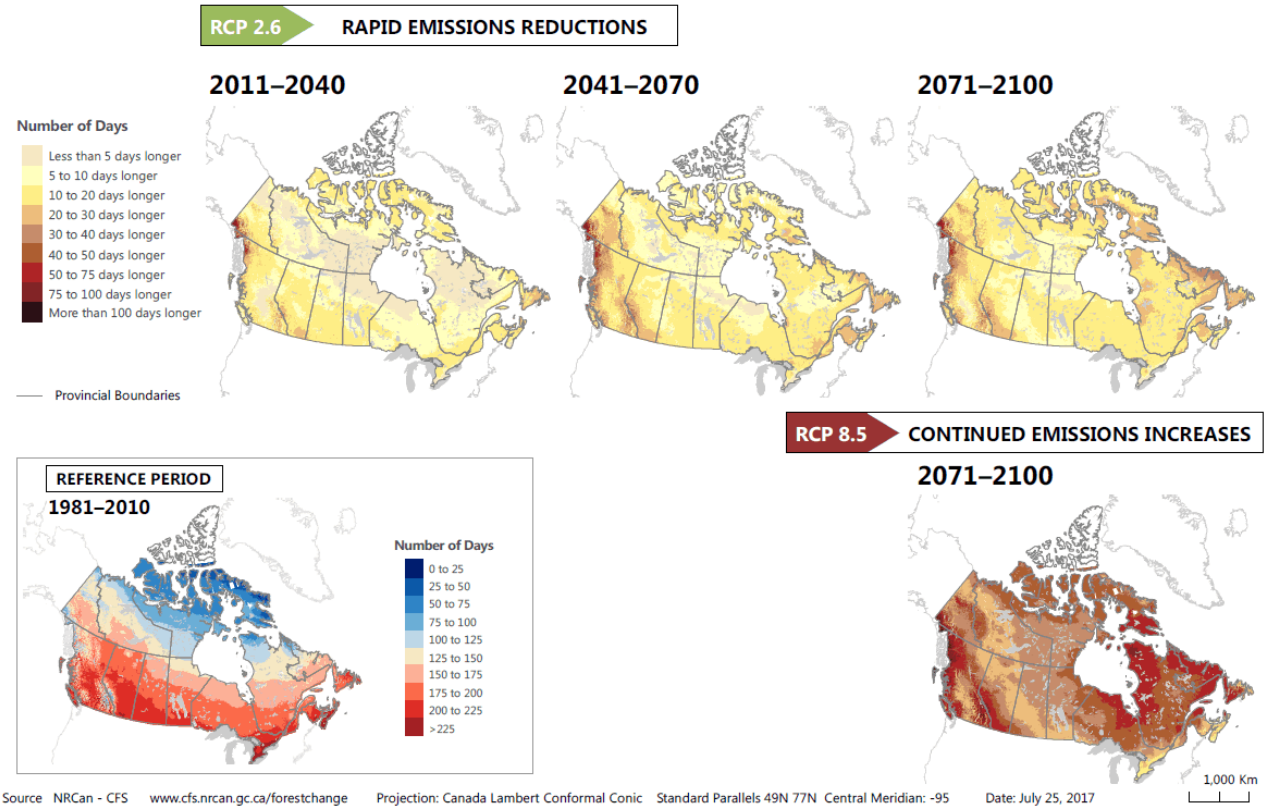


Figure 8: Changes in fire season lenght compared to reference period under different climate scenarios (Source: Natural Resources Canada)

Farming, Food and Food Security

Climate change is linked to food production, food distribution and overall food security. Local agriculture and the production of food is directly tied to precipitation and growing degree days, food distribution and food availability are also critical systems for residents and institutions. Disruptions to agriculture or food distribution systems can result in challenges to food security for residents in the region.

Climate change impacts on the food systems can have direct and immediate local impacts (e.g. local crop damage from extreme events), or distant and indirect impacts (e.g. price changes due to crop failures in other agricultural regions).

Regionally, climate change may result in climate risks such as:

- Longer growing seasons and continued warming may benefit the agriculture sector, however, multiple climate-risks may wipe-out those benefits if not anticipated and managed.
- Climate change will add heat stress, increase precipitation variability and extremes, increase potential for summer drought, and increase risk from pests and diseases.
- Precipitation will be more concentrated in the spring, and managing water throughout the summer may be more challenging.
- Regional agriculture connected to a provincial, national and international food systems. Challenges to the food systems, price shocks, commodity prices could have indirect local impacts.

Lakes, Rivers and Aquatic Ecosystems

Temperature increases due to global warming have been observed and are projected in lakes and rivers across Ontario in a changing climate. This can have present risks to ecosystems, as well as human health and recreation. Examples include:

- Increased extreme rainfall and warmer water temperatures lead to loss of water quality, increase in algae in lakes and rivers.
- Climate change has already started to impact the availability of suitable habitats for aquatic species. Changes in precipitation patterns alter the amount of habitat available.
- Increasing water temperature modifies the thermal habitats of lakes, rivers, and wetlands. For cold-water species like Lake Trout, warmer water temperature will decrease their habitat and productivity, and may favour other species such as bass.

Infrastructure

Canadian infrastructure systems are generally designed based on historical weather and climate patterns. The role of infrastructure in supporting a range of social, economic and environmental objectives, indicates that any vulnerabilities or impacts to these systems necessarily have wider impacts on municipalities, public health and safety, local businesses and industry.

Changes in precipitation, extreme precipitation, water levels or water availability can expose climate-related vulnerabilities in municipal water and wastewater infrastructure, including drinking water supply. Increased frequency of winter thaw events, rain on snow events, and extreme weather can lead

to stormwater and sanitary system failures, increased pumping requirements, or damage and blocking from movement of debris.

Similarly, transportation and linear infrastructure including roads, culverts, and bridges are subject to damage resulting in repair requirements, delays or detour requirements. Disruptions from extreme events such as floods, fire and storms are the most common reasons for concern for transportation infrastructure. In rural and northern areas, limited opportunities for detours and increased exposure to some climate events can compound risks associated with disruptions to transportation systems, triggering potential consequences for businesses in natural resource economies as well health and emergency services.

Risk Assessment Approach

Risk Identification and Assessment Process

During the workshop, participants developed risk and climate scenarios to examine intersections between climate-related risks. Multiple different scenarios were described and discusssed, including

(i) average summer temperature increase
(ii) average winter temperature increase
(iii) heat events
(iv) winter storm events
(v) wildfire
(vi) extreme rainfall events

Participants were asked to desribe first, second, third and fourth order impacts related to each climate event or scenario in order to help document both direct and indirect risks. Documenting these risks in this method helps to:

- Develop the potential sequence of risk events and identify potential opportunities.
- Collect data and establish risk baselines.
- Provide a preliminary screening of risk events.
- Identify current risk controls, their effectiveness and any gaps.
- Consider stakeholders and how they could be consulted (if necessary).
- Archive all data so that decisions can easily be revisited.

Following the risk identification exercises in workshop #1, participants in workshop #2 were asked to review the list of risks and determine the relative likelihood and consequence of the various risks.

Since the consequences of climate change could result in variety of impacts, workshop participants were asked to rank the likelihood of the risk, as well as the consequence in four key areas: people, economy and finances, environment and by individual department. These areas of consequence are described briefly here.

- People. Including department staff, contractors, or residents accessing or benefitting from assets or programs managed by your department). Includes access to services, as well as health and safety.
- Economy and Finances. Includes department and City operating budgets, repair costs, as well as financial impact to local residents or businesses.
- Environment. Includes risks to air quality, water, land (soil, shorelines, trees), and wildlife.

- Department. Includes plans, assets, operations and finances of individual departments or units. This reflects the risk to individual departments.

Guidance was provided to participants to help them consistently evaluate both likelihood and identified risks (see Table 2), and consequence (see Table 3). More detailed scoring tables are found in appendix.

Table 2: Guidance for ranking likelihood of climate risks

Event/ Risk Scenario	Likelihood Range (Planning period: 10-30 years)				
	1 - Very Low (rare)	2 – Low (unlikely)	3 – Moderate (possible)	4 – High (likely)	5 - Very High (almost certain)
	Not likely to occur in planning period	May occur once in the time period; less than 50% chance of occurrence.	50/50 change this occurs; may occur once in time period.	More likely than not to occur more than once in time period, likelihood increasing.	Likely to occur several times or annually in the time period.

Table 3: Sample guide for scoring consequence

Consequence Score	People	Economic and Financial	Environment	Department
Very Low (score 1)	No people impacted.	No noticeable economic impacts.	Negligible environmental consequence.	No significant impacts to the department.
Low (score 2)	Consequences for people, including health and safety, but not significant.	Some cost implications, indicative from past experience	Signs of impacts are assumed and/or apparent, assumed connection to changing climate	Some implications, minor changes, costs or adjustments expected.
Moderate (score 3)	Some impact to health and safety of workers, residents. Short duration, relatively minor. Short duration displacement.	Some economic impact, recovery possible and not prolonged.	Repeated negative stresses to environment. Ongoing low-level stress harms environment.	Multiple changes in policy, strategy expected. Costs must be closely managed.

High (score 4)	Significant health and safety consequence for small number of people; large number of people suffer minor impact. Frequent or longer duration displacement.	Larger losses, significant and worth reporting, Difficulty recovering.	Large impacts, strongly linked to climate change and extreme weather, potentially irreversible, larger scale	Larger losses, significant changes in mandate and strategy required.
Very high (score 5)	High number of people, significant impact. Prolonged displacement. Possible loss of life.	Significant, sustained financial and economic impact. Financial recovery not always possible	Very high impact over prolonged period, large scale. Permanent loss of environmental feature or service.	Significant changes in mandate and strategy required, large additional costs to address risks and adapt.

Responses and scores from each department were gathered, leading to the creation of an overall risk heat map (see Figure 9). Risk maps help illustrate highest priority risks, and can inform the development of climate change adaptation plans.

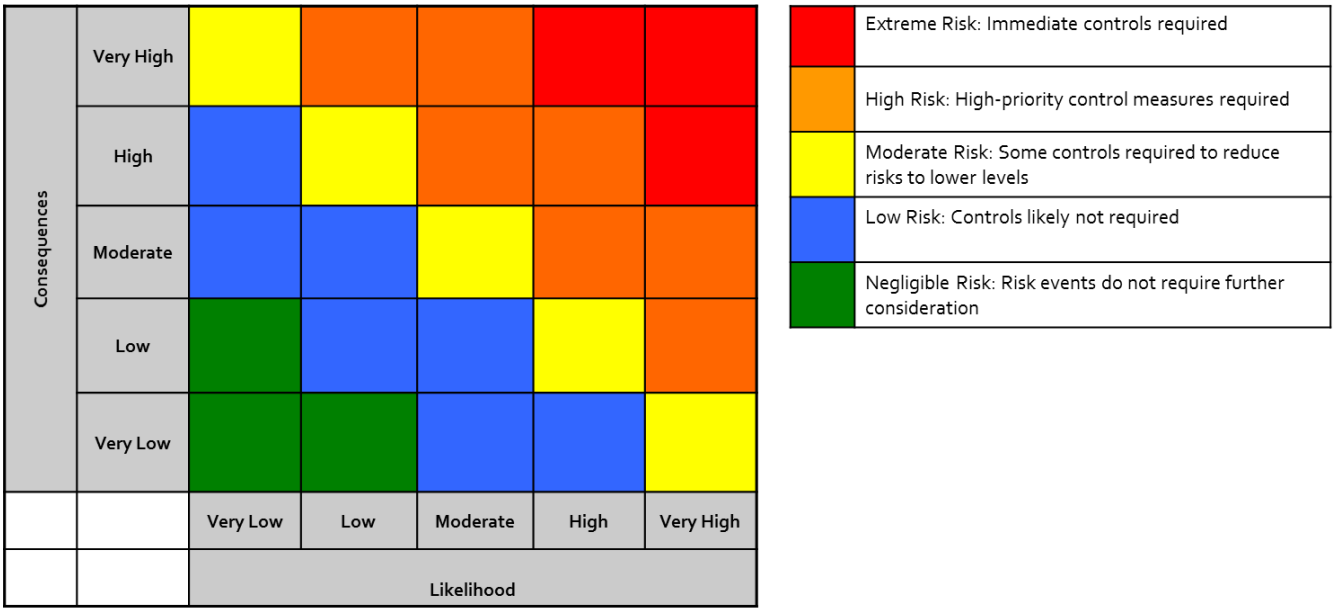


Figure 9: Conceptual risk heat map

Risk Assessment Outcomes

The following risk heat maps summarize and highlight the outcomes and commentary from the municipal workshops.[11]

Combined Risks

The heat map below provides illustrates outcomes of risk ranking when risks across different categories (consequences to people, economy, environment and city departments) are considered in a single, combined score.

The increase in average and extreme temperatures in summer, leading to risks including reductions in air quality (from increased pollen and allergens, and wildfire smoke), algae blooms, and increase in cooling demand and infrastruture stress, were viewed as having high likelihood and consequence. Increased average temperature and changes to seasonality are also thought to pose challenges to public health including air quality, vector borne diseases.

Changes to ecosystems and species, including increase in invasive species, impacts to urban tree canopies, and changing wildfire regimes, were viewed as having moderate likelihood and consequence.

Some risks identified in workshop one, including changes to recreational property values and the potential for an increase in school closures, were deemed to have both low consequence and low likehoood.

Table 4: Risk Heat Map - all consequence categories

Consequence	Very High					
	High			Air quality impacts from pollen (asthma, allergy increases).	Increase in water temperature lead to algae blooms.	Increase cooling demand, infrastructure stress leads to grid issues, power loss.

[11] Comprehensive results are recorded in a risk database, and presented in the appendix. Results presented here are not comprehensive.

				Increase public health impacts including displacement, injuries and accidents	Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)	
	Med			Increase in invasive species. Increased forest disturbance from pests or diseases increase fire risk. Increase demand for facilities with air filtration.	Air quality impacts from wildfire. Freeze-thaw cycles lead to watermain failures. Increase shoreline flooding and hazards. Increase shoreline erosion.	
	Low		School closures (lack of air conditioning). Changes in recreational property value.	Delays in basic service delivery.	Increase demand for cooling centres. Difficulty maintaining outdoor rinks; need to invest in compressors.	
	Very Low					
Overall Risks		Very Low (rare)	Low	Moderate	High	High (Frequent)
		Likelihood				

Risks to Health and Safety

Climate change presents some risks to City staff, workers and residents at large, many of which were identified and assessed through two community workshops. The table below highlights priority risks, including health risks for residents such as exposure to aglae blooms, vector borne diseases, or high frequency of food recalls. Other risks to personal safety including displacement, injury, or potential for loss of life were linked to extreme events including flooding, wildfire.

These risks pose challenges to health and safety of residents, but also City staff, emergency response personnel, and public health and social service providers. Impacts to infrastructure, including road washouts and utility disruptions, could have indirect health risks if service disruptions are delayed or critical access routes are damaged.

The risks assessed include immediate, short-duration events (temporary displacement, loss of recreational opporunities) as well as those that manifest over longer periods (e.g. mold growth following can decrease indoor air quality from mold growth, mental health from stress).

Table 5: Risk Heat Map - People, Health and Safety

Consequence	Very High				Air quality impacts from wildfire.	
	High			Increase in food recalls. Health impacts from wildfire (displacement, evacuation, injury). Injuries/deaths from extreme events (floods, ice storms). Impacts to social determinants of health (e.g. food security).	Increase water temperature leads to algae blooms. Infrastructure damage from extreme weather Increase in vector borne disease. Emergency response service disruptions. Increase electricity demand and cost.	
	Med			Increase in invasive species. Decrease water quality / increase water temperature.	Freeze-thaw cycles deteriorate roads; increase liability. Flood risks on forest roads and water crossings. Urban tree mortality increases due to drought, heat stress, diseases.	
	Low			Delays in basic service delivery due to extreme weather or fire. Increase demand for facilities with air filtration.	Snow accumulations increases drainage issues.	
	Very Low					
Health and Safety Risks		Very Low (rare)	Low	Moderate	High	High (Frequent)
		Likelihood				

Economic and Financial Risks

To assess the risks in this category, participants were asked to consider consequences for infrastructure, city operations and budgets, as well as financial impacts to residents and businesses. The City has significant assets and operate large annual budgets, and these assets and services in turn can have impact on economic and financial health of residents and local businesses.

The financial and economic consequences of infrastructure risks, including washouts, watermain failures, or service disruptions in the transportaiton or utility networks were noted to have high likelihood and consequence. Indirect economic impacts, including decreased workforce productivity, increased utility costs, were also of concern.

Changes in seasonality and increases in extreme weather could present risks as well, including risks to tourism through event cancellations, changes to recreational opportunities, or changes to value of recreational properties. The potential for improvements in productivity and diversity in the local agriculture sector was noted as well.

Other financial and economic risks highlighted are increased potential for crop losses from the regional / local agriculture sector (due to extreme weather events), or increased demand for health care services.

Table 6: Risk Heat Map - Economic and Financial Risks

Consequence	Very High					
	High			Service disruptions - transportation networks. Decrease workforce productivity.	Increase infrastructure damage (washouts of shoulders, culverts). Freeze-thaw cycles lead to watermain failures. Increase electricity demand and cost. Decrease tourism and event cancellations.	
	Med			Crop losses from extreme weather. Increase variety, productivity of local agriculture	Increase water temperature leads to algae blooms. Increase shoreline erosion. Loss of heat and utility services.	

				Increased demand for health care services. Increase variety and demand for summer activities (e.g. bike paths).		
	Low		Changes in recreational property value.	Increase need for preventive maintenance (e.g. forest clearing; fire-smart programming).	Air quality impacts. Changes in snow accumulation leads to changes in ecosystem.	
	Very Low					
Economic and Financial Risks		Very Low (rare)	Low	Moderate	High	High (Frequent)
		Likelihood				

Risks to Environment

Climate change impacts can lead to various consequences for the environment, including water, ecosystems or land, and City operations and assets are interconnected with these issues. Participants assessed a number of potential risks to the environment in the region, and found risk of increased water temperatures, migratory disease vectors, and higher frequency of blue-green algae events to be both high likelihood and high consequence for the local and regional environment.

Changes in distribution and range of pests could have environmental impacts in forestry and agriculture sectors, and (in forests) could contribute to increasingly severe wildfire events. Urban forests and trees could equally be at risk from pests and disease. Warming air and water temperatures could facilitate contribute to increasing range and productivity of invasive species, with consequences to local ecosystems and native species.

Water levels and flooding events can also contribute to shoreline erosion and washout events, with negative outcomes for environment.

Table 7: Risk Heat Map – Environmental Risks

Consequence						
	Very High					
	High			Increase forest fire activity; increase in forest disturbances (from pests or diseases) increase fire risk. Increase in invasive species. Urban tree mortality increases due to drought, heat stress, diseases.	Increase water temperature leads to algae blooms. Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)	
	Med			Decrease water quality / increase water temperature. Increases pests in urban forests (fewer cold nights). Impacts to forest growth and survival - increase resource and costs for forest renewable projects.	Increase shoreline flooding and hazards (affects zoning, environmental impacts). Increase shoreline erosion. Flood risks on forest roads and water crossings.	
	Low				Infrastructure damage. Freeze-thaw cycles increase frequency of watermain failures; service disruption. Increase demand for cooling centres.	
	Very Low				Loss of heat and utility services. Increased insurance costs.	
Overall Risks		Very Low (rare)	Low	Moderate	High	High (Frequent)
		Likelihood				

Risks Assesment by Scenario

Following the completion of the individual scoring tables, workshop participants were tasked with collaboratively placing risks for distinct scenarios on a likelilhood-consequence matrix. Small groups (5-6 participants) complete this exercise to jointly explore the relative priority of the risks identified.

Heat events

For a heat event, the team identified the need for cooling centres as being highest likelihood risk, and increase in forest fire activity as being highest potential for severe consequence. Impacts to health, and to the demand for health services, were high priority (both likely and high consequence).

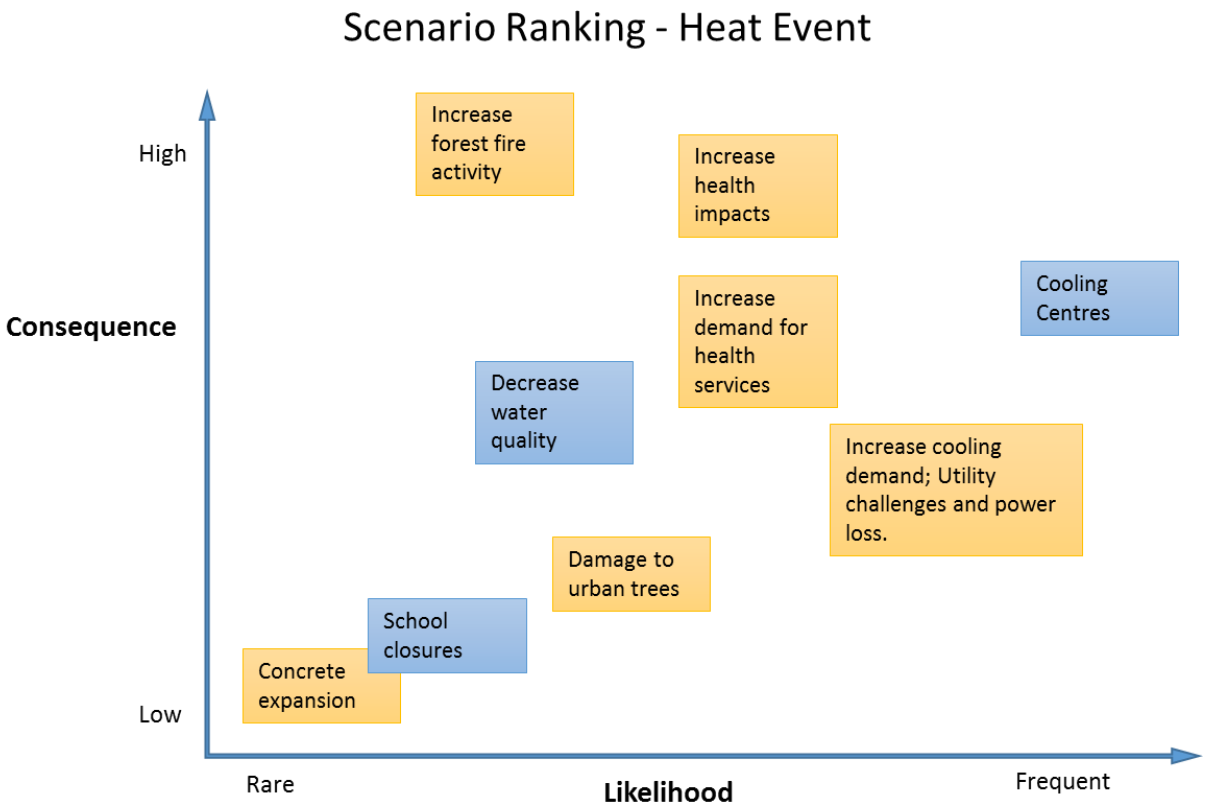


Figure 10: Scenario risk ranking - heat event.

Precipitation events

In exploring the risks associated with precipitation events, the groups determined that all risks were high likelihood of occuring frequently (e.g. annually, multiple events per decades). Shoreline erosion, infrastructure damage were of highest consequence. Also noted was the need to increase planning and capacity for emergency response, including provision of services to vulnerable populations in the

community. The need for increased outreach and communications from multiple departments may be required.

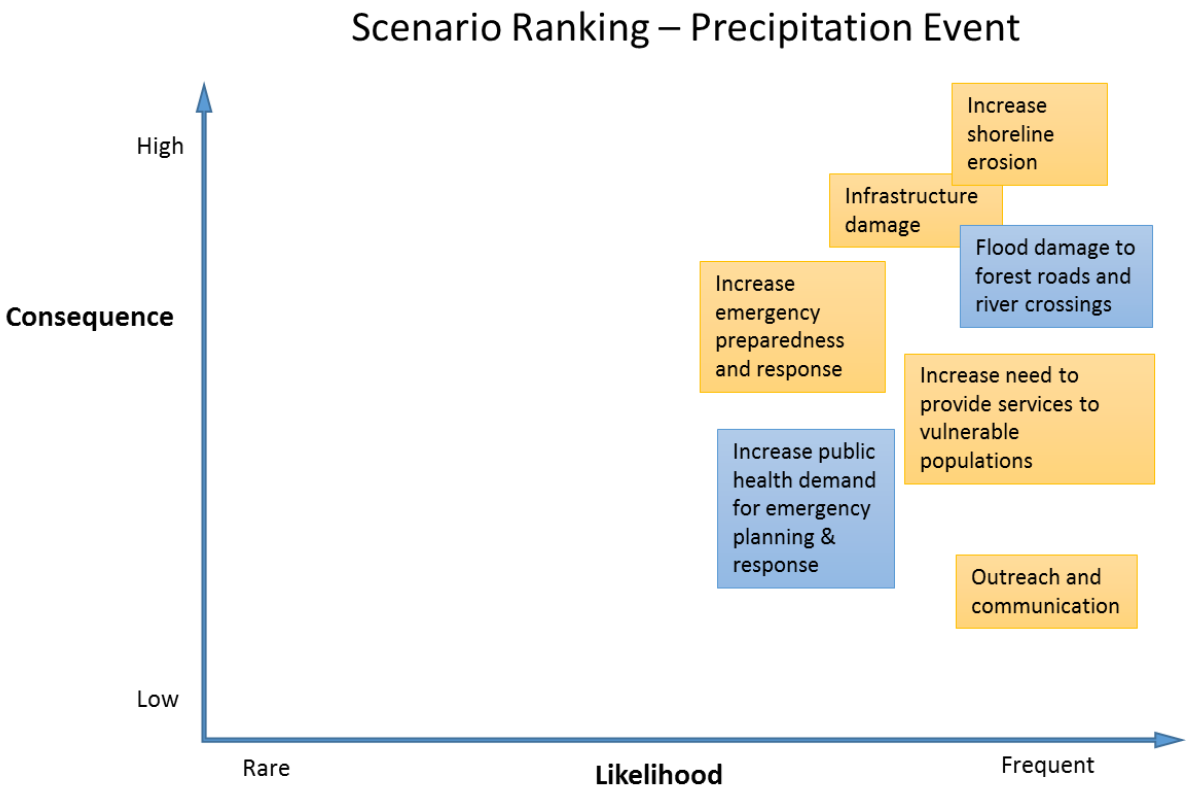


Figure 11: Scenario ranking of precipitation events

Increasing average temperature (Summer)

The observed and projected increase in average summer air and water temperatures in the region are expected to present a diverse set of risks to the community and corporation. An increased demand for electricity (and cooling) could drive increases in electricity demand and utility costs, posing challenges to both city budgets as well as residents and businesses already struggling with paying bills. Diverse health risks, from increase in prevalence of vector borne diseases, air quality impacts (including pollen and allergens, or wildifre smoke), and foodborne illnesses will have a high consequence for residents and staff. Recreational opportunities and lifestyles may shift due to closures (e.g. beach closures due to water quality issues) or limitations on access.

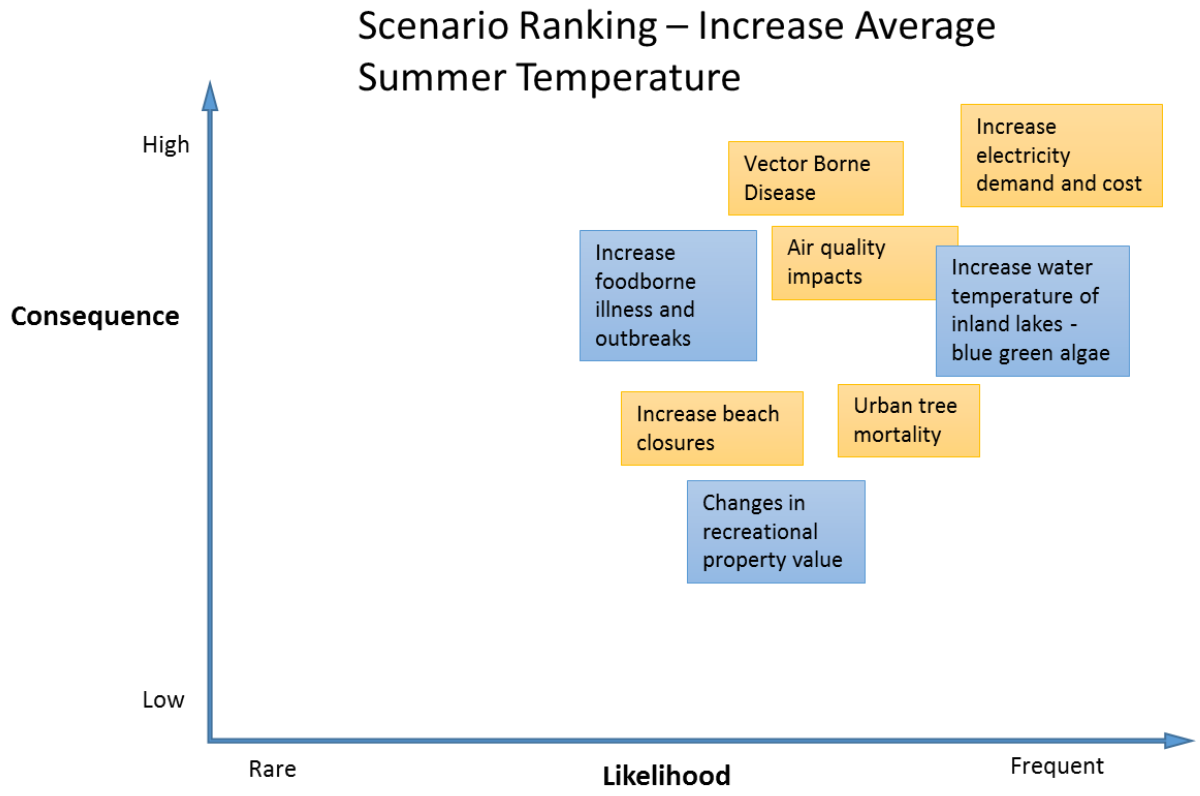


Figure 12: Scenario ranking of average summer temperature increase

Winter precipitation events

Average annual precipitaiton is projected to increase in the SSM region, with annual increases driven by seasonal increases in fall, winter and spring (and partly offset by decreased precipitaiton in summer). Winter storm events pose high priority risks in the areas of disruptions to emergency response services, and increased demand for public health services to support displacements, accidents and injuries. Disruptions to heat and utility services are expected to occur regularly and have tangible impacts on operations and residents. Heavy snow events may cause infrastructure damage, lead to drainage issues, or lead to ecosystem impacts.

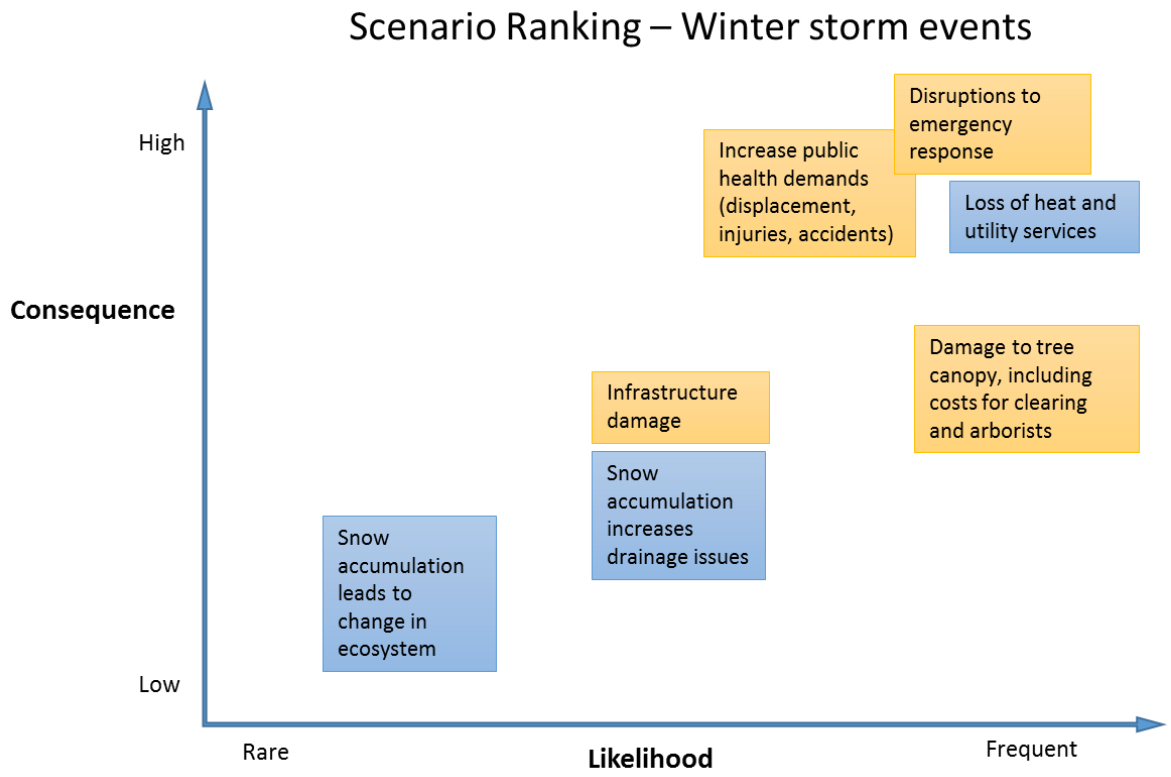


Figure 13: Scenario ranking of winter storm events

Wildfire

Wildfire risks across northern Ontario are increasing – longer fire seasons, warmer temperatures, increased evaporation are anticipated to contribute to more severe fires and more area burned in the province. For SSM region, this will present risks to human health (including City staff) due to air quality concerns. Regional fire events may also lead to regional displacements that require temporary centres for evacuation and shelter, and an increased demand for emergency services. Loss of life due to fire is considered a low probability by high consequence event. By comparison, loss and damage to physical assets, inability to access recreational spaces, are lower consequence but are expected to occur with greater frequency. Increased insurance costs may lead to financial impacts for residents or city assets.

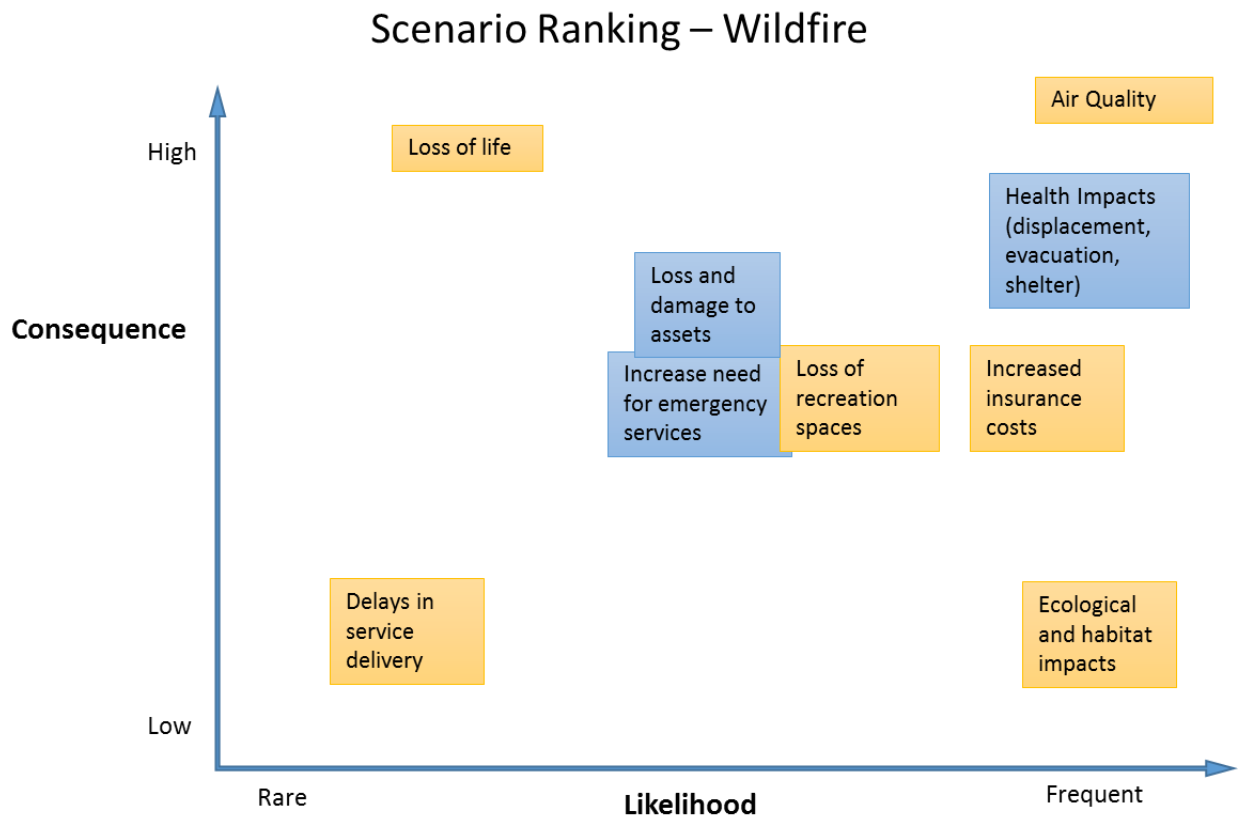


Figure 14: Scenario ranking of wildfire

Risk Assessment by Department or Agency

Each department has specific services, policies, staff, assets and operations that could be at risk in a changing climate. To understand the level of risk associated with specific departments, workshop participants were asked to rank likelihood and consequence from the perspective of their own department (i.e. the Algoma Public Health Unit). The top risks from each department are noted in the table below.

The Risk Score is the product of the likelihood of the risk and the consequence (a very high likelihood, very high consequence risks would score 25).[12]

Table 8: Departmental Risk Scores

Department	Risk	Risk Score
Public Health	> Increase health impacts (including excess mortality, heat stroke, hospitalization)	20
	> Increase variety and demand for summer activities (e.g. bike paths)	17.5
	> Increased demand for health care services during heat events	16
	> Increase public health impacts including displacement, injuries and accidents during extreme weather	16
	> Decrease water quality / increase water temperature	12
	> Increased Public health resources required for emergency preparedness and response (e.g. public health inspectors, inspecting premises post-flood)	12
	> Impacts to social determinants of health (e.g. food security)	10.5
Legal (Risk Management)	> Freeze-thaw cycles deteriorate roads; increase liability.	25
	> Freeze-thaw cycles increase frequency of watermain failures; service disruption	25
	> Damage to housing; increased insurance costs	25
	> Increase in food borne outbreaks and illnesses	20
	> Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)	16
	> Increase in forest disturbances (from pests or diseases) increase fire risk	25
	> Air quality impacts from pollen (asthma, allergy increases)	15
		25

[12] A comprehensive review of departmental risk scores can be found in the risk database.

Engineering	> Difficulty maintaining outdoor rinks - Outdoor rink and recreation impacts - rink closures or requirement to invest in compressors	16
	> Freeze-thaw cycles increase frequency of watermain failures; service disruption	15
	> Freeze-thaw cycles deteriorate roads; increase liability.	15
	> Infrastructure damage (extreme weather)	15
	> Snow accumulations increases drainage issues	15
	> Concrete expansion (during heat events)	15
	> Increase shoreline erosion	12
Community Development & Enterprise Services	> Increase water temperature (inland lakes) leads to algae blooms	20
	> Increase in food borne outbreaks and illnesses	20
	> Increase electricity demand and cost	16
	> Increase cooling demand, infrastructure stress leads to grid issues, power loss.	16
Emergency Management and Fire Services	> Increase cooling demand, infrastructure stress leads to grid issues, power loss.	25
	> Increase forest fire activity	25
	> Loss of heat and utility services	25
	> Increase demand for cooling centres	25
	> Increase health impacts (including excess mortality, heat stroke, hospitalization)	25
	> Air quality impacts from pollen (asthma, allergy increases)	10
Conservation Authority	> Increase demand for programs and services (e.g. public works, conservation authorities)	20
	> Increase demand for outreach and communication (e.g. to ensure people are aware of need to check insurance)	15

Discussion and Next Steps

The City conducted two workshops to identify and assess risks associated with changes in climate. Participants from a variety of City departments, as well as external agencies including the health authority, conservation authority, and emergency response. The diverse set of participants were able to generate in the first workshop, through scenario exercises, an extensive list of discrete climate-related risks (see Appendices for full list of risks). During the second worshop, participants were asked to rank and prioritize thoses risks by assigning scores to the likelihood and consequence of each risk. This semi-quantitative method relies on expert judgement of the individuals participating, but also provides a standardize methodology to help draw attention to the risks that warrant further investigation or action.

Discussion of risks

For the Sault Ste Marie, a variety of different risks emerged as a high priority. Many of these were associated with potential for infrastructure damage (e.g. road washouts, loss of utility services) and the potential for this to cause indirect impacts on service delivery, emergency response, or residents in the community.

Another area of particular concern was the intersection between climate change and public health. Noted among the risks were the possible impacts to air quality (pollen, allergens, smoke), water quality, prevalence of food-borne outbreaks or illnesses, and changes in vector-borne diseases. These risks are viewed as potential drivers of expanded need for responses that address public health, including increasing number of facilities with air filtration systems, increasing access to cooling centres, monitoring and treating vector borne diseases, and increasing communications and outreach.

Participants also noted the potential to capture benefits associated with global warming. Longer shipping seasons, potential increase in recreational property values, longer summer tourism and recreational opportunities – these may result in economic or social benefit if measures and steps are put in place to adapt. Longer summer and fall seasons can encourage healthy recreation habits in forests, for example. However this needs to be considered against potential increase in human health risks such as increases in vector borne diseases. Likewise, longer frost-free seasons may allow new agricultural products to be produced in the region, but managing for pests, extreme weather, drought and other downside risks are required to realize that benefit. Appropriate adaptation and risk management planning can support maximizing positive and minimizing negative outcomes.

Next steps

The City of Sault Ste Marie will review and circulate the findings of the risk assessment exercises. The risks identifed and assessed in this process should be reviewed and further vetted with participants and additional stakeholders, to ensure that there is agrement on the overall findings of the assessment.

The process of risk assessment is an initial stage in developing a climate change risk management or adaptation plan. Ultimately, climate change adaptation seeks to be an iterative process, where risks are constantly reevaluated, and the identification, implementation, and effectiveness of solutions is reviewed.

There are opportunities for the City to integrate the findings of these workshops in ongoing initiatives, including:

- Climate change mitigation planning
- Public health climate change and health vulnerability assessments.
- Emergency management risk asessmsent
- Development of Official Plan
- Development of Corporate Strategic Plans.

Identifying a lead resource or department to carry the work forward, with management support, will be a key step in advancing past the risk assessment stage into adaptation planning.

Appendix: Risk Database

A summary of the risk database is provided here for reference. This summarizes the individual results provided by the workshop participants. The category risk scores reflect the average of individual responses for likelihood multiplied by the average of individual responses for consequence for each of risks to health and safety, environment and economy. Since likelihood and consequence are ranked on a scale of 1 through 5, the maximum risk score would be 5 x 5 = 25.

The final column – combined risk score – is derived by multiplying the average likelihood by the sum of the average risk scores. The maximum potential score is then 5 x (5+5+5) = 75. This column represents the risk across all categories.

		Likelihood (1-5)	**Consequence (1-5)**			**Category Risk (likelihood x consequence)**			**Combined Risk** Score across all three categories (sum consequence scores) x likelihood
Climate Driver	**Identified Risk**		**H&S**	**Env**	**Econ**	**H&S**	**Env**	**Econ**	
INCREASE AVERAGE SUMMER TEMPERATURE	Increase water temperature (inland lakes) leads to algae blooms	4.1	3.8	4.1	3.0	15.6	16.9	12.4	45.0
INCREASE AVERAGE SUMMER TEMPERATURE	Increase electricity demand and cost	4.1	3.8	2.7	3.9	15.7	11.2	16.3	43.1
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase cooling demand, infrastructure stress leads to grid issues, power loss.	3.9	4.0	2.7	4.0	15.7	10.5	15.7	42.0
WILDFIRE / FOREST FIRE EVENT	Air quality impacts	4.0	4.3	3.3	2.8	17.3	13.1	11.2	41.6

INCREASE INTENSITY / DURATION HEAT EVENTS	Increase forest fire activity	3.7	3.5	4.2	3.5	13.0	15.4	13.0	41.3
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)	3.8	3.8	3.7	2.9	14.6	14.1	11.2	39.9
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles increase frequency of watermain failures; service disruption	4.2	3.6	2.4	3.4	15.1	10.2	14.4	39.7
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles lead to watermain failures	4.1	3.7	2.5	3.5	15.2	10.0	14.1	39.3
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase shoreline flooding and hazards (affects zoning, environmental impacts)	4.0	3.2	3.5	3.1	12.9	14.0	12.3	39.1
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Loss of heat and utility services	4.1	4.2	1.8	3.5	17.4	7.4	14.3	39.1
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles deteriorate roads; increase liability	4.3	3.0	2.3	3.6	13.0	9.8	15.6	38.4
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase shoreline erosion	4.0	3.1	3.5	2.9	12.3	14.0	11.4	37.7
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in food borne outbreaks and illnesses	3.9	3.9	2.7	3.1	15.2	10.5	11.8	37.5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase infrastructure damage (washouts increase, shoulders, culverts)	4.1	3.1	2.6	3.3	12.7	10.7	13.8	37.2

INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Infrastructure damage	4.1	3.1	2.3	3.8	12.5	9.2	15.5	37.1
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in invasive species	3.6	3.0	4.0	3.3	10.7	14.3	11.7	36.6
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in forest disturbances (from pests or diseases) increase fire risk	3.4	3.3	3.8	3.5	11.3	12.9	12.0	36.3
INCREASE INTENSITY / DURATION HEAT EVENTS	Crop losses	3.5	3.3	3.3	3.7	11.6	11.3	12.9	35.8
INCREASE AVERAGE SUMMER TEMPERATURE	Longer shipping season	3.9	2.3	3.1	3.8	8.7	12.0	14.9	35.6
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in food recalls	3.7	4.0	2.2	3.4	14.5	8.1	12.5	35.1
INCREASE AVERAGE SUMMER TEMPERATURE	Air quality impacts from pollen (asthma, allergy increases)	3.8	3.9	2.9	2.5	14.6	11.0	9.3	34.9
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulations increases drainage issues	3.9	3.1	3.1	2.7	12.1	12.1	10.8	34.9
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Flood risks on forest roads and water crossings	4.1	2.8	2.9	2.6	11.3	11.9	10.5	33.7
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulations increases freeze thaw issues	3.9	2.7	2.8	3.1	10.5	11.0	12.1	33.6

INCREASE AVERAGE SUMMER TEMPERATURE	Urban tree mortality increases due to drought, heat stress, diseases.	3.5	3.0	3.9	2.7	10.4	13.6	9.5	33.5
INCREASE INTENSITY / DURATION HEAT EVENTS	Increased demand for health care services	3.6	4.4	1.7	3.1	15.8	6.2	11.0	33.1
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Damage to housing; increased insurance costs	3.7	3.8	1.7	3.3	14.2	6.5	12.4	33.1
INCREASE INTENSITY / DURATION HEAT EVENTS	Decrease water quality / increase water temperature	3.4	3.3	3.7	2.7	11.1	12.7	9.1	32.9
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Damage to tree canopy; increase costs for clearing, arborists	3.9	2.8	3.2	2.3	11.0	12.6	9.2	32.8
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in beach closures	3.7	3.4	2.8	2.4	12.8	10.6	9.1	32.5
WILDFIRE / FOREST FIRE EVENT	Increased insurance costs	3.9	3.6	1.5	3.3	13.9	5.7	12.6	32.2
INCREASE AVERAGE WINTER TEMPERATURE	Changes to recreation patterns (including winter sports)	3.7	3.0	2.5	3.2	11.0	9.3	11.7	32.0
INCREASE AVERAGE SUMMER TEMPERATURE	Increase variety, productivity of local agriculture	3.6	2.9	2.9	3.1	10.4	10.5	11.0	31.9
INCREASE AVERAGE WINTER TEMPERATURE	Difficulty maintaining outdoor rinks - Outdoor rink and recreation impacts - rink closures or	4.0	3.1	2.1	2.8	12.3	8.3	11.2	31.7

	requirement to invest in compressors								
INCREASE AVERAGE SUMMER TEMPERATURE	Increase water temperature (Lake Superior)	3.5	2.4	3.8	2.8	8.5	13.3	9.9	31.7
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase health impacts (including excess mortality, heat stroke, hospitalization)	3.5	4.3	1.7	2.9	15.1	6.1	10.1	31.3
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase demand for cooling centres	3.7	3.8	1.9	2.6	14.1	7.2	9.8	31.0
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Service disruptions - transportation networks	3.7	3.5	1.3	3.3	13.2	5.0	12.4	30.6
WILDFIRE / FOREST FIRE EVENT	Ecological and habitat impacts	3.7	2.1	4.0	2.3	7.6	14.7	8.3	30.6
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Increase public health impacts including displacement, injuries and accidents	3.5	4.0	1.7	2.9	14.1	6.1	10.1	30.4
INCREASE AVERAGE SUMMER TEMPERATURE	Increase forest disturbance (from pests or diseases) decrease wood supply	3.2	2.5	3.4	3.4	8.1	10.9	10.9	29.9
INCREASE AVERAGE WINTER TEMPERATURE	Increases pests in urban forests. (fewer cold nights)	3.3	2.7	3.8	2.5	8.9	12.4	8.3	29.6
WILDFIRE / FOREST FIRE EVENT	Health impacts (displacement, evacuation, injury)	3.3	4.0	2.1	2.7	13.2	6.8	9.0	29.0

INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Service disruptions - emergency response	3.5	3.9	1.4	2.9	13.7	4.9	10.3	29.0
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase demand for programs and services (e.g. public works, conservation authorities)	3.7	2.9	2.1	2.8	10.6	8.0	10.3	28.9
WILDFIRE / FOREST FIRE EVENT	Increase need for emergency services (evacuations, shelter)	3.3	3.9	1.9	2.9	12.9	6.2	9.8	28.9
INCREASE AVERAGE SUMMER TEMPERATURE	Impacts to forest growth and survival - increase resource and costs for forest renewable projects.	3.1	2.5	3.7	3.1	7.7	11.5	9.6	28.8
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increased Public health resources required for emergency preparedness and response (e.g. public health inspectors, inspecting premises post-flood)	3.6	3.1	1.8	2.9	11.4	6.5	10.4	28.4
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Injuries/deaths from extreme events (floods, ice storms)	3.1	4.1	2.0	3.1	12.5	6.1	9.4	28.1
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulation leads to changes in ecosystem	3.5	2.3	3.6	2.0	7.9	12.5	6.9	27.3
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase need to provide services and support to vulnerable populations.	3.5	3.7	1.6	2.5	13.0	5.5	8.8	27.3
INCREASE AVERAGE SUMMER TEMPERATURE	Impacts to social determinants of health (e.g. food security)	3.1	3.6	2.3	2.8	11.2	7.2	8.7	27.1

INCREASE INTENSITY / DURATION HEAT EVENTS	Damage to urban trees	3.2	2.3	3.6	2.5	7.5	11.5	7.9	26.9
WILDFIRE / FOREST FIRE EVENT	Loss and damage to assets	3.3	2.9	1.9	3.2	9.6	6.4	10.7	26.7
WILDFIRE / FOREST FIRE EVENT	Increase demand for facilities with air filtration	3.1	3.3	2.4	2.7	10.2	7.5	8.4	26.1
WILDFIRE / FOREST FIRE EVENT	Decrease tourism and event cancellations	3.3	2.6	1.4	3.6	8.7	4.7	12.0	25.3
INCREASE INTENSITY / DURATION HEAT EVENTS	Decrease workforce productivity	3.1	3.1	1.5	3.3	9.6	4.7	10.2	24.5
INCREASE AVERAGE SUMMER TEMPERATURE	Decrease in ice-breaking exercises	3.8	1.4	1.9	3.1	5.3	7.2	11.6	24.2
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase demand for outreach and communication (e.g. to ensure people are aware of need to check insurance)	3.6	3.0	1.4	2.4	10.8	4.9	8.5	24.2
INCREASE AVERAGE SUMMER TEMPERATURE	Increase variety and demand for summer activities (e.g. bike paths)	3.0	2.8	2.6	2.6	8.3	7.8	7.7	23.8
WILDFIRE / FOREST FIRE EVENT	Loss of recreation spaces	3.1	2.6	2.3	2.8	8.0	7.2	8.6	23.7
WILDFIRE / FOREST FIRE EVENT	Increase need for preventive maintenance (e.g. forest clearing; fire-smart programming)	3.2	2.1	2.7	2.5	6.8	8.7	7.9	23.5

INCREASE AVERAGE SUMMER TEMPERATURE	Increase in urban tree canopy	2.8	2.4	3.3	2.5	6.7	9.2	6.9	22.8
INCREASE INTENSITY / DURATION HEAT EVENTS	Delays in basic service delivery	2.9	3.2	1.5	2.9	9.4	4.3	8.6	22.3
INCREASE INTENSITY / DURATION HEAT EVENTS	Concrete expansion	3.1	2.5	2.0	2.8	7.6	6.2	8.5	22.2
WILDFIRE / FOREST FIRE EVENT	Loss of life	2.4	3.7	2.3	2.9	9.0	5.4	7.0	21.4
WILDFIRE / FOREST FIRE EVENT	Delays in basic service delivery	2.9	2.7	1.5	2.7	7.8	4.3	8.0	20.1
INCREASE AVERAGE WINTER TEMPERATURE	Decrease cold-related mortality,	2.9	3.7	1.3	1.7	10.8	3.9	5.1	19.8
INCREASE AVERAGE SUMMER TEMPERATURE	Changes in recreational property value	2.7	2.6	2.2	2.5	6.9	5.9	6.6	19.4
INCREASE INTENSITY / DURATION HEAT EVENTS	School closures (lack of air conditioning)	2.6	3.3	1.7	2.4	8.7	4.3	6.2	19.2

Appendix: Risks by Department

Each department has specific services, policies, staff, assets and operations that could be at risk in a changing climate. To understand the level of risk associated with specific departments, workshop participants were asked to rank likelihood and consequence from the perspective of their own department (i.e. the Algoma Public Health Unit). Each column below represents the risk assessment from an individual department; in some cases (e.g. engineering, public health) there are responses from multiple representatives from that department. The Risk Score is the product of the likelihood of the risk and the consequence (a very high likelihood, very high consequence risks would score 25).

Table 9: Departmental risk scores

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE AVERAGE SUMMER TEMPERATURE	Increase water temperature (inland lakes) leads to algae blooms	3	3	8	4	4	4.5	25	9	4	25	12	20	10	4
INCREASE AVERAGE SUMMER TEMPERATURE	Increase electricity demand and cost	4	3	12	8	15	0	0	8	3	12	16	16	15	5
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase cooling demand, infrastructure stress leads to grid issues, power loss.	5	3	6	8	8	3	8	5	6	15	6	16	15	25

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
WILDFIRE / FOREST FIRE EVENT	Air quality impacts	4	3	6	4	2	5	20	20	3	25	9	16	20	10
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase forest fire activity	5	3	12	3	3	3	10	20	2	16	9	8	15	25
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)	16	3	6	3	6	10.5	22.5	9	4	25	25	15	15	5
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles increase frequency of watermain failures; service disruption	25	15	12	25	12	0	12	5	3	25	8	12	15	15
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles lead to watermain failures	25	15	12	25	12	3	9	5	4	25	8	9	15	15
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase shoreline flooding and hazards (affects zoning, environmental impacts)	6	6	15	20	15	3	0	20	25	25	8	8	10	5
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Loss of heat and utility services	10	6	9	5	4	4	10	15	4	12	10	12	15	25

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE AVERAGE WINTER TEMPERATURE	Freeze-thaw cycles deteriorate roads; increase liability.	25	15	12	25	12	5	5	10	3	5	6	12	10	5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase shoreline erosion	4	12	9	20	9	3	0	12	20	12	10	12	10	5
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in food borne outbreaks and illnesses	20	3	3	3	3	0	20	4	3	20	20	20	15	5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase infrastructure damage (washouts increase, shoulders, culverts)	25	12	12	25	16	3	4	15	8	12	8	6	10	5
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Infrastructure damage	25	15	9	12	8	3	4	5	6	4	4	25	10	10
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in invasive species	10	2	6	3	4	3	10.5	25	9	8	4	12	15	3
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in forest disturbances (from pests or diseases) increase fire risk	25	3	12	2	2	2	9	20	15	16	6	12	8	15

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE INTENSITY / DURATION HEAT EVENTS	Crop losses	10	3	9	3	4	3	8	3	3	5	3	3	8	5
INCREASE AVERAGE SUMMER TEMPERATURE	Longer shipping season	5	4	3	4	5	3	8	10	2	0	4	4	10	3
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in food recalls	5	3	3	3	1	6	18	4	3	15	15	3	15	5
INCREASE AVERAGE SUMMER TEMPERATURE	Air quality impacts from pollen (asthma, allergy increases)	15	3	6	3	3	10.5	12	8	4	4	12	12	10	10
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulations increases drainage issues	10	15	6	15	4	3	8	5	6	8	4	4	10	5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Flood risks on forest roads and water crossings	4	3	9	20	4	3	0	20	3	20	10	8	10	5
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulations increases freeze thaw issues	25	15	9	15	3	3	4	5	3	4	4	4	10	5

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE AVERAGE SUMMER TEMPERATURE	Urban tree mortality increases due to drought, heat stress, diseases.	25	6	12	3	12	3	9	8	12	6	2	12	10	6
INCREASE INTENSITY / DURATION HEAT EVENTS	Increased demand for health care services	5	2	6	3	8	16	16	4	3	8	4	8	15	5
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Damage to housing; increased insurance costs	25	3	6	3	6	3	6	10	2	3	8	12	10	5
INCREASE INTENSITY / DURATION HEAT EVENTS	Decrease water quality / increase water temperature	10	12	6	3	4	3	14	8	2	12	8	9	8	10
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Damage to tree canopy; increase costs for clearing, arborists	16	3	3	4	4	3	4	10	6	4	5	12	8	5
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in beach closures	25	4	3	3	2	8	0	4	3	12	6	16	15	5
WILDFIRE / FOREST FIRE EVENT	Increased insurance costs	3	3	9	4	4	3	3	12	4	5	10	8	15	5

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE AVERAGE WINTER TEMPERATURE	Changes to recreation patterns (including winter sports)	15	3	9	5	4	4	6	4	1	3	10	15	15	4
INCREASE AVERAGE SUMMER TEMPERATURE	Increase variety, productivity of local agriculture	5	3	9	4	12	3	3	12	0	16	9	6	8	4
INCREASE AVERAGE WINTER TEMPERATURE	Difficulty maintaining outdoor rinks - Outdoor rink and recreation impacts - rink closures or requirement to invest in compressors	25	16	9	4	5	3	4	4	2	3	3	25	10	5
INCREASE AVERAGE SUMMER TEMPERATURE	Increase water temperature (Lake Superior)	6	2	3	4	12	3	12	15	8	12	12	8	5	4
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase health impacts (including excess mortality, heat stroke, hospitalization)	10	2	6	3	9	4	20	4	2	16	4	6	15	25
INCREASE INTENSITY / DURATION HEAT EVENTS	Increase demand for cooling centres	10	2	6	4	9	4	0	3	3	20	6	16	15	25
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Service disruptions - transportation networks	12	15	6	5	8	3	8	15	9	4	6	6	15	10

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
WILDFIRE / FOREST FIRE EVENT	Ecological and habitat impacts	4	3	9	2	3	4	6	20	6	8	3	12	10	5
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Increase public health impacts including displacement, injuries and accidents	4	9	6	4	12	16	16	15	1	3	6	6	15	25
INCREASE AVERAGE SUMMER TEMPERATURE	Increase forest disturbance (from pests or diseases) decrease wood supply	5	3	9	2	1	2	6	20	3	4	4	9	8	3
INCREASE AVERAGE WINTER TEMPERATURE	Increases pests in urban forests. (fewer cold nights)	12	2	9	3	12	3	6	12	1	9	8	12	10	4
WILDFIRE / FOREST FIRE EVENT	Health impacts (displacement, evacuation, injury)	1	1	6	3	2	12	10.5	20	3	20	6	6	20	25
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Service disruptions - emergency response	4	3	6	3	3	0	8	4	3	3	6	12	15	20
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase demand for programs and services (e.g. public works, conservation authorities)	1	9	9	16	3	3	0	16	20	20	4	8	15	20

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
WILDFIRE / FOREST FIRE EVENT	Increase need for emergency services (evacuations, shelter)	1	2	6	3	2	4.5	14	12	3	20	9	12	20	20
INCREASE AVERAGE SUMMER TEMPERATURE	Impacts to forest growth and survival - increase resource and costs for forest renewable projects.	5	3	3	2	2	2	6	20	1	9	4	12	8	4
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increased Public health resources required for emergency preparedness and response (e.g. public health inspectors, inspecting premises post-flood)	6	3	9	3	3	12	0	5	12	25	12	6	16	5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Injuries/deaths from extreme events (floods, ice storms)	15	6	6	2	2	3	0	15	6	3	6	9	15	20
INCREASE FREQUENCY - INTENSITY WINTER STORM EVENTS	Snow accumulation leads to changes in ecosystem	5	3	9	2	2	3	8	12	3	4	4	8	10	5
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase need to provide services and support to vulnerable populations.	2	2	9	3	3	4	0	5	3	20	9	6	15	25
INCREASE AVERAGE SUMMER TEMPERATURE	Impacts to social determinants of health (e.g. food security)	5	2	6	2	6	10.5	9	8	2	16	9	9	15	4

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE INTENSITY / DURATION HEAT EVENTS	Damage to urban trees	20	3	12	2	4	3	4	6	2	2	2	12	10	4
WILDFIRE / FOREST FIRE EVENT	Loss and damage to assets	2	6	9	3	3	4	9	20	6	4	6	0	15	5
WILDFIRE / FOREST FIRE EVENT	Increase demand for facilities with air filtration	3	2	9	3	2	4	3	12	3	16	6	12	8	4
WILDFIRE / FOREST FIRE EVENT	Decrease tourism and event cancellations	4	2	9	3	2	3	6	3	2	4	2	25	10	5
INCREASE INTENSITY / DURATION HEAT EVENTS	Decrease workforce productivity	2	3	9	15	4	3	6	2	1	2	6	9	10	5
INCREASE AVERAGE SUMMER TEMPERATURE	Decrease in ice-breaking exercises	5	3	3	3	4	4	0	4	4	0	3	3	10	4
INCREASE FREQUENCY, DURATION, INTENSITY OF PRECIPITATION EVENTS	Increase demand for outreach and communication (e.g. to ensure people are aware of need to check insurance)	20	2	9	3	4	3	0	3	15	6	12	9	15	25

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
INCREASE AVERAGE SUMMER TEMPERATURE	Increase variety and demand for summer activities (e.g. bike paths)	25	6	15	2	15	17.5	12	3	3	2	4	12	10	3
WILDFIRE / FOREST FIRE EVENT	Loss of recreation spaces	1	2	12	3	1	4	9	12	3	8	6	15	12	5
WILDFIRE / FOREST FIRE EVENT	Increase need for preventive maintenance (e.g. forest clearing; fire-smart programming)	1	2	9	4	1	3	3	16	3	3	3	6	10	15
INCREASE AVERAGE SUMMER TEMPERATURE	Increase in urban tree canopy	15	6	15	2	6	2	4	8	3	3	2	8	8	3
INCREASE INTENSITY / DURATION HEAT EVENTS	Delays in basic service delivery	4	3	9	3	3	3	12	2	1	9	6	12	12	3
INCREASE INTENSITY / DURATION HEAT EVENTS	Concrete expansion	15	15	6	10	3	3	0	2	4	0	4	6	10	5
WILDFIRE / FOREST FIRE EVENT	Loss of life	1	1	6	2	2	3	4	8	2	3	4	3	16	15

Climate Driver	Identified Risk	Risk Manager (legal)	Engineering	Planning	Engineering	Planning	Public Health	Public Health	MNRF	Conservation Auth.	Public Health	Public Health	Community Development & Enterprise Services	Public Health	Emergency Mgmt & Fire Services
WILDFIRE / FOREST FIRE EVENT	Delays in basic service delivery	1	2	9	3	2	3	9	6	4	12	4	9	15	12
INCREASE AVERAGE WINTER TEMPERATURE	Decrease cold-related mortality,	2	2	3	2	12	4	4	4	1	15	6	2	10	5
INCREASE AVERAGE SUMMER TEMPERATURE	Changes in recreational property value	1	3	3	3	12	4	4	6	4	4	6	16	8	2
INCREASE INTENSITY / DURATION HEAT EVENTS	School closures (lack of air conditioning)	2	3	6	3	2	3	3	3	1	3	4	15	4	0

Appendix: Participants

Name	Department
Adam Shier	Risk Management / Legal
Carl Rumel	Engineering
Peter Tonazzo	Planning
Maggie McAuley	Engineering
Steve Turco	Planning
Tracey McClelland	Public Health
Kristi Harper	Public Health
Wylie	Ontario MNRF
Stephon Mayor	Ontario MNRF
Christine Ropeter	Conservation Authority
Nicole Lindahl	Public Health – Environmental Health and Emergency Management
Jennifer Flood	Public Health
Emily Cormier	Community Development and Enterprise Services
Jennifer Loo	Public Health
Lauren Perry	Fire Services – Emergency Management

Appendix: Scoring Guidance

Describing Consequences of Climate Risks

Thank you for taking the time to review the climate change risks identified in the workshop. To make the most of the work completed already, it's important for the City to gauge the consequence and likelihood of various risks from the perspective of your department. Your experience and expertise are essential.

The consequences of climate change could have impacts in different categories, and it's instructive to distinguish these. For each climate change risk identified, please rank the potential consequence to:

- **People.** Including department staff, contractors, or residents accessing or benefitting from assets or programs managed by your department). Includes access to services, as well as health and safety.
- **Economy and Finances**. Includes department and City operating budgets, repair costs, as well as financial impact to local residents or businesses.
- **Environment**. Includes risks to air quality, water, land (soil, shorelines, trees), and wildlife.
- **Department.** Includes plans, assets, operations and finances of individual departments or units. Reflect on the risk to your department.

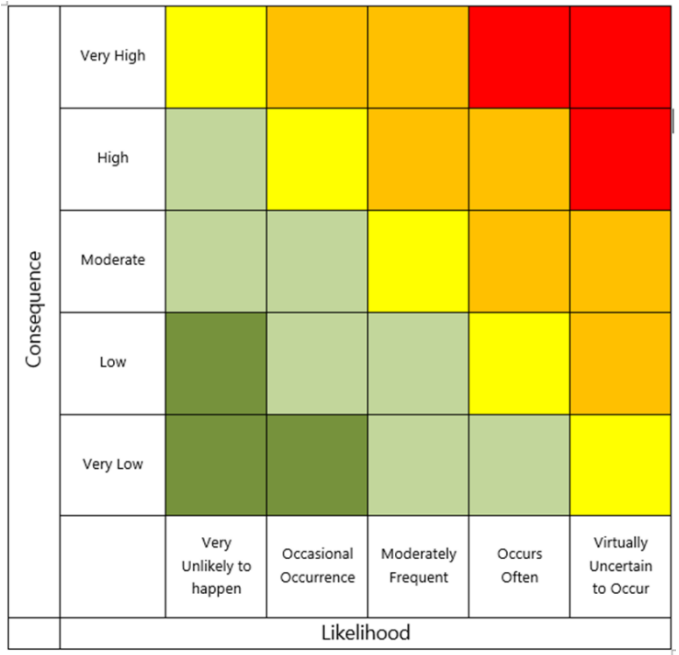


Figure 15: Risk Heat Map

Responses and scores from each department will be then be gathered, which will lead to the creation of overall risk heat maps (see sample figure) for the City. Risk maps help illustrate highest priority risks, and can inform the developing of climate change adaptation plans.

Table 10: Ranking Likelihood

	Likelihood Range (Planning period: 10-30 years)				
	1 - Very Low (rare)	**2 – Low (unlikely)**	**3 – Moderate (possible)**	**4 – High (likely)**	**5 - Very High (almost certain)**
Event/ Risk Scenario	Not likely to occur in planning period	May occur once in the time period; less than 50% chance of occurrence.	50/50 change this occurs; may occur once in time period.	More likely than not to occur more than once in time period, likelihood increasing.	Likely to occur several times or annually in the time period.

Consequence Category #1: Health and Safety

Understanding the consequences of climate change through eyes of people – including municipal staff, contractors and the residents of the City. Consider the impact to people who are carrying out their duties for the City *and* to residents who use or benefit from assets and services provided by the City. Examples: higher averages temperatures lengthen seasons for outdoor recreational activities (e.g. biking on city recreational paths, swimming at beaches).

Category	People			
Consequence Score	Health and Safety (H&S)	Livelihoods, Jobs	Displacement	General guidance
Very Low (Score 1)	No noticeable impacts to staff, contractors or residents	No impact on livelihoods	Residents not displaced	Lowest frequency, no people impacted.
Low (Score 2)	Recognition of H&S consequences but not classed as significant	Recognized as a possible but distant risk	Considered as a distant possibility	The consequence is considered and discussed, but no previous experience and seen as a distant or low-level risk
Moderate (Score 3)	Increased health and safety risks for people. Some appreciation for this	Some impacts to City and contractor work, or private sector	Small number of residents	Combination of higher frequency and lower

	due to past experience	businesses, but classed as short term or minor.	displaced for short periods	impact, or lower frequency and higher impact
High (Score 4)	Significant health and safety consequences for smaller number of individuals, or high consequence for larger number of individuals	People affected, larger scale (e.g. industry-wide)	Frequent displacements and possibly for sustained periods	High frequency, larger scale and sustained
Very High (Score 5)	Significant, serious health and safety risks for large number of staff and population, including increased mortality	Significant, sustained disruptions to job duties. Climate-related disruptions to assets or services have prolonged or serious impacts for livelihoods of residents.	Prolonged displacement of residents for extended periods.	High frequency, high number of people impacted, high consequence.

Consequence Category #1: Economic and Financial.

The City has significant assets and operate large annual budgets, and these assets and services in turn can have impact on economic and financial health of residents and local businesses. Rank the consequence to assets or operational budgets and economic consequence to local residents and businesses that use those assets or services. Example: intense rainfall increases washouts leading to infrastructure damage, impacts to operational budgets (project dollars have to be reallocated to emergency repairs), and economic impacts for businesses (employee access to business is disrupted and productivity declines).

Category	Economic and Financial			
Consequence Score	Infrastructure	Operations and Budgets	Financial impact on Residents, Businesses	General
Very Low (Score 1)	No or limited damage to infrastructure	No noticeable impact on operational finances	No or limited consequences for local residents and businesses.	No significant economic impacts.
Low (Score 2)	Small fluctuations to capital budgets	Small variations in annual operating and maintenance costs but still within the average range	Small increases in costs of home operations or maintenance	Some cost implications, indicative from past experience
Moderate (Score 3)	Limited infrastructure damage requires additional repair or replacement expenses	Some impact on departmental budgets and City finances.	Limited impact on financial security, bottom-line of residents and local businesses.	Some economic impact, recovery possible
High (Score 4)	Replacement and/or repair of assets required	High but manageable impact on departmental budgets occurring with increased frequency	Large impact to homes/homeowners, tangible business losses/disruption to business operations/lost revenue. Marginal business find difficulty in recovering	Larger losses, significant and worth reporting, marginal operations have difficulty recovering

Very High (Score 5)	Extensive damage to assets and infrastructure requiring extensive replacement or major repairs. Significant financial cost for department	Significant and ongoing impact to City or Departmental budgets on frequent basis. Financial health compromised	Significant financial impact on local residents or businesses. Financial security or residents or viability of businesses compromised	Significant, sustained financial and economic impact. Financial recovery not always possible

Consequence Category #3: Environment.

Climate change impacts can lead to various consequences for the environment, including water, ecosystems or land, and City operations and assets are related. Rate the consequence to environment associated with climate impacts to assets or services you provide, or City in general. Examples: heavy rainfall events increase runoff and discharge from stormwater systems, leading to decreases in water quality; increasing frequency of freeze-thaw cycles requires greater application of road salt, with impacts on local ecosystems and water bodies; increased temperatures and invasive species have consequences for urban trees.

Category	Environment			
Consequence Score	Water	Ecosystems	Land	General Guidance
Very Low (Score 1)	Negligible impact on water quality or quantity.	Ecosystems still intact, difficult to detect species movement or health	Negligible impact to land forms including parks and protected areas	Negligible environmental consequence.
Low (Score 2)	Few experiences with poor water quality (algae, turbidity, acidity, etc.), known impacts from previous incidences of rising water levels (flood)	Small impacts to segments of ecosystems/biodiversity including range expansion	Some pressure on existing flora and fauna, small declines in species habitat	Signs of impacts are assumed and/or apparent, assumed connection to changing climate
Moderate (Score 3)	Limited impact on water quality or quantity, or low frequency of events that compromise water quality, water quantity issues (e.g. low stream flow) appear and impacts are understood	Short-term impacts on ecosystems and biodiversity, recovery possible. Spatial extent limited. Documented species health issues	Larger losses of species habitat, examples of declining species habitat, appearance and impact of invasive terrestrial species	Events occur infrequently but with high consequence to environment, or ongoing low-level stress harms environment, clear connection to climate change

High (Score 4)	Clear evidence of water quality issues and water shortages, clear evidence of damage caused by extreme precipitation and too much water (flood)	High impact to aquatic, terrestrial and avian species, potential for long lasting impact/health, large and possibly irreversible impacts to certain flora, fauna.	Large scale damage to trees (fire, pests, drought) causing significant die off, clear evidence of invasive species impact, significant erosion or shoreline impacts	Large impacts, strongly linked to climate change and extreme weather, potentially irreversible, larger scale
Very High (Score 5)	Regular, significant or permanent impacts to water quality or quantity.	Significant long-term impacts on ecosystem health, loss of biodiversity across wider area, larger scale impacts to various species including extirpation.	Contamination, access or suitability of spaces impaired, major and potentially large-scale impacts to land forms (e.g. erosion, landslide, fire).	Very high impact over prolonged period, large scale

Consequence Category #1: Departmental Risks

Each department has specific services, policies, staff, assets and operations that could be at risk in a changing climate. From the perspective of your department, consider the consequence to assets or operational budgets and economic consequence to local residents and businesses that use those assets or services. Example: intense rainfall increases washouts leading to infrastructure damage, impacts to operational budgets (project dollars have to be reallocated to emergency repairs), and economic impacts for businesses (employee access to business is disrupted and productivity declines).

Category	Department			
Consequence Score	Strategic / Financial	Operational	Public Perception	General
Very Low (Score 1)	No or limited damage to infrastructure	No noticeable impact on operational finances	No public awareness.	No significant impacts to the department.
Low	Small fluctuations to capital budgets	Small or short term impacts to ability to	Some public response and observation of	Some implications,

(Score 2)		complete work or deliver services.	impact, including short-lived media coverage.	minor changes, costs or adjustments expected.
Moderate (Score 3)	Multiple changes in policy, strategy expected. Costs must be closely managed.	Some impact on department ability to meet objectives.	Moderate impact on public image of City and/or department.	Multiple changes in policy, strategy expected. Costs must be closely managed.
High (Score 4)	Larger losses, significant changes in mandate and strategy required. High but manageable costs associated.	Prolonged impact on operations of the department. Disruptions are high cost and/or prolonged.	Substantial impact on public image and trust.	Larger losses, significant changes in mandate and strategy required.
Very High (Score 5)	Significant changes in mandate and strategy required, large additional costs to address risks and adapt.	Significant and ongoing impact on ability to deliver services and complete work.	Severe impact to public impact and trust. Ongoing coverage through media.	Significant changes in mandate and strategy required, large additional costs to address risks and adapt.

Appendix: Risk Assessment Worksheets

The following tables were generated from the risks identified in workshop #1. These tables were used in workshop #2 for each participant to record their perception of likelihood and consequence of each identified risk.

Scenario: Average Temperature Increase (summer)

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Changes in recreational property value							
Increase water temperature (Lake Superior)							
Increase water temperature (inland lakes) leads to algae blooms							
Increase electricity demand and cost							
Increase in vector borne disease (e.g. forest or agriculture pests, human health risks)							
Increase in food borne outbreaks and illnesses							
Increase in food recalls							
Increase in beach closures							
Longer shipping season							
Increase in invasive species							

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Decrease in ice-breaking exercises							
Increase in urban tree canopy							
Urban tree mortality increases due to drought, heat stress, diseases.							
Air quality impacts from pollen (asthma, allergy increases)							
Impacts to social determinants of health (e.g. food security)							
Increase variety and demand for summer activities (e.g. bike paths)							
Impacts to forest growth and survival - increase resource and costs for forest renewable projects.							
Increase in forest disturbances (from pests or diseases) increase fire risk							
Increase forest disturbance (from pests or diseases) decrease wood supply							
Increase variety, productivity of local agriculture							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.

Scenario: Average temperature increase (winter)

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Freeze-thaw cycles deteriorate roads; increase liability							
Freeze-thaw cycles increase frequency of watermain failures; service disruption							
Decrease cold-related mortality,							
Freeze-thaw cycles lead to watermain failures							
Increases pests in urban forests. (fewer cold nights)							
Changes to recreation patterns (including winter sports)							
Difficulty maintaining outdoor rinks - Outdoor rink and recreation impacts -							

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
rink closures or requirement to invest in compressors							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.

Scenario: Extreme precipitation

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Increase in work absenteeism							
Impacts to work schedules, budgets							
Increase in downed trees, power disruptions							
Injuries/deaths from extreme events (floods, ice storms)							
Increased Public health resources required for emergency preparedness and response (e.g. public health inspectors, inspecting premises post-flood)							
Flood risks on forest roads and water crossings							

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Increase demand for programs and services (e.g. public works, conservation authorities)							
Increase need to provide services and support to vulnerable populations.							
Increase shoreline flooding and hazards (affects zoning, environmental impacts)							
Increase infrastructure damage (washouts increase, shoulders, culverts)							
Increase demand for outreach and communication (e.g. to ensure people are aware of need to check insurance)							
Increase shoreline erosion							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.

Scenario: Heat Events

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Increase demand for cooling centres							
Increase health impacts (including excess mortality, heat stroke, hospitalization)							
Increased demand for health care services							
Increase cooling demand, infrastructure stress leads to grid issues, power loss.							
Damage to urban trees							
Crop losses							
Decrease water quality / increase water temperature							
Concrete expansion							
Increase forest fire activity							
Decrease workforce productivity							
Delays in basic service delivery							
School closures (lack of air conditioning)							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.

Scenario: Wildfire

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Health impacts (displacement, evacuation, injury)							
Increase need for emergency services (evacuations, shelter)							
Air quality impacts							
Increase demand for facilities with air filtration							
Increase need for preventive maintenance (e.g. forest clearing; fire-smart programming)							
Loss and damage to assets							
Loss of recreation spaces							
Ecological and habitat impacts							
Decrease tourism and event cancellations							
Delays in basic service delivery							
Increased insurance costs							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.

Scenario: Winter storm events

Identified Risk	Adaptive Capacity (H-M-L)	Likelihood (1-5)	People (1-5)	Env (1-5)	Econ (1-5)	Dep't (1-5)	Comments (e.g. describe risk, current coping mechanisms, further research, adaptive capacity, adaptation options)
Increase public health impacts including displacement, injuries and accidents							
Loss of heat and utility services							
Damage to housing; increased insurance costs							
Damage to tree canopy; increase costs for clearing, arborists							
Infrastructure damage							
Service disruptions - emergency response							
Service disruptions - transportation networks							
Snow accumulations increases drainage issues							
Snow accumulations increases freeze thaw issues							
Snow accumulation leads to changes in ecosystem							

* Department - Workshop participant score consequence to operations, assets, finances, etc. of their own department.