

# Adapting to Climate Change in Ottawa

Ontario Centre for Climate Impacts and Adaptation  
Resources – OCCIAR

2009

### **Ontario Centre for Climate Impacts and Adaptation Resources**

OCCIAR is a university-based, resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation. The Centre communicates the latest research on climate change impacts and adaptation, liaises with partners across Canada to encourage adaptation to climate change and aids in the development of tools to assist with municipal adaptation. The Centre is also a hub for climate change impacts and adaptation activities, events and resources. <http://www.climateontario.ca>

### **Acknowledgements**

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Allan Douglas  
Coordinator  
OCCIAR  
MIRARCO/Laurentian University  
935 Ramsey Lake Road  
Sudbury, Ontario P3E 2C6  
705-675-1151 ext 1506  
[adouglas@mirarco.org](mailto:adouglas@mirarco.org)

Jacqueline Richard  
Assistant Coordinator  
OCCIAR  
MIRARCO/Laurentian University  
935 Ramsey Lake Road  
Sudbury, Ontario P3E 2C6  
705-675-1151 ext 2014  
[jrichard@mirarco.org](mailto:jrichard@mirarco.org)

Dr. David Pearson  
Professor, Department of Earth Sciences  
Co-Director, Science Communication Graduate Programme  
Co-Chair of Ontario's Expert Panel on Climate Change Adaptation  
Laurentian University  
935 Ramsey Lake Road  
Sudbury, Ontario P3E 2C6  
705 675-1151 x 2336  
[dpearson@laurentian.ca](mailto:dpearson@laurentian.ca)

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# **Adapting to Climate Change in Ottawa Workshop Report**

**January 30, 2009**

Embassy West Hotel and Conference Centre  
North American Ballroom  
1400 Carling Avenue, Ottawa ON

## Analysis

The goals of this workshop were to communicate the importance of adaptation as a response to climate change and to encourage and support the ongoing efforts underway within the City of Ottawa to adapt to climate change.

Attendees of this workshop, mostly members of Ottawa municipal staff, had some existing knowledge of climate change, its impacts and the need for adaptation. Previous engagements with Environment Canada (Adaptation and Impacts Research Division, Heather Auld, 2006) indicate that the City is concerned about the impacts of climate change and how it will affect the different facets of the community.

The City of Ottawa currently has some climate change adaptation initiatives under way. The purchase of ice removal equipment, West Nile virus guidelines, the 'Choosing our Future' planning process and its own climate change adaptation plan indicate that the City is already beginning to build climate change into its planning and decision-making processes. In 2009, the City intends to investigate which major sectors will be impacted by climate change, evaluate adaptive capacity levels, identify areas or sectors that are most vulnerable to climate change and propose what sorts of policies may be developed to mitigate against economic, environmental and health impacts from climate change. These focal areas will comprise the climate change adaptation planning process.

The National Capital Commission is also aware of the impacts of climate change and has taken steps to build resilience into their events and offerings so that climate change risks to tourism in the area are dealt with proactively.

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## Workshop Agenda

8:00 am to 8:30 am	<b>Registration and Continental Breakfast</b>
8:30 am to 8:45 am	Welcome Mr. Rob Mackay, Director, Community Sustainability Services, City of Ottawa
8:45 am to 9:15 am	Introduction and Overview of Climate Change Impacts and Adaptation Dr. David Pearson, Co-chair of Ontario's Expert Panel on Climate Change Adaption
9:15 am to 9:45 am	From Impacts to Adaptation: Canada in a Changing Climate: the Ontario Chapter Ms. Beth Lavender, Department of Foreign Affairs and International Trade
9:45 am to 10:15 am	Cold Capital? Adapting the National Capital Commission's Outdoor Public Program to the Changing Canadian Winter Dr. Mark Kristmanson, National Capital Commission
10:15 and to 10:30 am	Break
10:30 am to 11:00 am	Assessment of Water Resources Risk and Vulnerability to Changing Climatic Conditions Dr. Slobodan Simonovic, University of Western Ontario
11:00 am to 11:30 am	Adaptation by Design: Climate, Municipal Infrastructure and Buildings Ms. Heather Auld, Environment Canada
11:30 am to 12:00 pm	Impacts of Climate Change on Human Health Dr. Peter Berry, Health Canada
12:00 pm to 12:45 pm	Lunch
12:45 pm to 1:20 pm	Introduction to Risk Management Approach to Climate Change Adaptation Mr. Al Douglas, OCCIAR
1:20 pm to 3:00 pm	Break-out sessions: 1 - Canada Salon; 2 – Panorama Room
3:00 pm to 3:15 pm	Break
3:15 pm to 3:45 pm	Break-our group reporting
3:45 pm to 4:15 pm	Process feedback/Questions and Answers
4:15 pm	Workshop wrap-up and closing

## Presentations

The following are brief summaries of the presentations made at the workshop. Presentations are available for viewing on the [www.climateontario.ca](http://www.climateontario.ca) website.

### Welcome

Mr. Rob Mackay, Director, Community Sustainability Services, City of Ottawa

Mr. Mackay began by welcoming the delegates and thanking them for taking time out to participate in the workshop.

He continued by stating that Ottawa is already involved in some climate change initiatives to help reduce greenhouse gas emissions such as anti-idling bylaws, emissions reductions strategies and a green roof demonstration project. Increases in temperature and winter rain, intense storms and flooding have already impacted Ottawa's built and natural systems. Ottawa must begin to plan for future climate change and building resilience now will help reduce weather-related risks into the future. Developing an adaptation strategy to include climate change into the decision-making process will begin to work towards assessing and managing future risk.

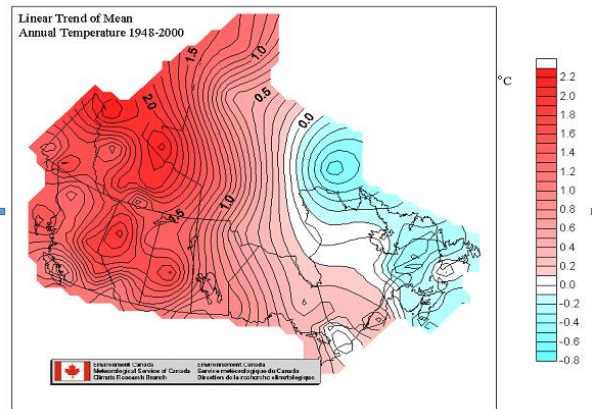
The Environmental Sustainability Branch will begin to assist other city branches in assessing climate change impacts on their tasks and operations and help to evaluate possible adaptations necessary. Infrastructure Services and the Community Sustainability Department are leading the development of a long-term sustainability plan which will assess sustainability and resilience over the next 50 to 100 years; a period when climate change impacts and adaptation measures will be realized.

Mr. Mackay thanked OCCAR and Birgit Isernhagen (City of Ottawa) for making the workshop possible.

## Introduction and Overview of Climate Change Impacts and Adaptation

Dr. David Pearson, Co-chair Ontario's Expert Panel on Climate Change Adaption

Dr. Pearson began the workshop with an introduction and overview of the science of climate change impacts and adaptation. Dr. Pearson began by stating that Canada has already experienced climate change with significant warming in the west and northwest up to 2°C and cooling in the east due to the warming of the Arctic and subsequent flow of cold Arctic water along the eastern shore of Canada. Ontario lies in the boundary of this warming and cooling, which will pose special challenges for the climate models.



It is now known that the Arctic is losing summer ice much more rapidly than originally anticipated. As the ice melts, reflection of energy in summer will be replaced by absorption creating a positive reinforcing feedback, ultimately contributing to the warming of the planet as a whole. Moreover, the Arctic warming is beginning to affect the boreal forest which contains a vast amount of carbon, potentially changing it from a sink for carbon to a source of carbon.

Another major store for CO<sub>2</sub> is the deep, cool ocean. The amount of CO<sub>2</sub> lost at the surface depends on the temperature of the air it encounters at the surface. In addition, because of the slow feedback of the ocean, the release of CO<sub>2</sub> will continue long after we have mitigated greenhouse gases. We are committed to climate change for decades to come, we have to adapt.

In the face of a changing climate, the coping capacity of a community can be surpassed when a climate variable (e.g. temperature) crosses a critical threshold. This is an indication of a community's vulnerability. This knowledge can help a community adapt by developing adaptation strategies to expand its coping range. Risk assessment and management can be used to design adaptation strategies.

The European Union adopted a goal of 2°C as a maximum average global temperature increase. Global CO<sub>2</sub> emissions have surpassed the IPCC's worst case scenario projection in 2005 and 2006. This is a very serious issue. If we do not limit the impact of climate change within the next 15 years, we are looking at very serious problems. We cannot manage the sorts of increases projected by the higher emission scenarios and there are limits to adaptation.

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**From Impacts to Adaptation: Canada in a Changing Climate: the Ontario Chapter**

Ms. Beth Lavender, Department of Foreign Affairs and International Trade

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Beth Lavender, a co-author of the Ontario chapter of From Impacts to Adaptation gave a brief overview of the national assessment with a focus on the Ontario Chapter. Ms Lavender began her presentation by discussing the goal of the National Assessment as one to assess current and future risks and opportunities (human and managed systems), based on published and grey literature across the country. She continued by stating that the Ontario chapter is divided into 3 sub-regions based on ecozone boundaries and roughly similar socio-economic circumstances. The sectors addressed include: ecosystems, forestry, water resource management, human health, agriculture, energy, mining, transportation and tourism and recreation.

Ontario's adaptive capacity within Canada is relatively high as we have access to technology, education and economic resources. However, adaptive capacity varies within the province.

In the **North sub-region**, impacts to water include spring and ice-jam flooding (Attawapiskat and Kashechewan) and decreased river flow with further reductions projected. In the **Central sub-region**, impacts to ecosystems and forests include the northward shift in distribution of species, an increase in productivity and an increase in natural disturbances (fire,

insects, disease and wind). Impacts to water include change in timing of spring runoff, heavy rainfall or rain on snow event and flooding. In the **South sub-region**, impacts to health include a potential doubling of the number of hot days by 2050 and a reduction in cold-related mortality up to 45%. Evaporation is an important impact for the Great Lakes (considered part of the south sub-region) water levels. Lower lake levels will impact the shipping industry, which was built for a specific water level. A 2.5 metre decline in lake level equals a 100 to 270 ton loss of ship capacity.

Adaptive capacity is determined by a variety of factors including economic resources (diversity), access to technology, information and skills, infrastructure, institutions and equity. Urban and rural communities each have unique strengths and weaknesses. Urban centres have greater access to financial resources, diversified economies and higher education, but have higher costs of living, aging infrastructure and more air quality and heat stress issues. Rural centres have strong social capital, strong attachments to communities and high rates of volunteerism, but have limited economic resources, higher reliance on natural resource sectors and lower population with technical training. Communities must prioritize actions (risk management is one tool to help).

Climate change considerations must be integrated into existing decision-making frameworks.

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## Cold Capital – Adapting the National Capital Commission’s Outdoor Public Programs to the Changing Canadian Winter - Dr. Mark Kristmanson, National Capital Commission

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In his presentation, Dr. Kristmanson stated that the National Capital Commission has a mandate to enrich the social and cultural fabric of Canada through activities in the capital. Accordingly, the NCC has taken a great interest in the climate change issue.

Summer programs which see 2,500,000 total visits at 10 primary event sites over 120 programming days include Canada Day celebrations, walking tours, Opera under the Stars and Orchestras in the Park. The NCC winter programs include Christmas Lights across Canada, Winterlude, the Rideau Canal Skateway, ski trails, tobogganing hills and snowmobile trails in Gatineau Park and the Greenbelt. The winter programs see 2,250,000 visits over 150 days of site operation.

Canada Day, in 2004, was a wake-up call on what extreme weather could do to NCC operations. A very severe thunderstorm passed through Ottawa and wind from the storm flipped over portable toilets, blew stage equipment off stages and broke windows. After the storm, the NCC realized that their weather monitoring was not effective and has subsequently taken steps to improve their monitoring efforts. A decline in winter tourism due to the uncertainty of freezing temperatures was seen for Winterlude in 2002. The skateway opened late (February 3), there were 50% fewer skaters, there was attrition of ice and snow carvings and some program elements

were cancelled. By 2050 (estimated), 12 to 20 days are projected to be above 0°C and the skateway season is projected to range between 7 and 36 days.

The NCC is engaged in formal talks to develop an environmental strategy and conservation and adaptation will be part of the strategy. Winterlude has already put in place conservation initiatives such as composting, biodegradable cups, LED lighting and a no-idling policy. Adaptation strategies include enhanced contingency planning (extra snow-making, refrigerated trucks to conserve ice, communications plan), change to 3 weekends rather than 10 consecutive days, creation of Snowbowl as a ‘weatherproof’ venue, installed boardwalks and shelters for ice carving.

More than just delivering programs, the NCC is about being Canadian. Winter is at the core of the Canadian identity. The question around adaptation is how are we going to adapt psychologically to these changes? Future considerations: ‘cold capital’, the cold is becoming a scarce commodity, how will this change our perception of ourselves? Some adaptive measures are not conservational (snow-making). Is there a symbiosis between adaptation and conservation that has to be considered? The NCC is a powerful communication tool and has a big role to play to figure out the message of climate change.

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## Assessment of Water Resources Risk and Vulnerability to Changing Climatic Conditions

Dr. Slobodan Simonovic, University of Western Ontario

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Dr. Simonovic began his presentation by stating that resource managers are interested in knowing how to take impacts from a global level down to a local level to help develop the appropriate adaptation and mitigation strategies. Dr. Simonovic's research uses an inverse approach to the traditional methods. In the inverse approach, the stakeholder (community, conservation authority) is brought in and using a bottom-up approach identify the critical hydrological exposures, transform the exposures into meteorological conditions, simulate the conditions under various scenarios (using a weather generator) and assess the frequency of critical meteorological events causing specific water resources risk.



Using two extreme scenarios (high flow, low flow), produced in the wet scenario for the City of London, flooding will become more severe and occur less in the spring, but more in the summer. In the dry scenario, more extreme low flow conditions are not expected; however, severe periods of low flows are still possible.

Another study utilized weather generator scenarios to develop IDF curves for the City of London to enable them to compare to the historical IDF curves. The results show that the rainfall magnitude and intensity will be different than observed in the past with a change in return period for storms.

The implications from a regulatory point of view include: issuing of permits for floodplain development; use of land for recreation along river; removal of pumping stations near rivers during a flood; patrolling river banks during periods of high water; and monitoring performance of critical infrastructure. From an engineering standpoint, changes in design standards for municipal structures are needed. Budgetary implications include: allocation of budget for safe operation and maintenance of existing flood management infrastructure; planning for future infrastructure; and the valuation of current structural and non-structural reservoirs.

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## **Adaptation by Design: Climate, Municipal Infrastructure and Buildings**

Ms. Heather Auld, Environment Canada

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Ms. Auld gave an overview of impacts of climate change on municipal infrastructure and buildings and provided some examples of adaptation measures. The IPCC states that globally we are seeing increases in heavy and very heavy precipitation. The climate is changing nationally and Ontario is seeing statistically significant warming trends; however, this warming is not the same across the province. Precipitation is also changing nationally with Ontario seeing increases in some locations. Ottawa has seen increases in 12 and 24 hour rainfall events.

Changing extremes are significant for infrastructure. Future climate will create challenges of designing infrastructure; we cannot construct on the assumption that past climate extremes will represent future conditions. We will have to design with uncertainty in mind.

There is scientific agreement that the future will include increased precipitation intensity, extreme precipitation changes, potential for more severe drought, and stronger hurricanes. Before the end of the century the current 50 year return period rainfall event could be expected at least every 25 years.

‘No regrets’ adaptation actions should be developed and implemented now and include: updating and improving climatic design values for existing climate

conditions; regularly monitor climate trends and identify ‘at risk’ regions; improve building codes by incorporating climate change; undertake forensic studies of failures; implement the ‘win-win’ solutions (e.g. energy efficiency). New adaptation actions include: incorporate future climate projections into codes and standards; develop new climate tools and guidance, especially for extremes; and engineering to retrofit vulnerable structures.

The City of Ottawa enacted an adaptation - type bylaw for its Surface Operations Branch in 2005. It noted that the adaptation actions were needed to address the changing climate (less cold winters; warm summers; more intense rainfall events; risks of severe ice storms; more precipitation; increased risk for drought conditions; more weather variability; and average conditions that are no longer average). The City of Ottawa By-Law for Winter Road and Sidewalk Maintenance – Winter Maintenance in a Changing Climate is considering new fleets, new winter road and sidewalk maintenance equipment and material, new practices guided by climate change impacts and adaptation science.

Under a changing climate, the past will not project the future, but knowledge of the past is needed to understand how risk is changing and how to prepare. Climate changes are happening faster than we realize – we need to adapt as soon as possible.

## Impacts of Climate Change on Human Health

Dr. Peter Berry, Health Canada

Dr Berry began his presentation with some key messages: Health risks from climate change are real and growing; many Canadians are vulnerable to health impacts; adaptation is needed to protect Canadians; we can learn from others; and Health Canada is supporting adaptation.

Climate change health risks are real and are growing. The National Climate Change and Health Vulnerability Assessment is a full technical report examining health issues related to how air pollution is expected to increase across Canada, impacts of climate change on water and insect and rodent borne diseases, and Canadians' vulnerability to natural hazards. The report also examines the adaptive capacity of Canadians and identifies adaptation options.

It is projected that the vector for Lyme disease will expand northward as documentation of new populations in the southern parts of Canada and northward migration already exist. Models suggest that in a 4°C warmer future, we can expect more ground ozone levels in some cities in Canada which translates to 312 more deaths and a 4.6% increase in health burden costs to society. Nationally Canadians are exposed to a wide variety of natural hazards. If hazards begin to occur more frequently, together or even combined with other non-climate related

hazards, there could be significant impacts to health.

Public Health and Emergency Services are critical in reducing vulnerability to the impacts of climate change. Vulnerability differs across Canada and there are specific groups within the general population that are more vulnerable (e.g. seniors). We now have information on how to capture these vulnerabilities and take the necessary actions. Adaptation can save lives. Adaptation priorities include: **monitoring** current impacts from climate related hazards; **mainstreaming** climate change into current actions; and **modeling** from a health perspective.

Health Canada is working with 4 communities in Canada who are developing their own Heat Alert and Response System. Health Canada will evaluate this process and try to determine whether if they system is effective in reducing health risks. From this, Health Canada will be developing a 'best practices' guidebook for Canadian communities. They are also developing clinical guidelines and training materials through Health Professional Interventions and Training.

Canadians possess the knowledge, institutions and skills to reduce climate change health risks, but need to become more engaged. Health Canada needs to support its public health partners and managers and we need to focus on what works at a practical level.

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## Introduction to Risk Management Approach to Climate Change Adaptation

Mr. Al Douglas, OCCIAR

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The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) is a university-based resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation.

C-CIARN began using a risk management tool in 2004 and continued to use it at several workshops in communities across Ontario. In a facilitated workshop setting, using a fictitious case study relevant to the community hosting the workshop, participants have the opportunity to work through the steps of the risk management process. The facilitator takes the participants through each of the steps and in the end comes up with a list of adaptation strategies to build resilience in their systems.

The purpose of the tool is to raise awareness of decision makers to the potential uses of the framework, develop adaptation strategies, provide ways to help decision-makers to identify community, industry or sectoral risks from climate variability and change, and to promote discussion among decision-makers on approaches that could be used to reduce risk.

There are 6 steps in the process: Initiation, Preliminary Analysis, Risk Estimation, Risk

Evaluation, Risk Control and Implementation and Monitoring. The framework is not meant to be used 'as is', but should be adjusted or tailored to each community or organization using it.

- Good facilitation is required when proceeding through the process. In the workshop setting, participants need to make some assumptions in order to move through the entire process.
- A lack of information and/or data is not an acceptable reason to quit. Find the information or the experts who can provide the information.
- Climate change is often not mentioned when identifying risk control mechanisms and adaptations are often best practices that might be already happening.
- Communication every step of the way is very important in this process.

## Risk Assessment Break-out Sessions

The following section communicates the results of a facilitated climate change risk management break out session that was conducted with workshop participants. The process began with the introduction of the process by Al Douglas of OCCIAR, then a review of the case study and then the risk management process was undertaken. This section of the report outlines the comments and sentiments of the workshop attendees who participated in this exercise.

### *Municipal Infrastructure Case Study*

As the City's chief infrastructure engineer you are required to be on call in case of emergencies as they pertain to city infrastructure. At 2:00 am you receive a phone call from the police stating that a section of a municipal road is flooded. Upon arrival, you notice that the road, surrounded by residential neighbourhoods on either side, has a torrent of water rushing down it and where there were once 4 lanes of blacktop is now a small river. A combination of melting snow and heavy spring rain has resulted in copious amounts of water unable to escape via over-land drainage routes. You also notice that pieces of debris are blocking other large catch basins thus prohibiting water from entering the storm-water system.

Four hours later the rain has stopped. The road and 200 homes now are flooded by 3 feet of water.

After a few phone calls, you realize that storm water arteries in the city are operating very close to capacity. Thinking back, you recall a previous council meeting where you requested funds to upgrade that drainage basin. That request was rejected 5 years ago and since then, 3 events have taxed the infrastructure to the point where the integrity of the road has been compromised.

A week later you are preparing your report for the infrastructure committee along with a briefing note and presentation to mayor and council. You realize that the City's infrastructure, specifically its storm water management system and over-land drainage routes, are very vulnerable to disruptions from events such as the heavy rain and spring melting. As a knowledgeable engineer, you are aware of climate change and the implications it will have on your infrastructure. Included in your report are regional climate projections to the year 2050. The projections state that your community could see:

- a 2°C increase in mean summer and a 3°C increase in mean winter temperatures;
- a 10% increase (on annual basis) in precipitation; with uncertain changes in seasonal distribution and more precipitation falling as rain and less as snow;

- more frequent and intense extreme events (e.g. droughts, heavy precipitation, wind, freezing rain);
- shorter winter and long summer seasons.

The report and presentation will conclude by requesting that the City conduct a risk-based assessment of all storm-water infrastructures. If accepted, the process will begin in two weeks.

Your initial tasks are to decide who should be at the table to conduct this study then move on into the risk assessment process, and a list of some potential impacts and possible ways of adapting that will illustrate the issues to the members of your task force.

### ***Municipal Infrastructure Case Study – Results***

Going through the steps of the Risk Assessment, the Municipal Infrastructure Case Study group decided that a broad range of people were necessary and would have to include all people who would have information on the systems in question. The people that should be around the table included: Planners, Academics, Engineers, Conservation Authorities, Health Unit, Transportation Department, Emergency Management and Operations people.

The group focused on a series of climate hazards that might occur in one event. They decided a combination of frozen ground, heavy spring rain and rapid snowmelt could result in rapid high volume surface runoff which would test the capacity of the drainage system. Areas of concern included: the hydrology, hydraulics, state of system, generation of runoff, route of flow and inflow from outside the normal system.

The first order impact identified resulting from the one day event was flooding. Higher order impacts resulting from flooding included:

- basement flooding
  - road closures
  - business disruption
  - water supply intake
  - strewn debris
  - damage to homes
  - damage to utilities
  - damage to natural spaces
  - damage to arts/culture
  - Health
  - Mould
  - Drinking water
  - Stress
-

The next step was to estimate the risk of each of the high order impacts. The higher order impacts chosen were drinking water quality, business disruption, damage to utilities and human stress. Risk was assessed for each of these and the results are summarized in Table 1. It should be noted that this is a subjective process and that time was constrained. Another group may have assessed the risk differently. Once the overall risks (severity and probability) were assessed for each impact, all of the risks were then prioritized.

$$\text{Risk} = \text{Severity} \times \text{Probability}$$

The impact with the highest priority was drinking water quality and damage to utilities.

Table 1: Natural Systems case study Risk Assessment Matrix

		Drinking water quality	Business Disruption	Damage to Utilities	Human Stress
Severity of Impact (1 to 5)	Economic	4	3	5	3
	Environmental	2	1	1	1
	Social	5	2	5	4
Probability of Occurrence (1 to 5)		4	2	4	4
Prioritized Risk (subjective assessment)		44	12	44	32

1 = lowest priority

5 = highest priority

The next step was to identify some adaptive strategies to reduce the risk of lowering the quality of drinking water and damage to utilities. The risk control options identified included:

- Planning – ability to retain water and re-route flow
- Maintenance and Operations – removing snow, clearing debris

**Natural Systems Case Study**

You are the Program Manager of the Tourism and Recreation Department at the City and are required to organize and coordinate projects to attract visitors to the city throughout the year. You know that tourism is very dependant on the climate and you have been paying attention to all the media coverage about climate change.

You remember reading a story in a professional travel magazine about how most of the warming will occur in the winter months with more precipitation coming in the form of rain versus snow. The story also mentioned that even though we will have a longer summer season, we can expect more heat waves, more intense storms, periods of drought and an increase in insect-borne diseases such as West Nile. All outdoor tourism such as winter carnivals, skiing, snowshoeing, camping, and festivals could be impacted.

After doing a little background research you notice changes have begun to take place to jeopardize and even in some cases cancel events. An intense storm two summers ago resulted in the poorest attendance record ever for the City's annual outdoor music festival, resulting in substantial economic losses.

For your next planning meeting you decide to put this on the agenda. In your presentation are regional climate projections to the year 2050. The projections state that your community could see:

- a 2°C increase in mean summer and a 3°C increase in mean winter temperatures;
- a 10% increase (on annual basis) in precipitation; with uncertain changes in seasonal distribution and more precipitation falling as rain and less as snow;
- more frequent and intense extreme events (e.g. droughts, heavy precipitation, tornadoes);
- shorter winter and longer summer seasons.

You conclude your presentation by suggesting that the City conduct a risk-based assessment of all projects.

Your task today is to decide who should be at the table to conduct this study then move on into the risk assessment process, and a list of some potential impacts and possible ways of adapting that will illustrate the issues to the members of your task force.

**Natural Systems Case Study – Results**

Going through the steps of the Risk Assessment, the Natural Systems Case Study group decided the people that should be around the table included: program managers, city councilors, Infrastructure Department, Ottawa Tourism Association, Parks and Recreation Manager, Ottawa Festivals Network, City Communication Department, Environmental Sustainability

Division, Cultural Affairs, local representative for the Ontario Ministry of Tourism, NCC, climate scientist, Environment Canada and Natural Resources Canada

Some of the climate related hazards identified include: extreme heat (one day event), extreme precipitation (one day event), wind, warmer winter temperatures, freezing rain (ice accumulation), climate variability, lightning and high humidity.

Based on the task of conducting a risk-based assessment of all recreational events/projects in the City, extreme heat (temperature > 35 to 40°C, over consecutive (5 – 7) days) was identified as the most critical climate-related hazard. The group continued and identified first, second and third order impacts resulting from extreme heat (figure 1). Higher order impacts poor water quality, power outages, human health and poor air quality were then assessed for risk.

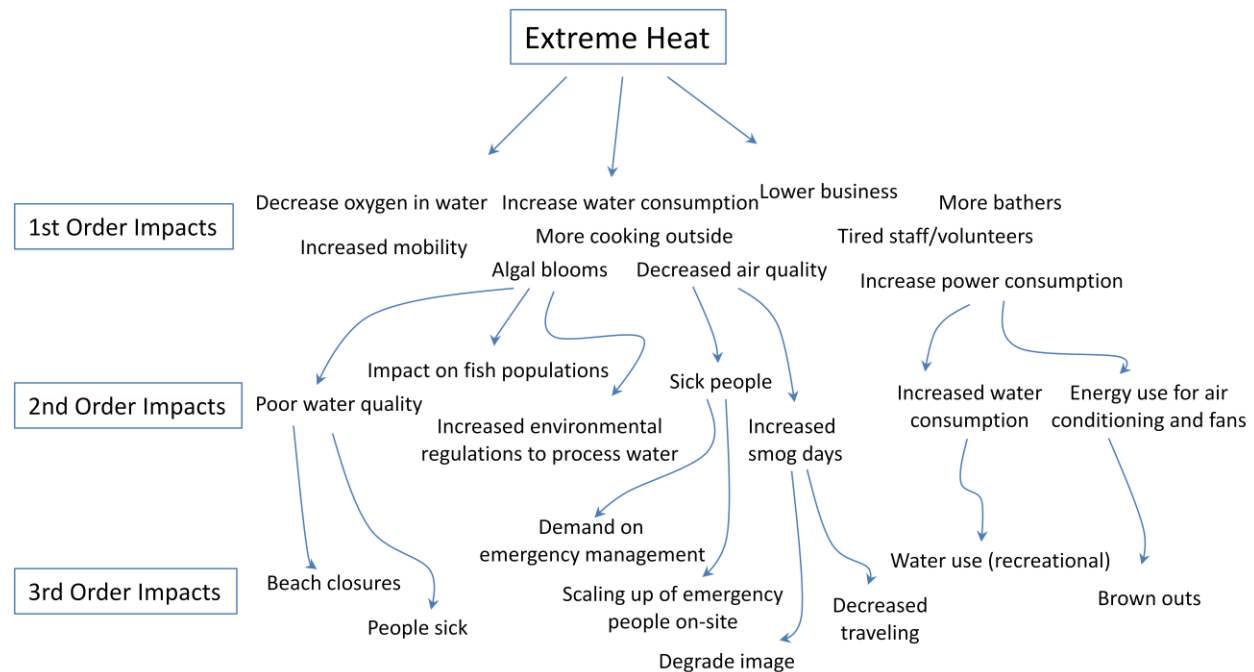


Figure 1: First, second and third order impacts resulting from a climate related hazard, extreme heat.

The next step was to estimate the risk of each of the high order impacts. After much discussion, the risk was assessed and summarized in Table 2. It should be noted that this is a subjective process and that time was constrained. Other groups may have assessed risks differently. Once the overall risks (severity and likelihood of occurrence) were assessed for each impact, all of the risks were then prioritized.

$$\text{Risk} = \text{Severity} \times \text{Probability}$$

The impact with the highest priority was poor air quality.

Table 2: Natural Systems case study Risk Assessment Matrix

		Poor Water Quality	Power Outages	Human Health issues	Poor Air Quality
Severity of Impact (1 to 5)	Economic	3	5	5	4 to 5
	Environmental	4	2	1 to 2	4 to 5
	Social	2	3	4	4 to 5
Probability of Occurrence (1 to 5)		4	3	5	5
Prioritized Risk (subjective assessment)		36	30	55	75

1 = lowest priority  
5 = highest priority

The next step was to identify some adaptive strategies to reduce the risk of poor air quality as a result of extreme heat. Adaptive strategies include:

- public transit
- limits/bans on lawn mowing
- green roof tops (albedo)
- plant trees (shade)
- cooling mechanisms
- public awareness
- physical fitness
- oxygen
- bike parks
- no smoking parks
- greening events
- free bus rides
- indoor events
- limit air conditioning
- reduce business
- close parliament

Due to time constraints, the process of implementation was not discussed but delegates noted the spectrum of ease and cost associated with the adaptation options. Some of the actions chosen to reduce climate-related risks were simple (low-hanging fruit), some complimented both mitigative and adaptive actions and some required more commitment from different levels of government and financial commitment.

In closing, the exercise, delegates realized the importance of continued monitoring of the adaptive measures as well as the importance of revisiting decisions in the face of new or updated information.

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## Evaluation Sheets

Thank you for taking the time to fill out the evaluation sheets. We appreciate all comments and are taking them into consideration in all future workshops. If you did not have a chance to fill out an evaluation sheet, or would like to make comments, please contact Al Douglas [adouglas@mirarco.org](mailto:adouglas@mirarco.org) or Jackie Richard [jrichard@mirarco.org](mailto:jrichard@mirarco.org).

The results below are from 15 delegates who handed in evaluation sheets:

### Workshop Evaluation - Adapting to Climate Change in Ottawa

#### Preparation

1	Did you receive information (delegate package) prior to attending this workshop?	
	Yes	10
	No	5
2	If yes, did you find this information useful?	
	Yes	8
	No	
	Did not have time to read it	1
3	Do you have background knowledge of climate change impacts and adaptation?	
	Yes, a lot	3
	Yes, a little	6
	Medium	4
	No, none	2

Comments:

#### Location

4	Was the chosen workshop venue adequate?	
	Yes	15
	No	0
5	Were the workshop facilities conducive to your needs?	
	Yes	14
	No	0
	Somewhat	1

Comments:

---

### Structure and format of this workshop

6	Did you find the breakout sessions useful?		
	Very high		1
	High		9
	Neutral		3
	Low		2
	Very low		
7	Was the facilitator able to convey instructions clearly to all participants?		
	Very high		2
	High		7
	Neutral		3
	Low		2
	Very low		
8	Did the facilitator lead the participants sufficiently through the breakout sessions?		
	Very high		1
	High		8
	Neutral		5
	Low		1
	Very low		

Comments:

More lecture than group working through tool

Good process in a complex topic

Not always clear where we were in the process

It's Friday at 50 days of a transit strike - did the best possible with the crowd.

Session was a little rushed so was "driver" a little more than ideal

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### Presenters and material presented

9	Were the presentations clear and concise?		
	Yes		13
	No		
	Sometimes		1
10	How would you rate the quality of the material presented?		
	Very high		5
	High		9
	Neutral		

---

Low  
Very low

11	Did the material presented meet your expectations?	
	Very high	5
	High	9
	Neutral	
	Low	
	Very low	

---

**Comments and Suggestions for Improvements:**

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Content Excellent  
Some presentations low energy  
Lots of new resources brought to my attention - Thanks!  
All speakers were excellent  
Content extremely interesting  
As communities complete these processes and make adaptations (however small), perhaps include 1 or 2 case studies presentations to spur peer to peer learning and encourage that YES this is doable

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## Appendix 1 – Delegate Package

### Climate Change

Climate is naturally variable and has changed significantly over the history of the Earth. Over the past two million years, the Earth's climate has alternated between ice ages and warm interglacial periods. There are a number of climate variability drivers, from changes in the Earth's orbit, changes in solar output, sunspot cycles, volcanic eruptions, to fluctuations in greenhouse gases and aerosol concentrations. When considered together, they effectively explain most of the climate variability over the past several thousand years. These natural drivers alone, however, cannot account for the increase in temperature and accompanying suite of climatic changes observed over the 20th century.

Climate change may manifest itself as a shift in mean conditions or as changes in the variance and frequency of extremes of climatic variables. Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850) (IPCC 2007). There is growing recognition that planning for these changes may pose challenging problems for natural resource managers (IPCC 2001). There is confidence in the ability of climate simulation models to provide natural resource managers with useful projections of future climate scenarios to support planning and management across a range of space and time scales.

Globally, two broad policy responses to address climate change have been identified. The first is mitigation, which is aimed at slowing down climate change by emitting less greenhouse gases in the atmosphere. The second is adaptation, which is aimed at adjusting resource uses and economic activities in order to moderate potential impacts or to benefit from opportunities associated with climate change. The focus of this workshop is on the latter approach.

### Impacts and Adaptation

There is broad consensus among international scientists that climate change is occurring, that the impacts are already being felt in regions all around the world and that they will only get worse. "Impacts due to altered frequencies and intensities of extreme weather, climate and sea-level events are very likely to change" (IPCC 2007).

Even after implementing measures to reduce greenhouse gas emissions, some degree of climate change is inevitable and is already having economic, social and environmental impacts

on communities. Adaptation limits the negative impacts of climate change and takes advantage of new opportunities. It is not an alternative to reducing greenhouse gas emissions in addressing climate change, but rather a necessary complement. “Adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions” (IPCC 2007). Reducing greenhouse gas emissions decreases both the rate and overall magnitude of climate change, which increases the likelihood of successful adaptation and decreases associated costs. Adaptation is not a new concept as many approaches have already allowed us to deal with our extremely variable climate. The nature and rate of future climate change, however, poses some new challenges.

Developing an effective strategy for adaptation requires an understanding of our vulnerability to climate change. “Future vulnerability depends not only on climate change but also on development pathway” (IPCC 2007). Vulnerability is determined by three factors: the nature of climate change, the climatic sensitivity of the system or region being considered, and our capacity to adapt to the resulting changes. The tremendous geographic, ecological and economic diversity of Canada means that the 3 factors mentioned above, and hence vulnerabilities, vary significantly across the country. In many cases, adaptation will involve enhancing the resiliency and adaptive capacity of a system to increase its ability to deal with stress.

Adaptation responses include biological, technical, institutional, and economic, behavioural and other adjustments that reduce vulnerability to the adverse impacts, or take advantage of positive effects, from climate change. Effective responses to climate change require an integrated portfolio of responses that include both mitigation and adaptation. At this workshop, the focus is on adaptation.

### **Purpose of the Workshop**

The purpose of the workshop is to provide information about the vulnerability of Ontario's communities to climate change and variability as well as to review vulnerability assessment concepts in the development and evaluation of climate change adaptation strategies. The workshop will also demonstrate the practical application of a risk-based approach to climate change adaptation by applying a five-step framework to community scenarios.

Over the course of the workshop we will explore the following questions:

- What are we adapting to?
  - How has climate change already affected and will continue to affect our communities' natural resources, infrastructure and economies?
-

- What is currently being done in communities in Ontario and around the world to make us more resilient to climate change?
- What will be the consequences if we do not act?
- How can a community develop an adaptation strategy?

Delegates to the workshop will:

- Learn from experts about community-level impacts from a changing climate focusing on the Ontario chapter of the National Assessment.
- Draw from the experiences and insights of researchers and practitioners to identify current feasible approaches to climate risk management including how to integrate climate change into existing processes.
- Highlight the issues and challenges involved and explore the interconnectedness and complexity of climate risk management and adaptive responses.
- Share knowledge and global best practices for enhancing climate risk management and adaptive capacity and assess their applicability to the Ottawa context.
- Identify common barriers to effective climate risk management and explore approaches for overcoming these barriers.

### **Ontario Centre for Climate Impacts and Adaptation Resources**

The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) is a university-based, Ontario Ministry of the Environment funded, resource hub for researchers and stakeholders searching for information on climate change impacts and adaptation. The centre communicates the latest research on climate change impacts and adaptation; liaises with partners across Canada to encourage adaptation to climate change and aids in the development of tools to assist with municipal adaptation.

The mandate of the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) is to:

- effectively communicate the science of climate change including its current and future impacts;
  - encourage the development and implementation of adaptation strategies in order to reduce climate vulnerability and increase resiliency;
  - to create and foster partnerships with stakeholder groups;
  - and support the work of Ontario's Expert Panel on Climate Change Adaptation;
-

within the Province of Ontario and beyond. The Centre will also be a hub for climate change impacts and adaptation activities, events and resources.

The Centre will:

- hold stakeholder workshops across the province;
  - enhance existing and foster new relationships with a variety of stakeholder groups;
  - host and create a webpage with pertinent and up-to-date information on climate change impacts and adaptation ([www.climateontario.ca](http://www.climateontario.ca));
  - develop and disseminate resource material pertaining to climate change impacts, vulnerabilities and adaptation;
  - populate a reference database containing climate change articles, books and other reports;
  - and create an adaptation toolkit for municipalities in an attempt to encourage mainstreaming of climate change into decision-making processes.
-

## **Community Profile for the City of Ottawa Demographics and Climate information**

### **Demographics**

Ontario's second largest city, Ottawa is located on the banks of the Ottawa, Rideau and Gatineau Rivers. It consists of the Region of Ottawa-Carleton and 11 local municipalities: Cumberland, Gloucester, Goulbourn, Kanata, Nepean, Osgoode, Ottawa, Rideau, Rockcliffe Park, Vanier, and West Carleton.

According to the 2006 Census, 812,130 people live in the city Ottawa with 52% of the population being female and 48% male. Ottawa is 2,796 kilometers in area and 90 percent of the area is rural.

### **Climate Information**

The Ottawa area receives about 235 cm of snowfall annually. However, the snow season is quite variable; in an average winter, snow cover lasts from mid-December until early April, although some years are snow-free until after December, particularly in recent years. The average temperature in January is -10.8 °C and high wind chills are common, with annual averages of 51, 14 and 1 days with wind chills below -20 °C, -30 °C and -40 °C respectively. Freezing rain is also relatively common compared other parts of the country.

Summers are fairly warm and humid in Ottawa and are moderate in length. The average July maximum temperature is 29.5 °C and temperatures of 30 °C or higher occurs frequently. During periods of hot weather, humidity can be high, especially close to the rivers. Ottawa annually averages 41, 12 and 2 days with humidex readings above 30 °C, 35 °C and 40 °C respectively.

Spring and fall are variable, with extremes in temperature being common. Average annual precipitation averages around 943 mm.

Historical climate and selected climate projections for the area are shown in Table 1.

Table 1: Historical climate and climate projections for Ottawa ([www.CCCSN.ca](http://www.CCCSN.ca)) using CGCM3T47, SR-A2.

Variable	1971-2000	2011-2040 (2020s)	2041-2070 (2050s)
Annual average temperature (°C)	6.2	7.7	9.3
Extreme maximum temperature (°C)	35.6	37.3	38.6
Extreme minimum temperature (°C)	-35	-33.1	-30.6
Annual precipitation (mm)	913.1	917.5	979.9
Number of days with temperatures above 25 °C	57	78	91
Number of days with temperatures above 30 °C	11	23	45
Number of days with temperatures above 35 °C	0	1	3
Days with rain	118	109	118
Days with snow	29	23	21

## Resources

The purpose of the following template for risk management is to give you the opportunity to:

1. Appreciate that adaptation to climate variability and change is not an unattainable, extensive endeavour. Rather it is a **tangible approach** that practitioners and decision-makers can comprehend and undertake, if they so desire.
2. Realize that adaptation to climate variability and change is almost always addressing issues and problems that are influenced by climate now. Climate is not the primary driver in most cases, and identifying and reducing the contribution to the problem from the other drivers that are involved is the key to reducing risk.
3. Be engaged in identifying adaptation options that are feasible.
4. Understand that climate-related risks are part of a comprehensive risk management strategy and will be considered alongside multiple stressors, not independently.

Risk assessment / management is a tool that can help identify current risks caused by climate-induced hazards and impacts and reduce these risks. If these risks will continue or grow in the future, possibly resulting in a greater magnitude of loss or a higher probability of loss, then risk management can also be used in adapting to the future risks of climate change.

Risk management is the process of measuring, or assessing risk and then developing strategies to manage the risk. In ideal risk management, a prioritization process is followed whereby the risks with the greatest loss and the greatest probability of occurring are handled first, and risks with lower probability of occurrence and lower loss are handled later.

Risk assessment is a step in the risk management process. Risk assessment is measuring two quantities of the risk, the **magnitude of the potential loss**, and the **probability that the loss will occur**. The purpose of risk assessment, in the context of climate change, is to identify risks and hazards that may be induced or exacerbated by climate change and to evaluate the magnitude of their impacts and the probability that they will occur. It can be a useful tool in adapting to the negative aspects of climate change since it can be used to address a range of climate-related impacts with both a high or low probability of occurrence.

The following risk assessment/risk management approach is based on the previous experiences of C-CIARN Ontario and follows an approach outlined in **An Overview of the Risk Management Approach to Adaptation to Climate Change in Canada** as produced by Global Change Strategies Incorporated.

[http://adaptation.nrcan.gc.ca/pdf/NobleBruceEgener2005\\_e.pdf](http://adaptation.nrcan.gc.ca/pdf/NobleBruceEgener2005_e.pdf)

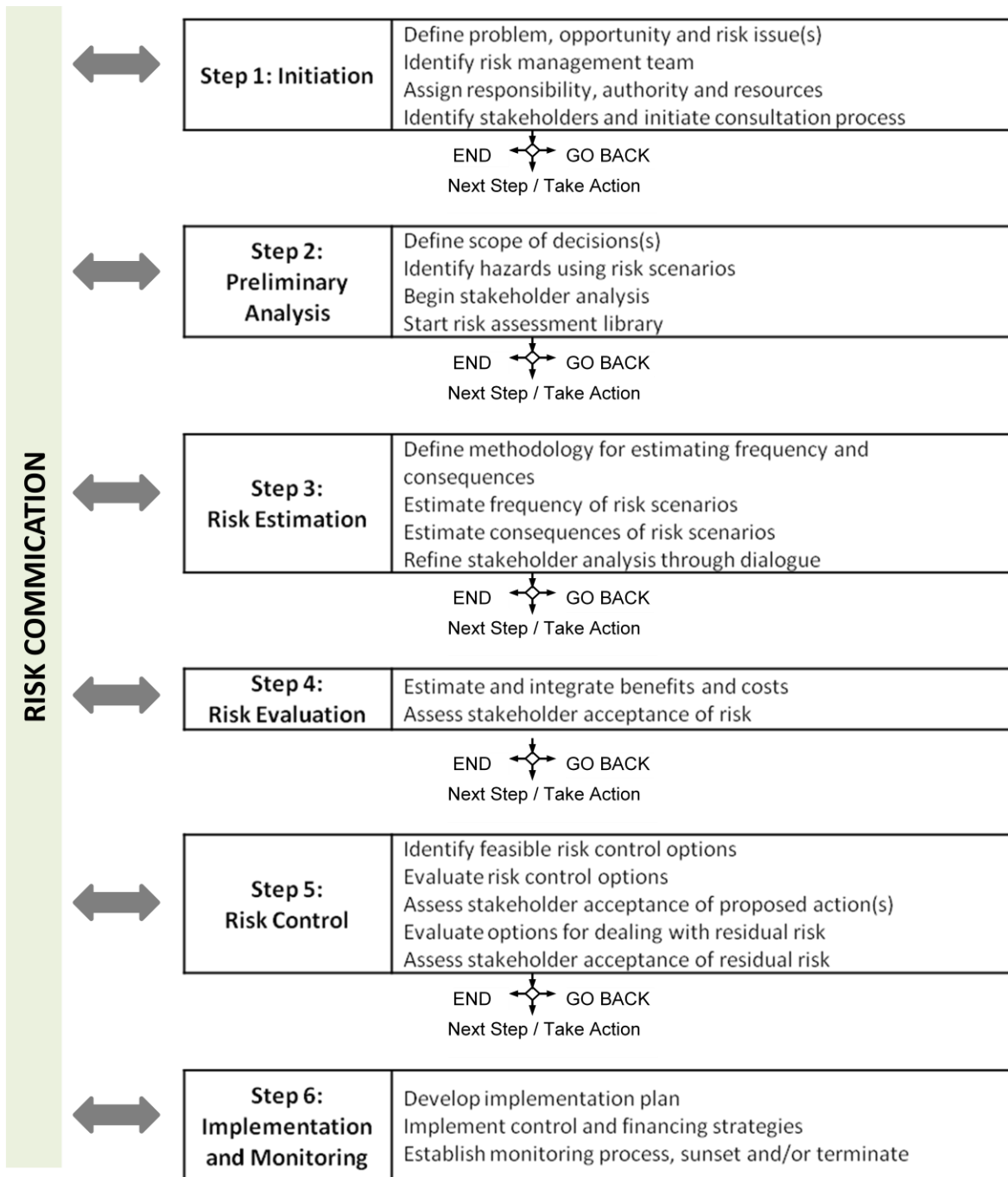
The guide, **Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities**, is intended primarily for Ontario municipalities and Conservation Authorities which share responsibilities for planning and managing important climate-sensitive systems in Ontario. It presents a risk-based approach that can be used to facilitate municipalities' efforts to adapt to climate change through both longer term planning and short-term responses (Bruce et al., 2006).

[http://adaptation.nrcan.gc.ca/projdb/pdf/176a\\_e.pdf](http://adaptation.nrcan.gc.ca/projdb/pdf/176a_e.pdf)

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### Overview of the Risk Management Approach

The risk management process provides a systematic, information and science-based tool to help decision-makers analyze risks (and potential benefits), and select optimal courses of action. It uses a pragmatic or evolutionary approach that builds existing structures and functions within the community. The completion of each step leads logically to the next or ends the process if the hazard/risk is resolved. The process is iterative. Each step can be revisited if new information becomes available. The process assists in priority setting and balancing complex risk control strategies, their effectiveness and costs.



### **Step 1 – Initiation**

Identify current climate extremes that could produce negative impacts; and that will likely not diminish with climate change and may increase in magnitude or frequency *e.g. heavy summer precipitation, rapid spring melt of snow, extreme and extended drought, etc.*

In small groups or as a full group, review current climate impacts, identify vulnerabilities, consider future climate, identify priority impact/risk issues to consider, complete Step 1. Be sure to limit scope of analysis in this exercise. A complete analysis is not required; participants need only understand the process.

### **Step 2 – Preliminary analysis**

For each one of these extremes (in practice it may only be feasible to choose one extreme, such as “heavy summer precipitation”), identify the impacts and hazards that current climate (and therefore future climate) extremes could cause through a “risk scenario”. This scenario would include low and higher order impacts.

Participants construct event trees that show the outcomes that may occur for a series of interdependent events (sequenced over time) stemming from the risk issue identified in Step 1 and based on the community’s particular context and vulnerabilities. Analysis of the event tree will allow participants to identify risk control points, develop risk management strategies and contingency plans.

**Tool for Step 3: Risk Estimation – Impact Rating Matrix**

Impact	Social Factors		Economic Factors		Other Factors
Very Low					
Low					
Moderate					
Major					
Extreme					
N/A					

**Tool for Step 4: Risk Evaluation – Risk Assessment Matrix**

		Frequency/Probability				
		Unlikely to occur	Occasional occurrence	Moderately frequent	Occurs often	Virtually certain to occur
Impact Severity	Extreme	2	2	1	1	1
	Major	3	2	2	1	1
	Moderate	4	3	2	2	1
	Low	4	4	3	2	2
	Very low	5	4	4	3	2
1		<b>Extreme risk:</b> This indicates an unacceptable level of risk that requires immediate controls to move the activity out of the extreme range.				
2		<b>High risk:</b> This level will require high-priority control measures to reduce risk to an acceptable level.				
3		<b>Moderate risk:</b> Some controls will be required to move this risk scenario to lower levels.				
4		<b>Low risk:</b> Probably no controls are needed. However, depending upon stakeholder perceptions, some low-level controls or other actions such as public education and awareness may be desirable.				
5		<b>Negligible risk:</b> Scenarios in this category probably do not need to be considered further.				

**Risk Assessment Conclusion**

The goal of this exercise is to communicate one tool that may be used to develop actions to reduce the risk associated with climate change and climate variability. Communities or stakeholder groups who attempt to use this framework are encouraged to make adjustments that will accommodate specifics within their area.

## Case Studies

### Case Study 1 - Setting the Stage

#### Municipal Infrastructure

As the City's chief infrastructure engineer you are required to be on call in case of emergencies as they pertain to city infrastructure. At 2:00 am you receive a phone call from the police stating that a section of a municipal road is flooded. Upon arrival, you notice that the road, surrounded by residential neighbourhoods on either side, has a torrent of water rushing down it and where there were once 4 lanes of blacktop is now a small river. A combination of melting snow and heavy spring rain has resulted in copious amounts of water unable to escape via over-land drainage routes. You also notice that pieces of debris are blocking other large catch basins thus prohibiting water from entering the storm-water system.

Four hours later the rain has stopped. The road and 200 homes now are flooded by 3 feet of water.

After a few phone calls, you realize that storm water arteries in the city are operating very close to capacity. Thinking back, you recall a previous council meeting where you requested funds to upgrade that drainage basin. That request was rejected 5 years ago and since then, 3 events have taxed the infrastructure to the point where the integrity of the road has been compromised.

A week later you are preparing your report for the infrastructure committee along with a briefing note and presentation to mayor and council. You realize that the City's infrastructure, specifically its storm water management system and over-land drainage routes, are very vulnerable to disruptions from events such as the heavy rain and spring melting. As a knowledgeable engineer, you are aware of climate change and the implications it will have on your infrastructure. Included in your report are regional climate projections to the year 2050. The projections state that your community could see:

- a 2°C increase in mean summer and a 3°C increase in mean winter temperatures;
- a 10% increase (on annual basis) in precipitation; with uncertain changes in seasonal distribution and more precipitation falling as rain and less as snow;
- more frequent and intense extreme events (e.g. droughts, heavy precipitation, wind, freezing rain);
- shorter winter and long summer seasons.

The report and presentation will conclude by requesting that the City conduct a risk-based assessment of all storm-water infrastructures. If accepted, the process will begin in two weeks.

Your initial tasks are to decide who should be at the table to conduct this study then move on into the risk assessment process, and a list of some potential impacts and possible ways of adapting that will illustrate the issues to the members of your task force.

## Case Study 2 - Setting the Stage

### Natural Systems

You are the Program Manager of the Tourism and Recreation Department at the City and are required to organize and coordinate projects to attract visitors to the city throughout the year. You know that tourism is very dependant on the climate and you have been paying attention to all the media coverage about climate change.

You remember reading a story in a professional travel magazine about how most of the warming will occur in the winter months with more precipitation coming in the form of rain versus snow. The story also mentioned that even though we will have a longer summer season, we can expect more heat waves, more intense storms, periods of drought and an increase in insect-borne diseases such as West Nile. All outdoor tourism such as winter carnivals, skiing, snowshoeing, camping, and festivals could be impacted.

After doing a little background research you notice changes have begun to take place to jeopardize and even in some cases cancel events. An intense storm two summers ago resulted in the poorest attendance record ever for the City's annual outdoor music festival, resulting in substantial economic losses.

For your next planning meeting you decide to put this on the agenda. In your presentation are regional climate projections to the year 2050. The projections state that your community could see:

- a 2°C increase in mean summer and a 3°C increase in mean winter temperatures;
- a 10% increase (on annual basis) in precipitation; with uncertain changes in seasonal distribution and more precipitation falling as rain and less as snow;
- more frequent and intense extreme events (e.g. droughts, heavy precipitation, tornadoes);
- shorter winter and longer summer seasons.

You conclude your presentation by suggesting that the City conduct a risk-based assessment of all projects.

Your task today is to decide who should be at the table to conduct this study then move on into the risk assessment process, and a list of some potential impacts and possible ways of adapting that will illustrate the issues to the members of your task force.

## Definitions

### Adaptation

Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected *climate change* effects. Various types of adaptation exist, e.g. *anticipatory* and *reactive*, *private* and *public*, and *autonomous* and *planned*. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

### Adaptation benefits

The avoided damage costs or the accrued benefits following the adoption and implementation of *adaptation* measures.

### Adaptation costs

The costs of planning, preparing for, facilitating, and implementing adaptation measures, including transaction costs.

### Adaptive capacity

The ability of a system to adjust to climate variability and change to moderate potential damages, to take advantage of opportunities, or cope with the consequences.

### Barrier

Any obstacle to reaching a goal, *adaptation* or *mitigation* potential that can be overcome or attenuated by a policy, programme, or measure. *Barrier removal* includes correcting market failures directly or reducing the transactions costs in the public and private sectors by e.g. improving institutional capacity, reducing risk and uncertainty, facilitating market transactions, and enforcing regulatory policies.

### Climate scenario

A plausible and often simplified representation of the future *climate*, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of *anthropogenic climate change*, often serving as input to impact models.

*Climate projections* often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate. A *climate change scenario* is the difference between a climate scenario and the current climate.

### Climate variability (CV)

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the *climate* on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (*internal variability*), or to variations in natural or *anthropogenic external forcing* (*external variability*).

## **Event**

An incident induced or significantly exacerbated by climate change that occurs in a particular place during a particular interval of time, e.g. floods, very high winds, or droughts.

## **Hazard**

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

## **Hazard identification**

The process of recognizing that a hazard exists and defining its characteristics.

## **(Climate change) Impacts**

The effects of *climate change* on natural and *human systems*. Depending on the consideration of *adaptation*, one can distinguish between potential impacts and residual impacts:

- *Potential impacts*: all impacts that may occur given a projected change in climate, without considering *adaptation*.
- *Residual impacts*: the impacts of climate change that would occur after adaptation.

## **Projection**

A potential future evolution of a quantity or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasize that projections involve assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized, and are therefore subject to substantial *uncertainty*.

## **Residual risk**

The risk remaining after all risk control strategies have been applied.

## **Resilience**

The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

## **Risk**

The chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to health, property, the environment, or other things of value.

## **Risk communication**

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

## **Risk control option**

An action intended to reduce the frequency and/or severity of injury or loss, including a decision not to pursue the activity.

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### **Risk information library**

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

### **Risk perception**

The significance assigned to risks by stakeholders. This perception is derived from the stakeholder's needs, issues, and concerns.

### **Risk scenario**

A defined sequence of events with an associated frequency and consequences.

### **Vulnerability**

The degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

## **References**

Bruce, James P., Egener I. D. Mark and Noble, David. 2006. Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities. [http://adaptation.nrcan.gc.ca/projdb/pdf/176a\\_e.pdf](http://adaptation.nrcan.gc.ca/projdb/pdf/176a_e.pdf)

Canadian Climate Change Scenarios Network (CCCSN) Website. <http://www.cccsn.ca>

City of Ottawa [http://www.ottawa.ca/city\\_services/statistics/index\\_en.shtml](http://www.ottawa.ca/city_services/statistics/index_en.shtml)

Ottawa <http://www.ottawa.com/>

Noble, D., Bruce, J. and Egener M. 2005. An Overview of the Risk Management Approach to Adaptation to Climate Change in Canada.

[http://adaptation.nrcan.gc.ca/pdf/29156ce6051f409990f872d838bcbbbb\\_e.pdf](http://adaptation.nrcan.gc.ca/pdf/29156ce6051f409990f872d838bcbbbb_e.pdf)

Statistics Canada: Population and Dwelling Counts. 2009.

<http://www12.statcan.ca/english/census06/data/profiles/community/Details/Page.cfm?Lang=E&Geo1=CSD&Code1=3506008&Geo2=PR&Code2=35&Data=Count&SearchText=Ottawa&SearchType=Begins&SearchPR=01&B1=All&Custom=>

Wikipedia. <http://en.wikipedia.org/wiki/Ottawa>

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