Adaptation Planning in Eastern Ontario

Final Report

Ontario Centre for Climate Impacts and Adaptation Resources - OCCIAR

March 2012

Ontario Centre for Climate Impacts and Adaptation Resources
OCCIAR is a university-based resource hub for researchers and stakeholders that provides 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 and application 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

Community Adaptation Initiative

The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and the Clean Air Partnership (CAP) have been selected to coordinate an outreach project on climate change. The Community Adaptation Initiative is a project to help communities address the challenges of climate change. This initiative will work with private and public sector groups, conservation authorities and non-governmental organizations to become more resilient to climate change and its impacts.
http://www.ene.gov.on.ca/en/air/climatechange/communityadaptation.php

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OCCIAR

Introduction

OCCIAR Director and workshop facilitator Al Douglas began the day by welcoming everyone to the workshop and introducing Ontario Centre for Climate Impacts and Adaptation Resources - OCCIAR. Through the Community Adaptation Initiative, OCCIAR has been helping communities and Conservation Authorities plan for the impacts of climate change by introducing adaptation tools and frameworks that build climate change into their decision-making. As the world struggles with the challenges of mitigation, adaptation planning becomes more and more important. It is important for municipalities to know how they will be impacted by climate change and how to respond locally.

The objectives of the workshop were to provide a forum for attendees to communicate their interests and activities in the area of climate change impacts and adaptation, to hear from a variety of experts conducting work and research in the field of climate change impacts and adaptation, and to initiate the development of a watershed/regionally-based adaptation discussion group.

Paul Egginton, formerly of Natural Resource Canada's Climate Change Impacts and Adaptation Division, continued by stating the importance of encouraging professionals in the area to talk about climate change. It is important to understand that the environment is changing, and that our struggles to reduce emissions highlight the importance of adaptation. Delegates were also welcomed by Paul Lehman, General Manager of Mississippi Valley Conservation, workshop co-organizers.

Presentations

Some Recent Developments in Climate Change Science, Impacts and Adaptation

Don Lemmen, Natural Resources Canada

Warming of the climate system is unequivocal. Most of the observed increase in global temperature is very likely due to human activity and best estimates project increases in the range of 1.8 to 4°C by the end of the century. Even if greenhouse gas concentrations were stabilized now, warming would continue for centuries. We need to start acting now.

Since 2007, the year of the last Assessment Report (#4) released by the Intergovernmental Panel on Climate Change, global emissions have been trending near the upper limits of the greenhouse gas emission scenarios. Observed decreasing levels of sea ice in the northern hemisphere have also exceeded projections and ocean ecosystems are being affected by increasing ocean acidity. Limiting warming to 2°C will be difficult because as levels of global CO_2 emissions would have to level off immediately and decline to negative values before the end of the century.

What does this mean for Canada? The impacts of climate change are already being felt across the country. Recent extreme weather events have highlighted the vulnerabilities of communities and infrastructure. Climate change is a risk multiplier - it will exacerbate these vulnerabilities (e.g. reduced water quality and quantity) along with presenting new risks (e.g. new disease and pests) and opportunities (e.g. more profitable crops) for communities, infrastructure and ecosystems.

Adaptation is adjusting decisions, activities and thinking because of observed or expected changes in climate. While we adapt to moderate harm and take advantage of new opportunities (e.g. warmer winters mean less energy required to heat homes) it is important to recognize that adaptation and mitigation are both necessary components in addressing climate change.

> "Adaptation means not clinging to fixed methods, but changing appropriately according to events, acting as is suitable"
>
> Zhang Yu (Sung Dynasty 960-1278)

Adaptation is happening in Canada, e.g. building structures on pylons to reduce damage from flooding, implementing health heat alert initiatives, and making changes to policy in coastal regions. Adaptation involves many different players and tools, and integrating climate change into existing planning processes is a practical approach to adaptation (good risk management). Collaboration is key for successful adaptation.

Climate Ready: Ontario's Adaptation Strategy and Action Plan (2011-2014)

Kathleen O'Neill and Louis Des Rosiers, Ontario Ministry of the Environment

The presentation began by providing an overview of the changes in weather and climate we have already seen and will continue to see into the future in Ontario. The ice storm of 1998 damaged electrical and communication infrastructure, left over 1.2 million people without power and resulted in 700,000 insurance claims with total payouts of $1.5 billion. In August of 2011, a tornado in Goderich resulted in $110 million in damage to the city's downtown and disruptions in electricity and natural gas utilities. Into the future Ontario can expect more intense and frequent storms, flooding and drought, heat waves and spread of disease.

A recent study by NRTEE (2011) found the cost of climate change in Canada could escalate from $5 billion in 2020 to $21 to $43 billion by 2050 and that well-targeted, early investment to improve climate resilience is likely to be cheaper and more effective than complex disaster relief efforts after the event.

Climate Ready: Ontario's Adaptation Strategy and Action Plan was developed in response to the recommendations of the Expert Panel on Climate Change Adaptation and represents 37 actions across 12 government ministries to help the province adapt to the impacts of climate change.

Water resources will be impacted by climate change and Climate Ready has a series of adaptation actions to help reduce these impacts including promoting water conservation through the new Water Opportunities and Water Conservation Act, 2010 (Action 3). Actions to reduce the impact of climate change on buildings and infrastructure include proposed changes to the Building Code that would see hurricane straps being added to garage roofs and backflow prevention devices in new homes. In addition, there are actions for health, agriculture, communities and modeling and science.

VISION
A province prepared for the impacts of a changing climate through implementation of policies and programs that minimize risks to our health and safety, the environment and the economy, and maximizes the benefits from opportunities which may arise.

The government will have to report annually to the public on the action plan as part of Ontario's climate change annual report and indicators of success will be that climate change becomes integrated into policies, programs, information and monitoring across government.

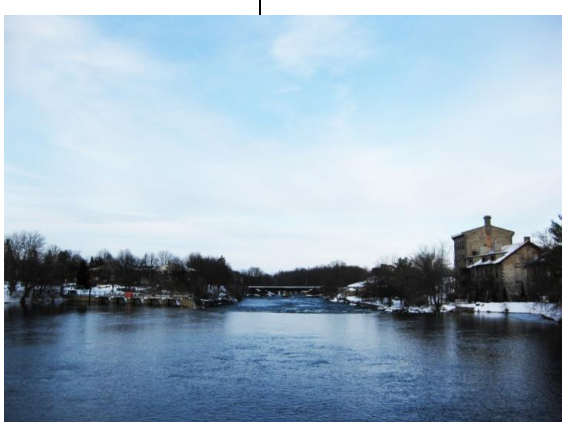
Climate Ready is a 'living document' and over the next four years, they will be looking for opportunities across government to further integrate adaptation into government policies and programs.

Integrating Climate Change into Watershed Policy – Challenges and Opportunities

Paul Lehman, Mississippi Valley Conservation

Paul began his presentation by talking about the Mississippi River Water Management Plan. Mandated by the Ministry of the Environment, the plan focuses on hyrdo-electric facilities and significant water control structures that manage flows and water levels. Climate change impacts were not addressed in the plan. The public advisory committee for the plan is very active and includes cottage associations and municipal staff. The objectives of the plan were to maintain/improve aquatic ecosystem health, address public safety and minimize property damage, maintain water levels and flows for navigation, recreation, cultural and social opportunities, recognize power generation values and develop public awareness.

In order to integrate climate variability into the plan, they used a risk management process. The preliminary analysis phase defined the scope of the problem, quantified the projected changes in precipitation and temperature, modeled the hydrologic response, assessed the reservoir performance and capacity to satisfy constraints and objectives and assessed secondary impacts (to fisheries and water quality). One hundred years of historical data showed the average stream flow has not changed significantly since the early 1900's, however stream flow in winter has been increasing, maximum summer stream flows have become more variable, and minimum summer stream flow has decreased. The annual hydrograph shows that changes have been occurring with higher stream flows in the winter and fall.



Models of temperature and precipitation in the Mississippi River watershed using the A2 scenario for the 2020's, 2050's and 2070's compared to 1974-2002 suggest that the area may see slight increases in mean precipitation into the later time period, significantly higher minimum winter temperatures, lower (28%) and earlier (6 to 7 weeks earlier) spring freshets, lower summer flows (44%) that persist longer, and higher fall and winter flows (70%). These factors will force the Conservation Authority to rethink reservoir operations which have not changed in 50 years. Primary water management implications - these changes may lead to greater flood risk in the fall and winter, increased shoreline erosion, increased frazil ice generation and greater variability in water levels. Secondary impacts include higher evapotranspiration rates, higher surface water temperatures and degraded water quality.

Water management options include maintaining/ increasing reservoir capacity, minimizing nutrient loading, improving capacity for watershed monitoring and assessment, and facilitating integrated watershed management. Risk evaluation will help them understand the scope of the problem but they now have to develop capacity/tools to assess reservoir performance under multiple scenarios, look at secondary impacts and information/data gaps.

Climate Change and Eastern Ontario Fish Populations: Driving Environmental Factors and Shifting Baselines. *What to expect, how to adapt.*

John M. Casselman, Queen's University

Dr. Casselman began his presentation by saying that fish have been good at documenting changes in water quality, habitat changes and loss, and now changing climatic conditions. Conditions are shifting and fish are sensitive to these changes. Are we assessing these changes and can we adapt? The objectives of his work were to examine changing environmental conditions and baselines, examine responses of freshwater fish and communities in eastern Ontario water bodies and consider how we might manage and adapt.
Long term sampling provides valuable quantitative indices for assessing environmental conditions and fish populations and communities. Beginning in the 1970's, data from the Bay of Quinte shows April to September water temperature has increased by 1.3°C. This is far more indicative of climate change than air temperature as it is less variable. The data also shows an increase in evaporation of approximately 8% and data from the month of December shows dramatic changes to ice cover since the 1980s. Water temperature is much less variable than air temperature. It traps radiant energy, therefore is more descriptive of thermal energy coming into the system.

In the Mississippi watershed (at Appleton), fall and winter discharge has increased dramatically and models of mean daily streamflows suggest that fall and winter flow could increased by 70% into the future, spring flows could become lower (33%) and peak earlier (6 -7 weeks) and summer flows could be lower (44%) and last longer (28%).

In the fish community, warm, cool and cold water species have specific ranges of preferred water temperatures. In terms of spawning, warm water fish spawn in the early summer and cold water fish spawn in the fall and hatch in the spring. Warm water species recruitment is best correlated with summer temperatures, that is higher temperature equals higher recruitment and lower temperatures equal lower recruitment (log relationship, not linear). With increases to water temperature of a couple of degrees, the recruitment of cool water fish drops dramatically (curvilinear relationship). If the temperature is warm, the survival of cold water fry survival is 0. Warmer temperatures results in rapid development and consumption of the yolk sack. Subsequently, the fry hatch too early and die. Spawning for cold water fish is controlled by photoperiod and not temperature.

> Changing climate is already affecting aquatic resources, fish and fisheries. Fish and fisheries can be very sensitive to these environmental influences. Are we assessing these changes and managing for them? Will we adapt?

The Bay of Quinte has experienced years where the temperature of the water was too high for recruitment. In Quebec and Ontario, the recruitment of Lake Trout has been dropping and it has been correlated with increasing summer temperature in the Great Lakes Basin. In the southern part of the Great Lakes Basin, Lake Trout are spawning 6 weeks late and there is evidence to suggest they are spawning deeper, below the thermocline. When looking at relative changes for fish (warm, cool and cold) in an increasing temperature regime, recruitment could change entirely to warm water fish with only a 2°C increase (e.g. . sunfish in Bay of Quinte). Some warm water fish are considered undesirable – but they are increasing in abundance in Ontario.

Data from Carleton Place shows a significant increase in water temperature. With increasing water temperatures, cold water fish decline in number and warm water fish become more abundant. Some of the cold water species have disappeared from lakes in Mississippi watershed even though they have never been fished either recreationally or commercially. Over the last two decades, a 60% increase (3.4% per year) in warm water fish and a similar decrease in cold water species has occurred. An angler survey has shown angler behaviour changes in the Mississippi Watershed as they are starting to utilize the fish that are becoming more abundant.

Within the next 100 years, if the water temperature in the Mississippi Watershed increases 4°C, it could see a 24 fold increase in Small Mouth and Rock Bass. We need to adapt by using the new species as well as looking at regulations to allow us to use it – the MNR is now looking at changing the fishing season for warm water fish.

There is a well documented positive relationship between recruitment and spring discharge for some river-spawning walleye populations. If peak discharge in the Mississippi River decreases, Walleye recruitment could decrease by 24% by the 2070's.

In summary, the new challenge will be to manage changing water and fish resources and fisheries in a changing and more variable environment. Fortunately, some of these changes and responses are predictable and can be quantified. Changing environmental conditions necessitate more regular and rigorous monitoring of not only fish and fisheries but also environmental conditions, taking into consideration water-body specifics. There is also a need for more locale-specific data to support local management strategies. We should publicize that fish are very sensitive indicators of climate change and that fish are responding and communities are changing; some fish are adapting, but displacement will be most common. Unprecedented change is underway. It should also be emphasized that there is significant value in local fish resources and that management strategies should take advantage of increases in certain fish populations and protect those that are declining and being displaced.

Building Adaptive Communities in Eastern Ontario

Dr. Robert McLeman, Ottawa University

Dr. McLeman began his presentation by saying that adaptive communities can identify their key natural assets are and take measures to protect them. Communities build adaptive capacity by understanding their strengths and weaknesses, recognizing potential risks, knowing where partnership opportunities exist and building and maintaining social capital.

In the Eastern Ontario highlands, Dr. McLeman works upstream with local community organizations and community members and is currently involved in a number of activities. Communities face challenges everyday such as energy prices (consumption is very high), harsh economic declines in smaller communities, the US dollar (negatively impacted the tourism sector), commodity prices (lumber is cheap), future of farming, aging population, youth out-migration and poor ICT access. Employment sectors in the area include construction, forestry, hunting and fishing, tourism and agriculture – all of which are sensitive to climate. Adaptive communities continually work to maximize or leverage their assets to overcome existing challenges while looking out for new challenges.

Residents have seen changes to weather and climate in their area. They have reported less snow in the winter, shorter winters, less cold snaps in the winter, earlier starts to spring, longer and hotter summers, more wind and extreme wind occurring more often. Data shows that there is less snow in the winter, and that winters are becoming shorter and milder. Maple syrup season is earlier in the year and hot, dry summers are occurring more frequently. Pollen extracted from sediment cores show that there is less white pine and hemlock more birch and oak in the forest today than before the arrival of Europeans.

There are some positive impacts resulting from these trends. Contractors can work almost year round, real estate agents can show seasonal properties almost year round and winter heating requirements are lower in some years. Warmer, less variable summers benefits tourism and increases the likelihood of return visits. Conversely, negative impacts include increasingly dangerous lake ice conditions, poor snow conditions for snowmobiling conditions, shortening of the forestry season and challenges to the road maintenance budgets.

How do we adapt? We adapt by taking care of natural and social assets, looking for win-win opportunities and low hanging fruit for adaptation; all of which can be accomplished through greater cooperation between local governments, institutions and residents.

Enabling Climate Change Watershed Adaptation across Ontario: Access and Discovery through the Gateway

Dr. Quentin Chiotti, Association for Canadian Educational Resources

Dr Chiotti began his presentation by saying that decision-makers need improved monitoring and datasets in order to make informed decisions around climate change. Since decision-makers do not know what tools to use, the MNR developed a weather and water data access portal. The Gateway will provide some clarity by providing access to tools and data which help users move along the adaptation continuum.

Local Adaptation Collaboratives (LACs) that were developed as part of the study identified several 'needs' for successful adaptation planning at the local or regional level including:

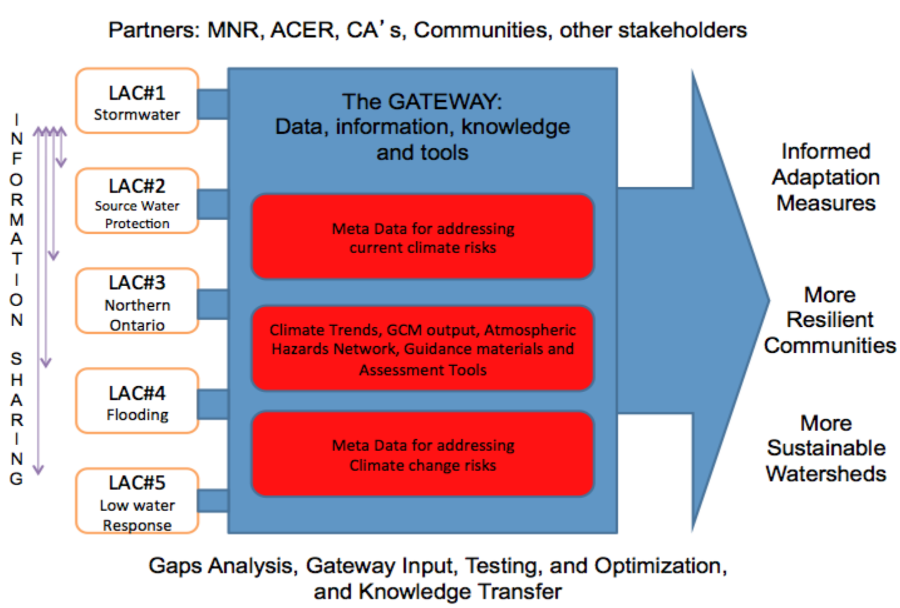
Baseline information: More complete/updated data-sets for climate, IDF curves, stream characterization, stormwater systems, floodplain mapping, vulnerable groups, policy environment, standards and best practices.

Climate Change Information: Climate Change Scenarios, hydrologic effects, IDF curves, current practices and future adaptation (e.g. pipe size, low impact development, water takings, intake areas).

Guidance and Tools: to assess climate change impacts, effects, risks, vulnerability and effectiveness of adaptation options.

Case studies: learning from others, sharing information, experiences and responsibility so we don't have to reinvent the wheel when making more informed, economically justified and effective adaptation decisions.

Performance measures include the exchange and sharing of information, demonstration that each LAC is using the Gateway and that each LAC is able to use the data to make more informed decisions regarding adaptation.



Ontario Weather and Water Information Gateway – Overview of the what, the why and the how

James Britton, Ontario Ministry of the Environment

The (Weather and Water Information) Gateway is a web-based data discovery and access tool created by local decision makers to help them (and people like them) find the information they need to plan for climate change adaptation. It links to information that has been identified by local groups as being useful for climate change adaptation, such as raw data and best practices. It does not store information, but instead points and directs to the information. It follows an open-distribution concept where the data providers host their own data and retain ownership and control.

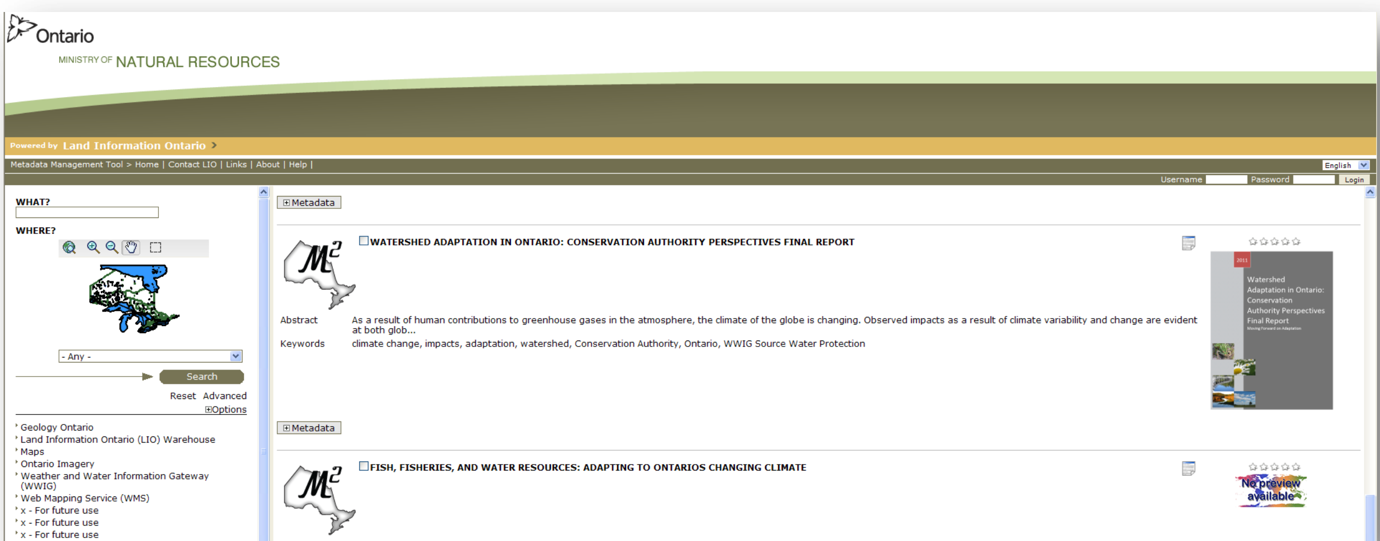
The pilot project supported the development and implementation of the Gateway tool, fostered the development of the first LAC's and initially populated the Gateway. As users become more experienced with climate change adaptation, they can contribute information they found to be useful to them.

The Water Resource Information Program at MNR will populate the Gateway with data that has been identified and will operate the Gateway as part of its mandate to support better Information Management in government. However, growth will be dependent on crowd-sourcing.

The Gateway can be found at: ontario.ca/d538

To create metadata contact: lio@ontario.ca

To include metadata in the Gateway contact: wrip@ontario.ca



Afternoon Session

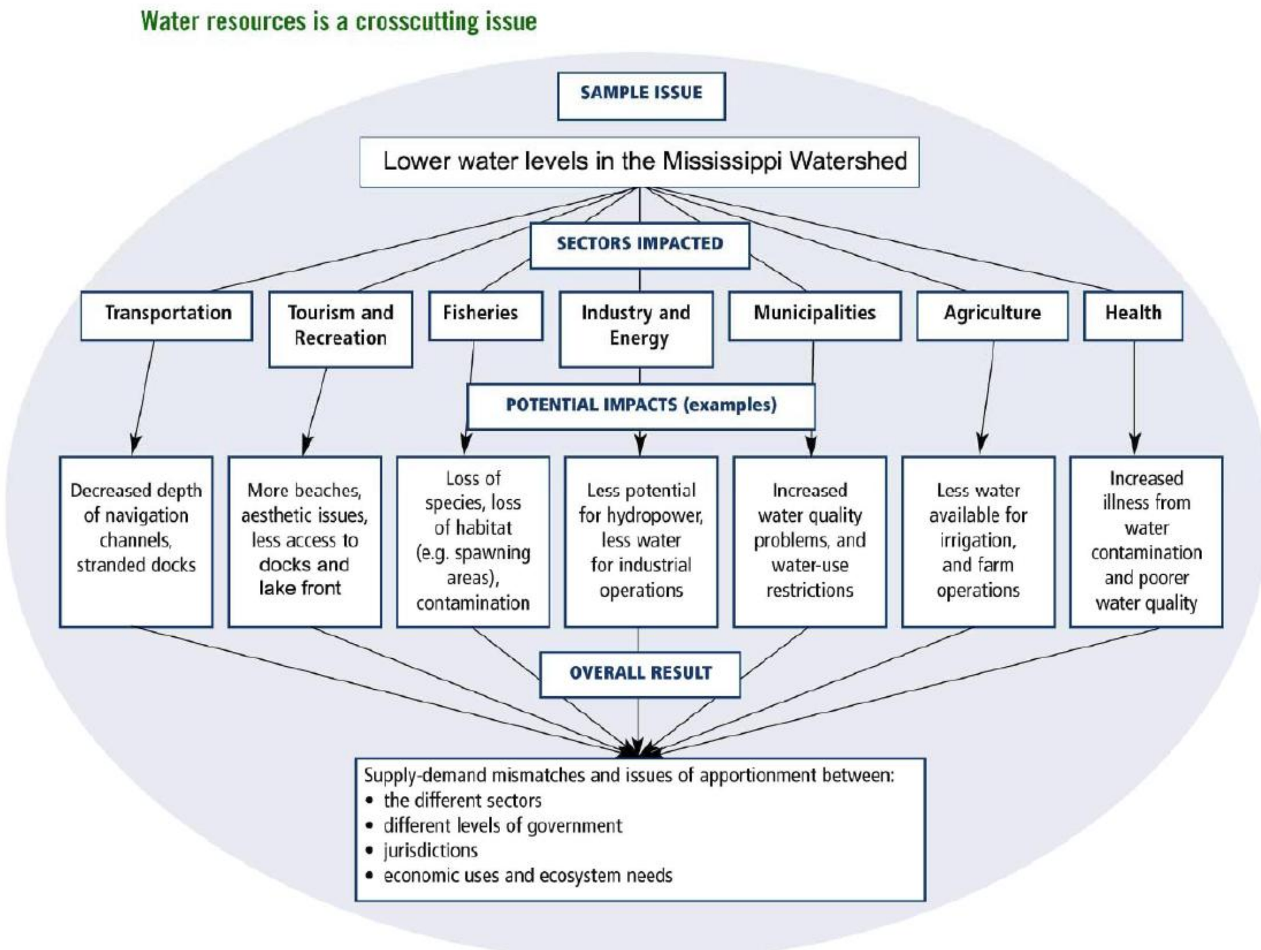
Afternoon Session:

Discussion Perspectives - Information Gaps and Data Needs

The afternoon session allowed the audience to provide comment into what are the next steps to develop adaptation plans.

Due to time constraints, this session only focused on water resources. Looking at impacts to water resources - water is a crosscutting issue – it affects other areas such as health, transportation, land use planning, etc. Where do linkages exist?

The afternoon also included discussion about how to collaborate and move forward. Working together, across sectors, avoids duplication and ensures groups move in the same direction.



Egginton and Lavender

Questions

1) **Is there anyone who is undertaking adaptive activities? Considering climate change in their job? In what ways?**

2) **Are there any specific challenges in considering climate change? What is missing? (data, information, resources, political or management support, other)**

3) **Can you associate with any of the noted impacts on various components of the water sector and water management? Is this extensive? How do we/can we deal with these sorts of impacts?**

Group Discussion

Question 1:

Is there anyone who is undertaking adaptive activities? Or, considering climate change in their job? In what ways?

- Agriculture and Agri-Food Canada (AAFC) – are developing a process looking at how to aggregate information for a whole region and how agriculture is, and has, impacted other sectors and other attributes of the system (e.g. landscape perspectives). They are working with Environment Canada (at Carleton University) and academics at University of Toronto. This process is being piloted in eastern Ontario and involves Conservation Authorities. They are trying to determine the key climate issues and how can government be involved in the assessment of risks. In addition, they seek to understand the pathways using science and a participatory engagement approach. They want to adapt process to what the local issues are (rather than regional, more local).
- Environment Canada is studying how species are currently responding to current and future climate conditions (e.g. how vertebrates will shift as climate envelopes shift in response to emissions - A2 scenario). EC is also developing a broader perspective on what other kinds of data are being modeled (e.g. tree species, disease and pest species) and are looking to layer in other types of information.
- The county (Mary Kirkham) is embracing an Integrated Community Sustainability Plan as part of their official plan. They held focus group meetings last October and many sectors said that climate change is on their minds. Throughout the document there is mention of climate change – how can they address it and how can public works departments at all levels of government address the issue. It is ongoing. By late March or April they will hold additional focus group sessions to add to sustainability plan.
- Some workshop attendees stated difficulty in dealing with climate change. They felt that the Provincial Policy Statement, Building Code, and Official Plans are ways to send information down to the communities, making it easier for them to implement local adaptive strategies. Without those tools it is difficult to support attention to climate change impacts. Regardless, Carleton Place is going beyond what the province is mandating them to do. With respect to water and water quality – they are undertaking long term planning to deal with stormwater runoff.
- Through the Gateway Project, the question of policy has often come up with local stakeholders – what is the role of governments, who is responsible, and what are the tools.
- In Carleton Place, they are trying to educate the public and they have provided input to the Provincial Policy Statement.
- Momentum in the City of Ottawa is building slowly for adaptation – they have some long term planning that incorporates climate considerations and are looking at resiliency and building capacity. Adaptation is happening and some departments do not necessarily realize that is what they are doing.
- The City of Ottawa's water and environment strategy includes a characterization of Ottawa watersheds. They are working with

Conservation Authorities and climate change is a critical component. They have weather data from Environment Canada showing how climate is changing from place to place. Ottawa is 2,800 km^2, with urban and rural areas and changes east to west. With respect to climate, engineers assume stable climate but it is changing. For example, the average seasonal maximum temperature has decreased and winter has become warmer. Minimum temperature has increased in all seasons; rainfall has increased and snow has decreased.

- Impermeable surfaces are increasing in Ottawa – it is important to consider climate change when planning development in other parts of the City.
- From an individual perspective, the Mississippi Lake Sustainability Plans is looking at lakeside pollution including input from agricultural runoff and water quality. Carleton Place has done many proactive things – e.g. has switched to LED lighting in the downtown; has built a new snow dump (snow is no longer being dumped in the river); and is looking at better ways to manage storm water.

- Mississippi Valley Conservation has found that over the last 5 to 10 years, the operations staff have shifted from increased spring activity for flood forecasting, to being active 365 days a year. Many municipalities have adapted to changing conditions – without even realizing they are doing it.

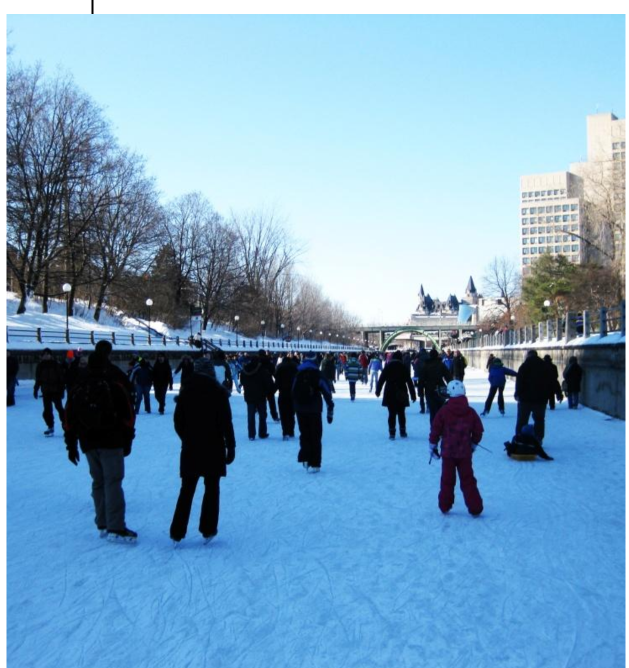
Question 2:

Are there any specific challenges in considering climate change? What is missing – data, information, resources, political or management support, other?

- In the City of Ottawa, the climate varies from station to station. This inconsistent/insufficient spatial distribution of weather stations highlights specialized climate pockets within the City limits.
- There was some concern about the quantity of different climate models, downscaling, work being done at both the provincial and federal level, the CCCSN, A2, B1, etc. It's difficult to know what you are looking at – it's like comparing apples to oranges. We need to be on the same page. We need some collaborative thinking.
- Baseline information is critical. With respect to water, it's not only a quantity issue but a quality issue – whatever happens upstream is critical.
- The AAFC project is not at a stage where they have identified data gaps, but data gaps are being considered in their process. How can data be stitched together and validated? The most obvious data gap is policy – they are doing policy mapping for an area.
- The City of Ottawa hopes its water and environment strategy and characterization initiative will be a one-stop-shop characterization of climate data – a consistent interpretation across the city. It is very powerful tool that will support modeling consistency.
- Although, the scenario issue is a central piece to determine what climate change means, it is only a guide. Scenario outputs for different time slices and different parameters can be found at the Canadian Climate Change Scenarios Network (cccsn.ca). Output is good for water budgets, but may not be good for engineers who work down to the minute. Climate change models cannot deal with the frequency and duration of events – other analyses, such as risk analyses are needed. It is also important to share data as jurisdictional (upstream and downstream) issues are enormous.
- Boards of Directors and Councilors are interested in political encouragement and policy. For example, the provincial and federal governments are encouraging green energy – this led Mississippi Mills to double their capacity at the hydro station (4.6 MW, from 2.4) – it was made possible by the encouraging hydro rates they were offered. They also managed to get 2 grants of $9 million toward the $28 million waste water treatment plant – needed septage treatment capability for rural area. They are about to decommission the plant and are waiting for administrative instructions to implement their waste management plan. The new plan will prohibit waste application on fields, but bring it to the closest plant that can treat it. The new water and waste water management plan does not include stormwater it is uncertain as to whether climate impacts have been considered. What is the absolute conclusive argument for climate change and how can it find its way into the budget – some people are not convinced. They need simple arguments to be put forward for the increase in budgets that will be required.
- Climate data is important for modelling and there are only 2 climate stations in the watershed.
- Stories are needed to convince the layperson of the science (e.g. how fish are impacted -

Casselman). It is difficult to convince the layperson, they need stories they can connect to. Having the layperson onside is important when it comes time to spend the money. This is a challenge for municipal and elected officials.

- Communicating science is important. Research has been undertaken in the area that tried to determine what residents value and how to relate this to ecosystem services. It also included a social network analysis of governance associations - how were they collaborating on working on the ecosystem services that people valued. This information will provide some traction to move into climate change adaptation.
- The concept of stories and narratives is being struggled with in each of the Gateway's LACs. Ontario is very diverse, has an assortment of Conservation Authorities and municipalities, each at different states of readiness. In places that have experienced extreme events, it was the event that catalyzed and galvanized interest politically, as well as at the staff and public level (e.g. Peterborough flood, Finch Avenue washout, Nottawasaga low water levels). We need the linkages and support to make change when an event happens and need to find something that resonates with the community.
- Public support is important. For example, in Mississippi Mills, they had to increase rates to pay for the WWTP. They have not had much resistance to what they are doing because people understand that they need to be careful what is put into the river. Water is a basic service for life.
- People may talk about changing weather instead of climate change. Grandparents could talk about what the weather was like when they were young. Local newspapers archives could be a source of weather stories and local hunters and fisherman would be happy to talk about how weather is not how it used to be.



Question 3:

Can you associate with any of the noted impacts on various components of the water sector and water management? Is it extensive? How do we/can we deal with these sorts of impacts?

- Understanding the impacts of climate change on ecosystems/wetlands, species at risk and others at a watershed level is an integral part of adaptation planning.
- When looking at broader ecosystems, the range of changes and their interactions are complex and unknown. Can we anticipate how ecosystems will change?
- Need to make linkages and engage the right people. Ruth was involved in a project done in Cape Breton. There were 5 municipalities with varying resources (e.g. some have engineers others do not) – the municipalities never talked to one other and were very busy dealing with small scale issues including shoreline erosion, loss of fish habitat due to sedimentation, runoff, declining tourism and recreation. They conducted a workshop on climate change from a big picture perspective – a forum to present information. On the first day they brought planners and policy people together and looked at infrastructure and habitat related issues. At the end of the day they discussed what could be done – the planners and engineers came up with immediate actions that could be undertaken with existing resources, who to contact and how to coordinate their actions to get it done by linking resources. They addressed all the issues they could with existing tools and resources. On the second day, elected officials attended and they felt everything was doable except increasing taxes. A lot can be done by integrating information. Developing solutions is easier when you have the right people contributing.
- Low flows in summer will impact hydro generation which will in turn impact the community if the plant closes. Also, poor water quality impacts recreational activities (e.g. beach closures).
- Mississippi Valley Conservation felt today was a day to establish linkages with decision makers – they have a forum through the water management plan to engage stakeholders around reservoir operations and hydroelectric facilities. Today they wanted to connect decision makers and learn what others are doing.
- Mississippi Valley Conservation would also like to collaborate with the agriculture sector to determine how it will impact water demand especially in a dry year. If the growing season increases how will it impact water quantity and quality?
- Land use planning and other planning policy is important in the context of climate change. How are we going to handle issues such as population growth and the increase in impervious surfaces, etc? Also, there are going to be parts of the globe badly hit by climate change which may translate into immigration and humanitarian issues and questions in the future. A movement of people into this area may be one of the unknown unknowns that will have significant impacts. We need strong thinking around future planning policies.
- Forestry is an issue that needs to be thought about in the watershed – some trees transpire a huge amount of water thus a real need to integrate this information when thinking about water availability in the area.

Wrap Up

Paul Lehman began wrapping up the day by saying that the comments throughout the day pertaining to information gaps and linkages were greatly appreciated. The workshop was meant to initiate linkages with different groups in the area to support adaptation planning. He then highlighted some of the important points from the day:

- The City of Ottawa water plan is an opportunity to consider climate change;
- The Mississippi Mills Waste Water Plan may provide an opportunity to incorporate climate change into risk assessments relatively easily;
- The Mississippi Lake Association and their observations of change and resulting lake plan represents a opportunity for synergy;
- Carleton Place and Lanark County sustainability plans reveal ways through which we can engage the county to deal with climate change impacts;
- Developing stories may prove to be a very successful way to engage local residents. The residents have a strong affinity to the river and recognize that as a big reason why they live there. This invokes a sense of stewardship.

Given all the opportunities listed above and to maintain the momentum on how to incorporate climate change into these initiatives, Paul asked if there was interest in regrouping in 6 weeks to learn what other communities are doing and how to incorporate climate change into initiatives. The following points were suggestions on moving forward:

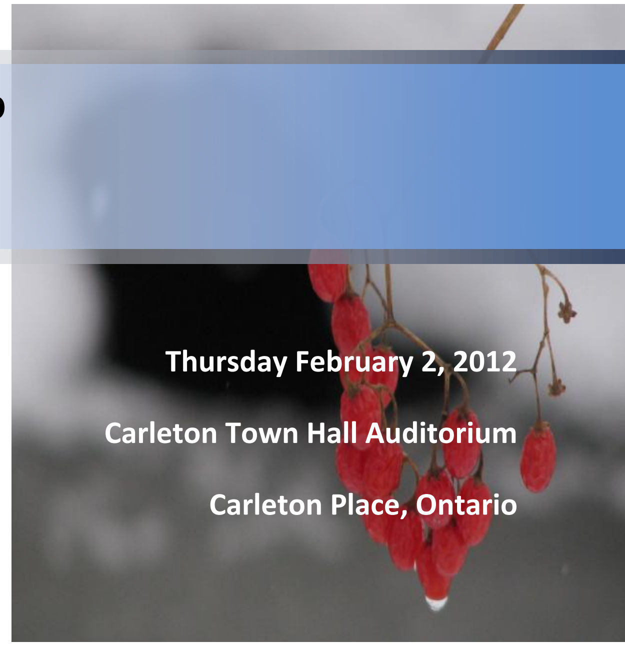
- Forming an adhoc group to talk about climate change;
- Spatially, should it be the Mississippi watershed and municipality or are we interested in learning what the city is doing;
- Think about what the MVC can contribute and what can it take away. The adhoc group will want some kind of reporting method (to county) in order to allow some county and municipal players to be freed up to participate;
- Reconvene in 6 to 8 weeks to hear from another community that is working on adaptation;
- Any other suggestions are welcome.

The chairs concluded the meeting with a note that the workshop report will be posted to the OCCIAR webpage with a subsequent meeting to follow.

Delegate Information Package

Adaptation Planning in Eastern Ontario

An OCCIAR Workshop



Mississippi Valley Conservation

Lanark

OCCIAR
Ontario Centre for Climate Impacts and Adaptation Resources

Ontario Centre for Climate Impacts and Adaptation Resources

OCCIAR is a university-based resource hub for researchers and stakeholders that provides 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 and application 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

Community Adaptation Initiative

The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and the Clean Air Partnership (CAP) have been selected to coordinate an outreach project on climate change. The Community Adaptation Initiative is a project to help communities address the challenges of climate change. This initiative will work with private and public sector groups, conservation authorities and non-governmental organizations to become more resilient to climate change and its impacts.
http://www.ene.gov.on.ca/en/air/climatechange/communityadaptation.php

Acknowledgements

OCCIAR would like to thank the Ontario Ministry of the Environment for their generous support of the Community Adaptation Initiative.

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Ontario Centre for Climate Impacts and Adaptation Resources

Adaptation Planning in Eastern Ontario Workshop is being held by the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) as part of its Community Adaptation Initiative Project, in partnership with the Mississippi Valley Conservation (MVC). 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, develops tools and frameworks to assist with municipal adaptation and liaises with partners across Ontario and Canada to encourage and support adaptation to climate change.

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

- to communicate the science of climate change including its current and future impacts;
- to encourage the development and implementation of adaptation strategies in order to reduce climate vulnerability and increase climate resilience in communities and sectors across Ontario; and
- to create and foster partnerships with stakeholder groups within Ontario and Canada in order to advance adaptation action.

The Centre is also a hub for climate change impacts and adaptation activities, events and resources. For more information please visit www.climateontario.ca.

The workshop will be an interactive session where attendees will hear about climate change impacts and adaptation and also have an opportunity to discuss what is needed to support adaptation.

Specifically, the objectives of this capacity building workshop are:

- to provide a forum for attendees to communicate their interests and activities in the area of climate change impacts and adaptation
- to hear from a variety of experts conducting work and research in the field of climate change impacts and adaptation
- to initiate the development of a watershed/regionally-based adaptation discussion group

Adaptation Planning in Eastern Ontario

February 2, 2012
Carleton Place Town Hall Auditorium
175 Bridge Street, Carleton Place

Agenda

Morning Session: Presentations	**8:15 am – 8:45 am**	**Registration (light breakfast)**	Information and Poster Displays
	8:45 am to 9:00 am	Welcome and Introductions	
	9:00 am to 9:30 am	Climate Change Adaptation – Don Lemmen, Natural Resources Canada	
	9:30 am to 10:00 am	The Ontario Climate Change Adaptation Strategy – Action in Play - Kathleen O'Neil, Ontario Ministry of the Environment (via teleconference)	
	10:00 am to 10:30 am	Integration of Climate Change into Watershed Policy – Opportunities and Challenges - Paul Lehman, Mississippi Valley Conservation	
	10:30 am to 10:45 am	**BREAK**	
	10:45 am to 11:15 am	Climate Change Impacts on Eastern Ontario Fish Populations – John Casselman, Queen's University	
	11: 15 am to 11:45 pm	Building adaptive communities in Eastern Ontario: challenges and opportunities – Robert McLeman, University of Ottawa	
	11:45 am to 12:15 pm	The Weather and Water Information Gateway – Quentin Chiotti	
	12:15 pm to 1:00 pm	**LUNCH**	
Afternoon Session: Roundtable/ Breakout	1:00 pm to 2:15 pm	Information Gaps and Data Needs	
	2:15 pm to 2:30 pm	**BREAK**	
	2:30 pm to 3:00 pm	The Path Forward	

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. Global average surface and lower-troposphere temperatures during the last three decades have been progressively warmer than all earlier decades, and the 2000s (2000–09) was the warmest decade in the instrumental record (NOAA, 2010). Arndt et al., (NOAA, 2010) compared temperature data for the last 6 decades in Canada and concluded that the 2000s was the warmest decade out of the six that are available for its national study, with an average temperature of 1.1°C above normal. In order, from warmest to coolest, the remaining decades are: 1990s (+0.7°C); 1980s (+0.4°C); 1950s (+0.1°C); 1960s (0.0°C); and 1970s (-0.2°C) (Arndt et al., (NOAA), 2010).

There is growing recognition that these changes may pose challenging problems for sectors and watersheds as well as all levels of government. There is confidence in the ability of climate simulation models to provide 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 and lessening the potential future impacts of climate change by emitting less greenhouse gases in the atmosphere or capturing it through various sequestration methods. The second is adaptation, which is aimed at reducing the negative impacts of climate change through actions other than the reduction of GHG emissions, and also making the best of the positive effects of climate change. The primary focus of this workshop is on adaptation.

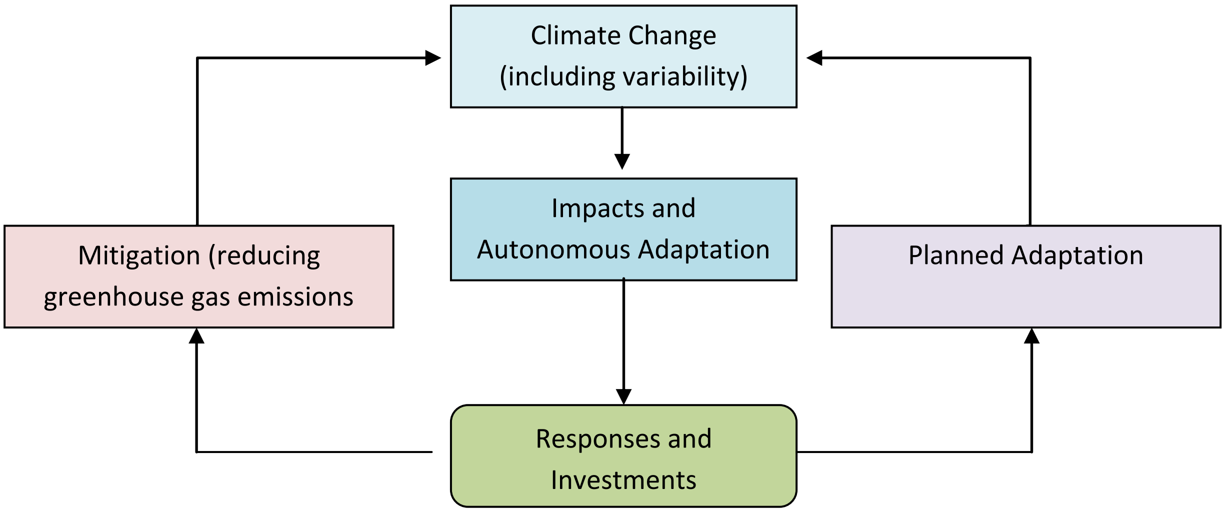

Figure 1: Adaptation and mitigation in the context of climate change (*modified from* Smit et al., 1999 cited in Lemmen et al., 2008).

Impacts and Adaptation

There is 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.

Ontario is relatively well adapted to present climatic conditions; however, it may not be ready for the impacts resulting from changes in average and extreme climatic conditions. Recently, Ontario has experienced climatic events such as such as drought, flooding, heat waves and warmer winters. These have resulted in a wide range of impacts including water shortages, lower Great Lakes water levels, declines in agricultural production, power outages and outbreaks of water-borne diseases.

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, 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.

Ontario is generally well equipped to adapt to climate change, but this adaptive capacity is not uniformly distributed across the province. Ontario has noted differences in adaptive capacity between urban and rural communities (Table 1). Indicators such as: economic resources; availability of, and access to, technology, information and skills; and the degree of preparedness of its infrastructure and institutions (Smit, et al., 2001) are all necessary in developing and acting on a climate change adaptation strategy (Figure 2).

It is imperative that decision-makers understand current vulnerabilities and the extent of future change to make well-informed adaptation planning decisions. Without this, insufficient actions or actions that inadvertently increase vulnerabilities could be made.

Table 1: General differences in adaptive capacity, which affect vulnerability to climate change, between urban and rural communities (Atlantic Canada, Quebec, Ontario and Prairies) (Lemmen et al., 2008).

URBAN CENTRES	RURAL COMMUNITIES
Strengths	Strengths
Greater access to financial resources	Strong social capital
Diversified economies	Strong social networks
Greater access to services (e.g. health care, social services, education)	Strong attachments to community
Higher education levels	Strong traditional and local knowledge
Well-developed emergency response capacity	High rates of volunteerism
Highly developed institutions	
Limitations	Limitations
Higher costs of living	Limited economic resources
More air quality and heat stress issues	Less diversified economies
Lack of knowledge of climate change impacts and adaptation issues	Higher reliance on natural resource sectors
High dependence on critical, but aging infrastructure	Isolation from services and limited access
Issues of overlapping jurisdictions that complicate decision-making processes	Lower proportion of population with technical training

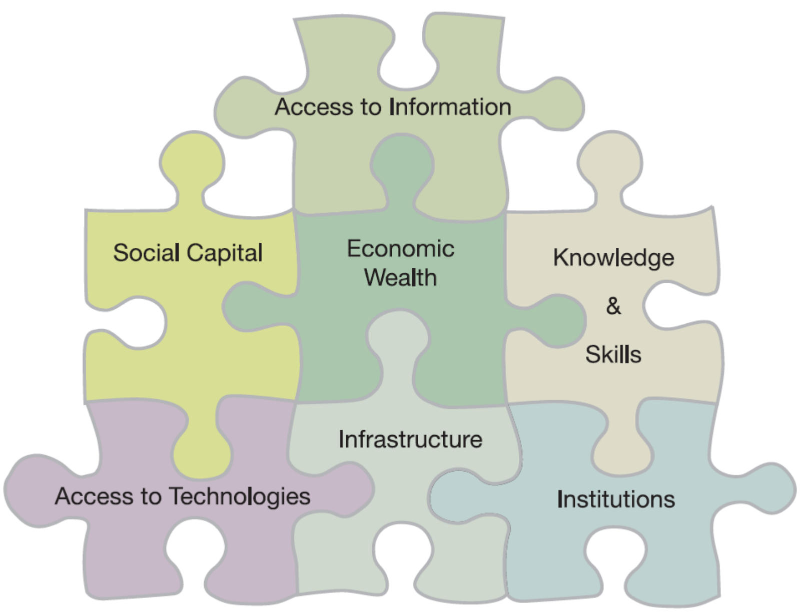

Figure 2: Determinants of adaptive capacity (*adapted* from Smit et al., 2003 as cited in Warren and Egginton, 2008)

Historic Climate and Trends

The following is a compilation and summarization of weather and climate data for Ottawa, Ontario. These graphs provide insight into how much certain climate variables, in this case temperature and precipitation, have changed over the life of the weather station. In conducting a regional analysis of climate change, additional stations from multiple sources would provide a more substantive evaluation. The data below were obtained from Environment Canada.

Following the rules set out by Environment Canada, the length of record required for plotting data is 30 years (or more). The Ottawa CDA and Ottawa A weather stations are the only two stations in the area that have a data record of more than 30 years. Other stations in the area do not meet this requirement: the Appleton weather station in Mississippi Mills has data from 1992 to present; the Drummond Centre weather station has data from 1984 to present; and the Kemptville CS weather station has data from 1997 to present.

Ottawa CDA Weather Station

Daily climate (temperature and precipitation) data from the Ottawa CDA weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and totaled for monthly values for precipitation (Environment Canada, 2012). Seasonal temperature values (winter (DJF), spring (MAM), summer (JJA) and fall (SON)) were calculated by averaging the monthly data and seasonal precipitation values were calculated by summing the monthly data. In the following section, temperature and precipitation data, for the years 1939 to 2011, are displayed annually and seasonally (winter, spring, summer and fall) with line charts (Figures 3 to 7) and includes: mean, maximum and minimum temperature and total precipitation.

Data was missing from the years 1899, 1945, and 1951. As a result, annual temperature values could not be calculated for 1899 and 1945 and average annual maximum temperature could not be calculated for 1951. Total annual precipitation could not be calculated for 1899 and 1951. Average temperature could not be calculated for spring of 1899, fall of 1945. Total precipitation values could not be calculated for spring of 1899 and spring of 1951.

Annual Temperature and Precipitation

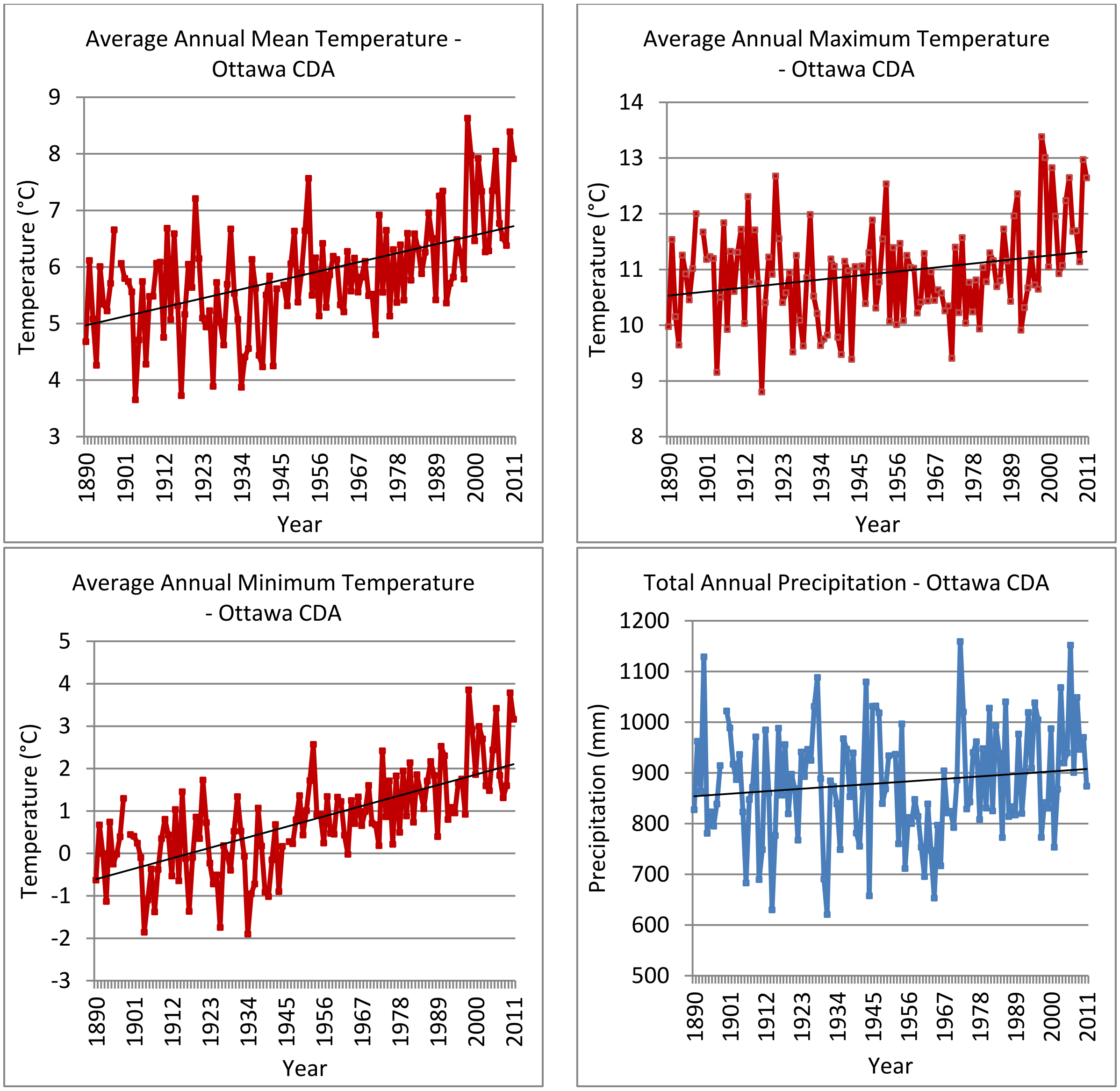

Figure 3: Average annual mean, maximum and minimum temperature (°C) and total annual precipitation (mm) from 1890 to 2011. A trend-line through the data from the Ottawa CDA weather station (Environment Canada, 2012) shows that average annual mean temperature has **increased 1.7 °C**, average annual maximum temperature has **increased 0.8°C**, average annual minimum temperature has **increased 2.7°C** and total annual precipitation **increased 54 mm** at this location over the 122 years of record.

Winter Temperature and Precipitation

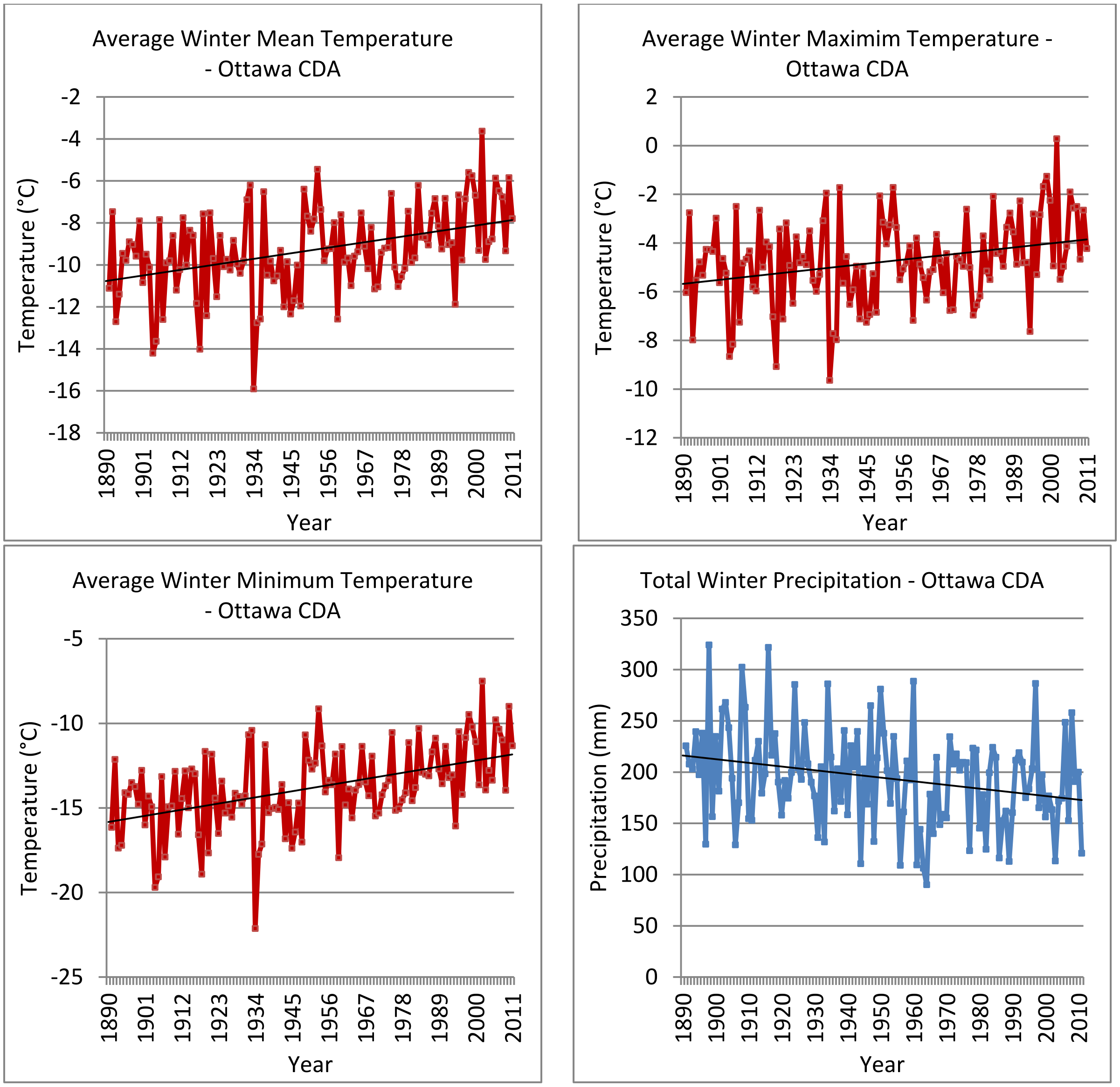

Figure 4: Average winter mean, maximum and minimum temperature (°C) and total winter precipitation (mm) from 1890 to 2011. A trend-line through the data from the Ottawa CDA weather station (Environment Canada, 2012) shows that average winter mean temperature has **increased 3.0 °C**, average winter maximum temperature has **increased 1.9°C**, average winter minimum temperature has **increased 4.0°C** and total winter precipitation has **decreased 44 mm** at this location over the 122 years of record.

Spring Temperature and Precipitation

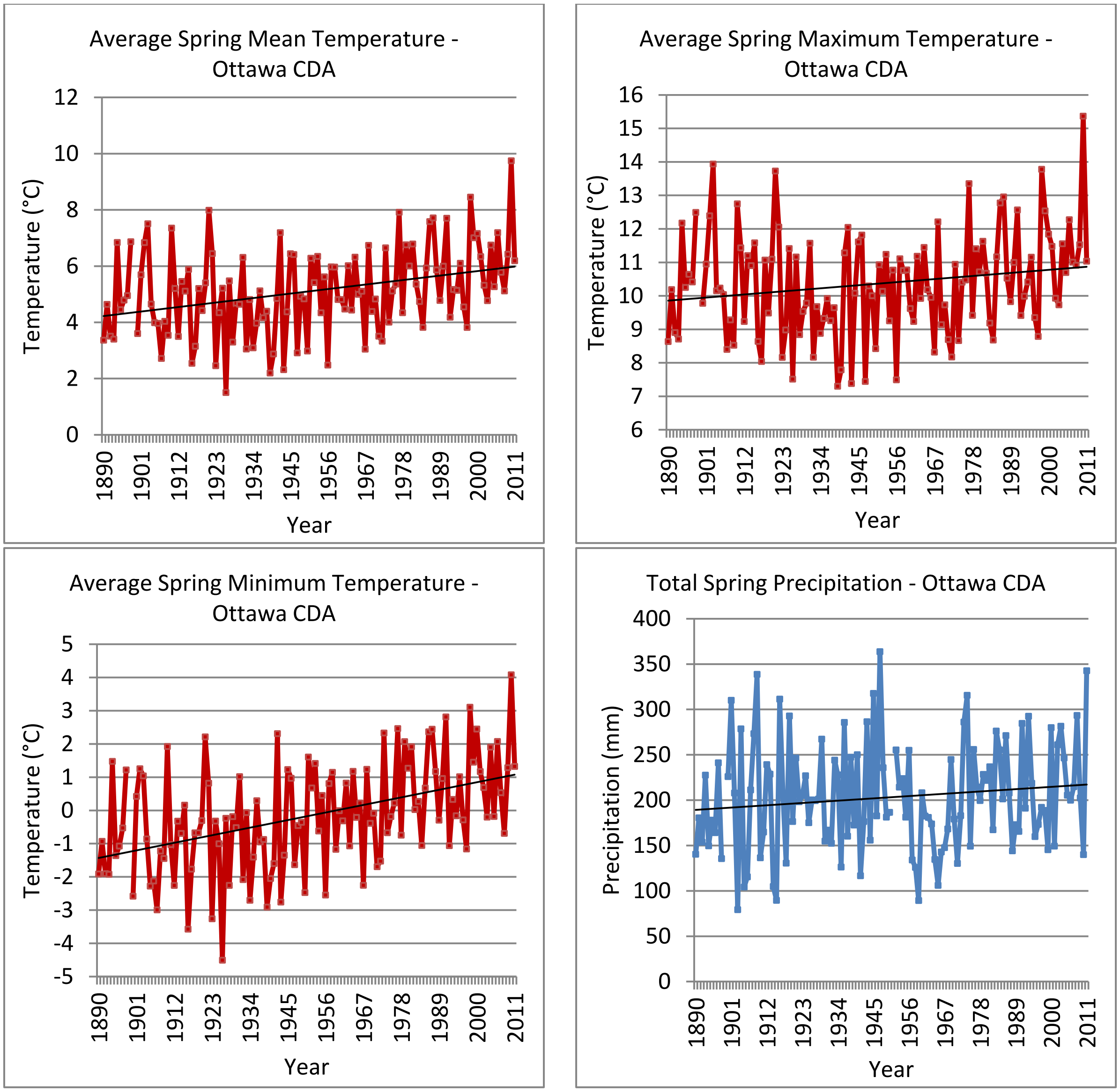

Figure 5: Average spring mean, maximum and minimum temperature (°C) and total spring precipitation (mm) from 1890 to 2011. A trend-line through the data from the Ottawa CDA weather station (Environment Canada, 2012) shows that average spring mean temperature has **increased 1.8°C**, average spring maximum temperature has **increased 1.1°C**, average spring minimum temperature has **increased 2.5°C** and total spring precipitation **increased by 28 mm** at this location over the 122 years of record.

Summer Temperature and Precipitation

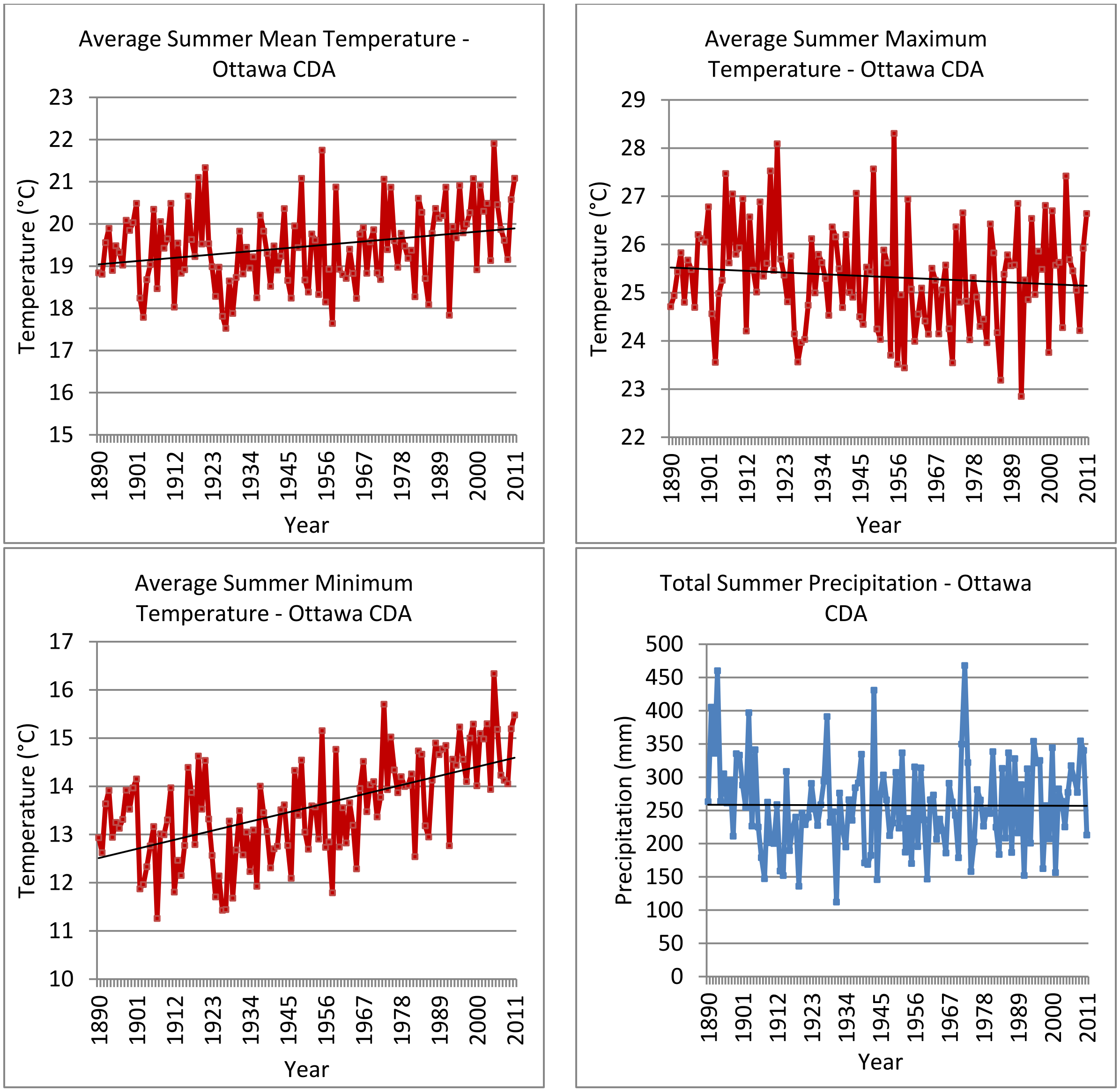

Figure 6: Average summer mean, maximum and minimum temperature (°C) and total summer precipitation (mm) from 1890 to 2011. A trend-line through the data from the Ottawa CDA weather station (Environment Canada, 2012) shows that average summer mean temperature has **increased 0.9°C**, average summer maximum temperature has **decreased 0.4°C**, average summer minimum temperature has **increased 2.1°C** and total summer precipitation **has remained unchanged** at this location over the 122 years of record.

Fall Temperature and Precipitation

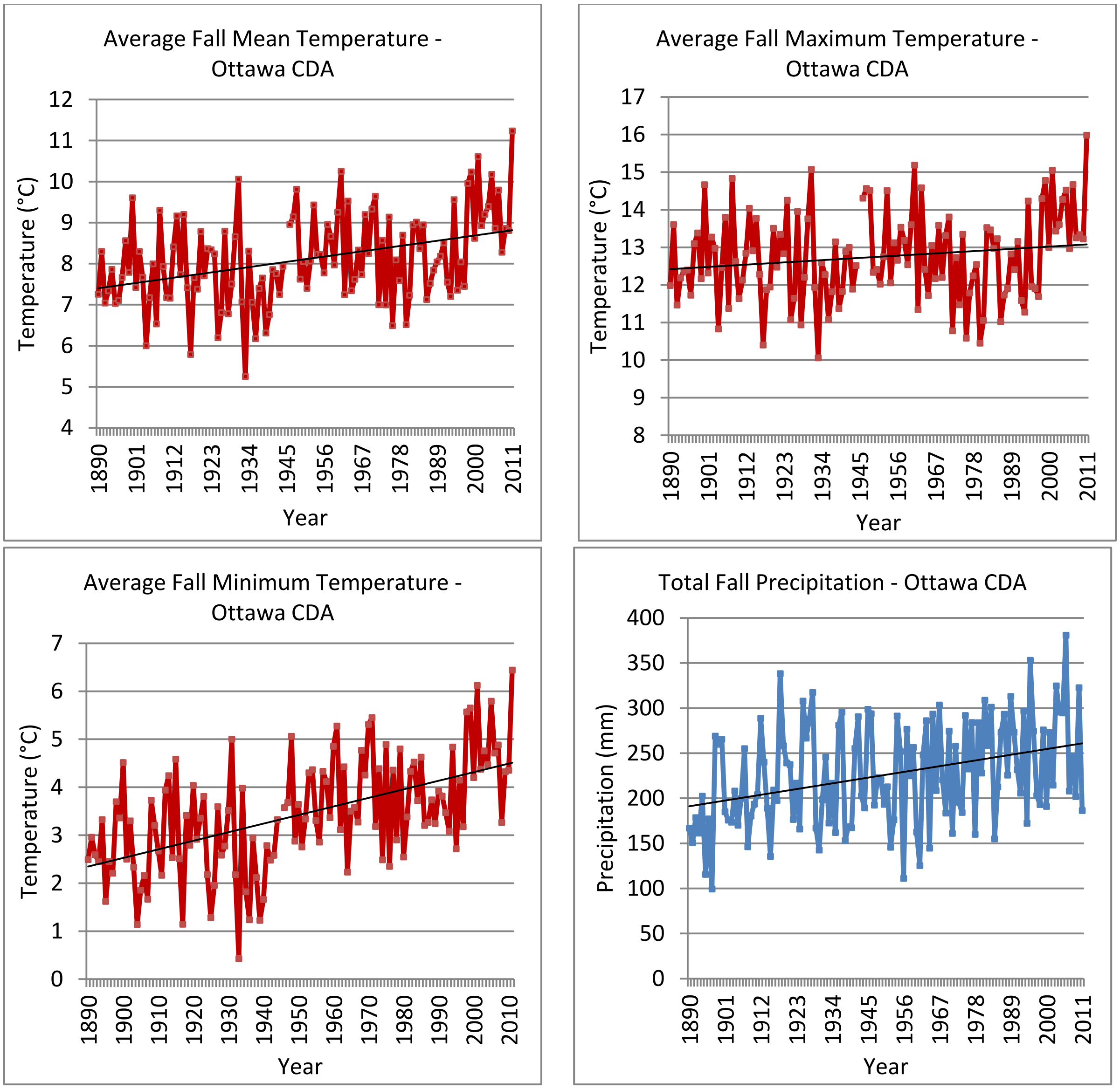

Figure 7: Average fall mean, maximum and minimum temperature (°C) and total fall precipitation (mm) from 1890 to 2011. A trend-line through the data from the Ottawa CDA weather station (Environment Canada, 2012) shows that average fall mean temperature has **increased 1.4°C**, average fall maximum temperature has **increased 0.7°C**, average fall minimum temperature has **increased 2.2°C** and total fall precipitation has **increased 70 mm** at this location over the 122 years of record.

Ottawa A Weather Station

Daily climate (temperature and precipitation) data from the Ottawa A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and totaled for monthly values for precipitation (Environment Canada, 2011). Seasonal temperature values (winter (DJF), spring (MAM), summer (JJA) and fall (SON)) were calculated by averaging the monthly data and seasonal precipitation values were calculated by summing the monthly data. In the following section, temperature and precipitation data, for the years 1939 to 2010, are displayed annually and seasonally (winter, spring, summer and fall) with line charts (Figures 8 to 12) and includes: mean, maximum and minimum temperature and total precipitation.

Data was missing from the years 1939, 1992, and 1993. As a result, annual temperature and precipitation values could not be calculated for those years. Average temperature could not be calculated for the winters of 1993 and 1994, fall of 1993 and average maximum and mean temperature could not be calculated for the fall of 1939. Total precipitation values could not be calculated for the winters of 1993 and 1994 and fall of 1993.

Annual Temperature and Precipitation

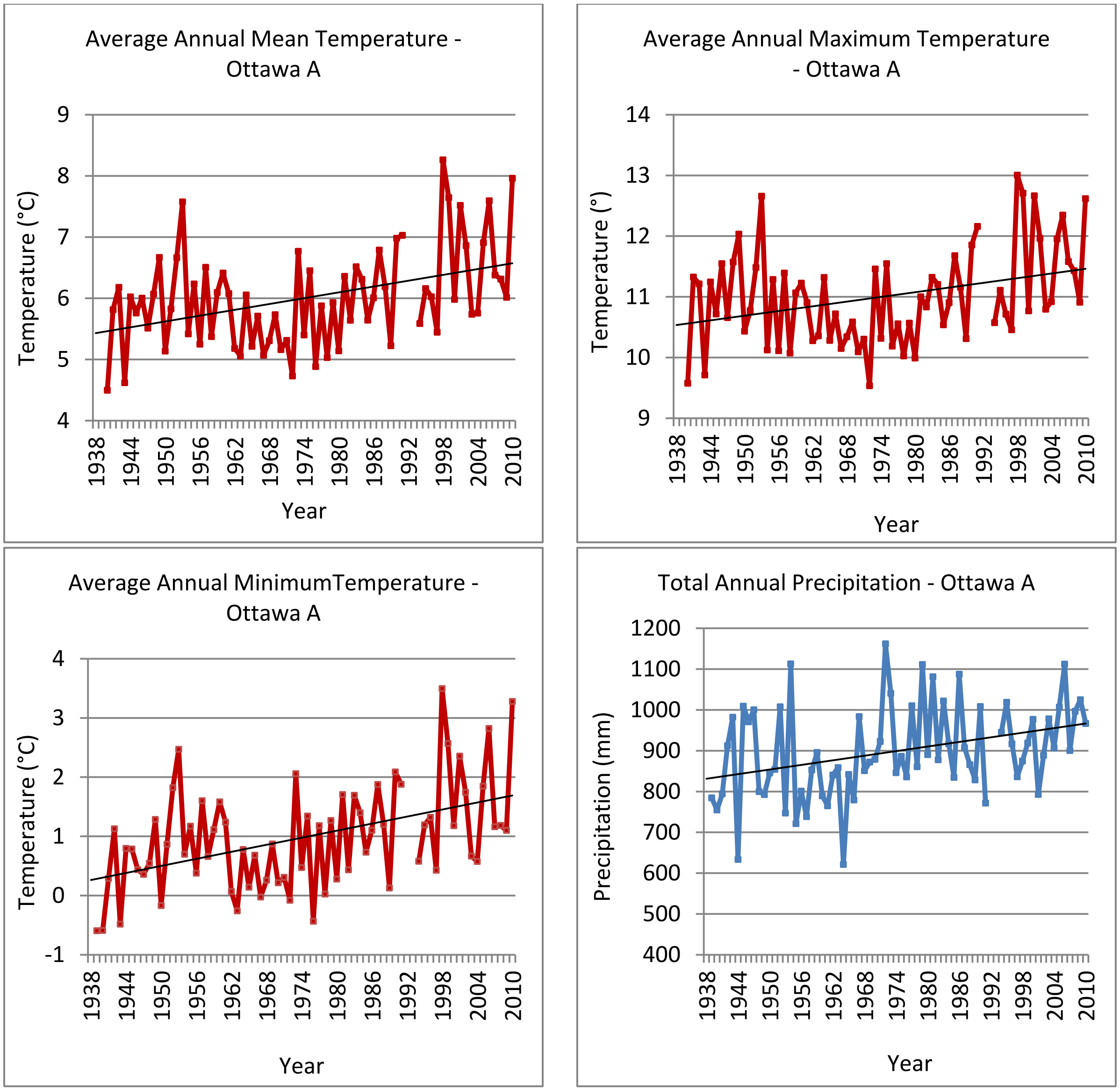

Figure 8: Average annual mean, maximum and minimum temperature (°C) and total annual precipitation (mm) from 1939 to 2010. A trend-line through the data from the Ottawa A weather station (Environment Canada, 2011) shows that average annual mean temperature has **increased 1.1 °C,** average annual maximum temperature has **increased 0.9°C**, average annual minimum temperature has **increased 1.3°C** and total annual precipitation **increased 142 mm** at this location over the 72 years of record.

Winter Temperature and Precipitation

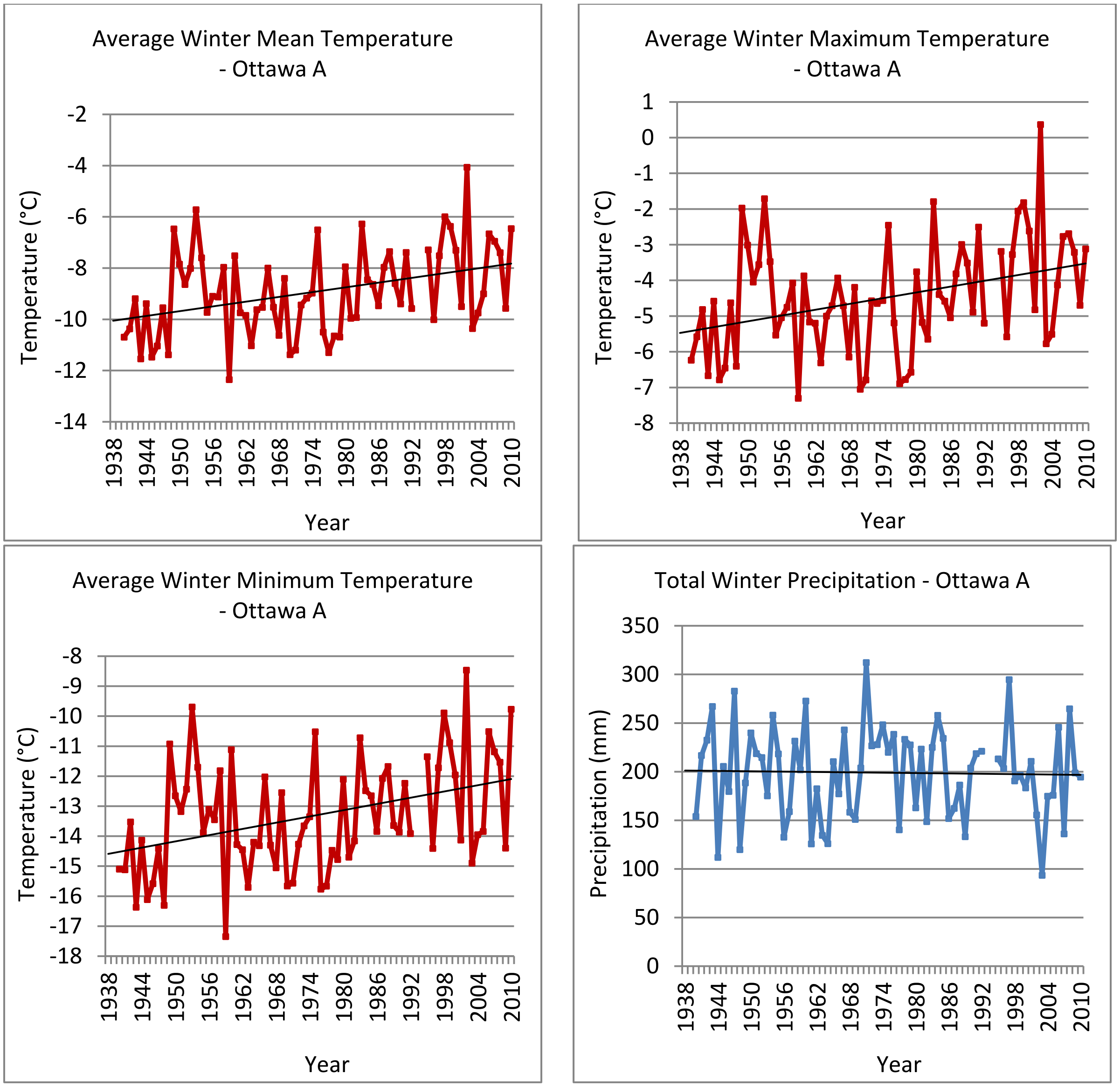

Figure 9: Average winter mean, maximum and minimum temperature (°C) and total winter precipitation (mm) from 1939 to 2010. A trend-line through the data from the Ottawa A weather station (Environment Canada, 2011) shows that average winter mean temperature has **increased 2.2 °C**, average winter maximum temperature has **increased 2°C**, average winter minimum temperature has **increased 2.5°C** and total winter precipitation has **decreased 9 mm** at this location over the 72 years of record.

Spring Temperature and Precipitation

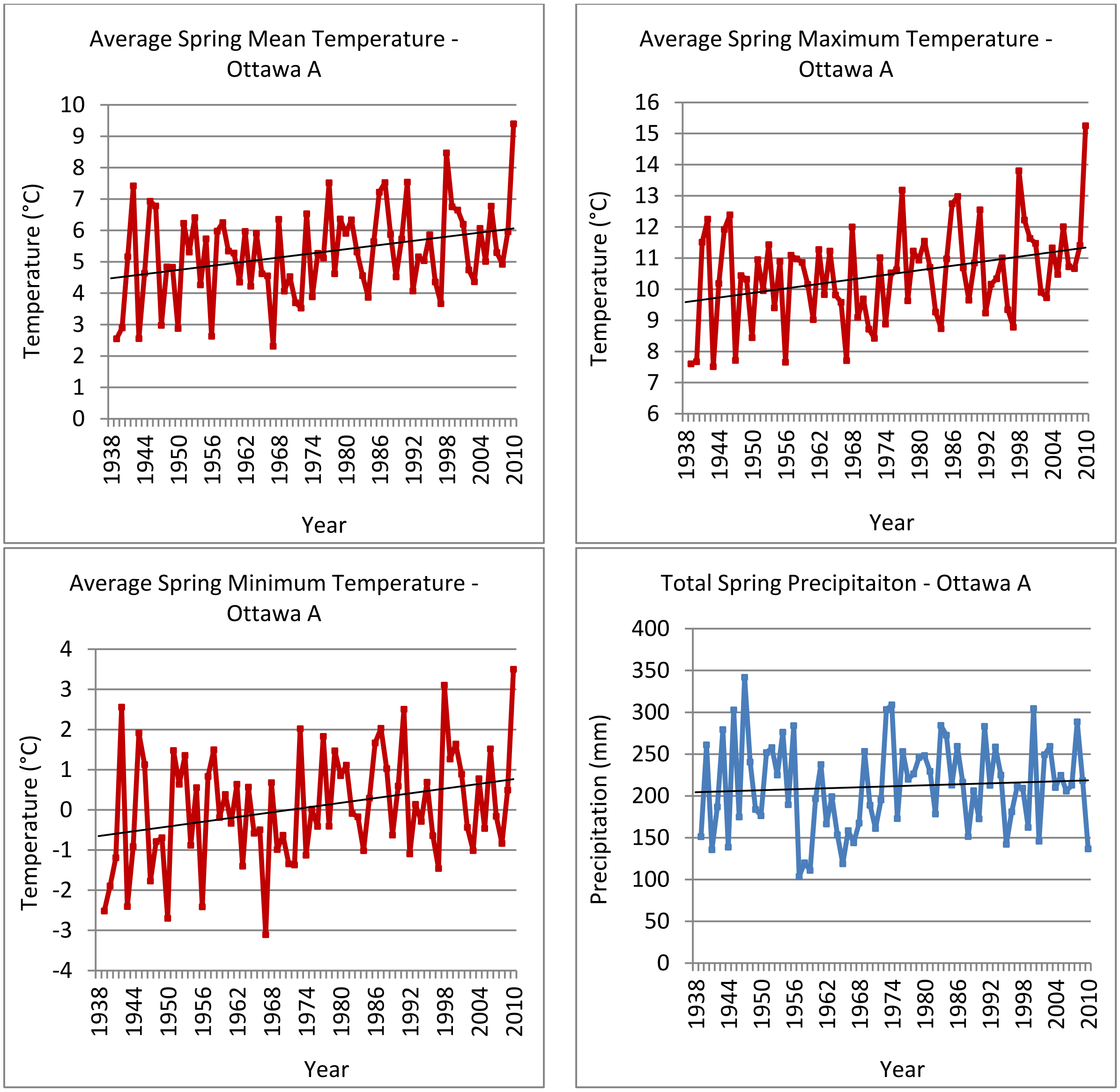

Figure 10: Average spring mean, maximum and minimum temperature (°C) and total spring precipitation (mm) from 1939 to 2010. A trend-line through the data from the Ottawa A weather station (Environment Canada, 2011) shows that average spring mean temperature has **increased 1.6°C**, average spring maximum temperature has **increased 1.7°C**, average spring minimum temperature has **increased 1.3°C** and total spring precipitation **increased by 15 mm** at this location over the 72 years of record.

Summer Temperature and Precipitation

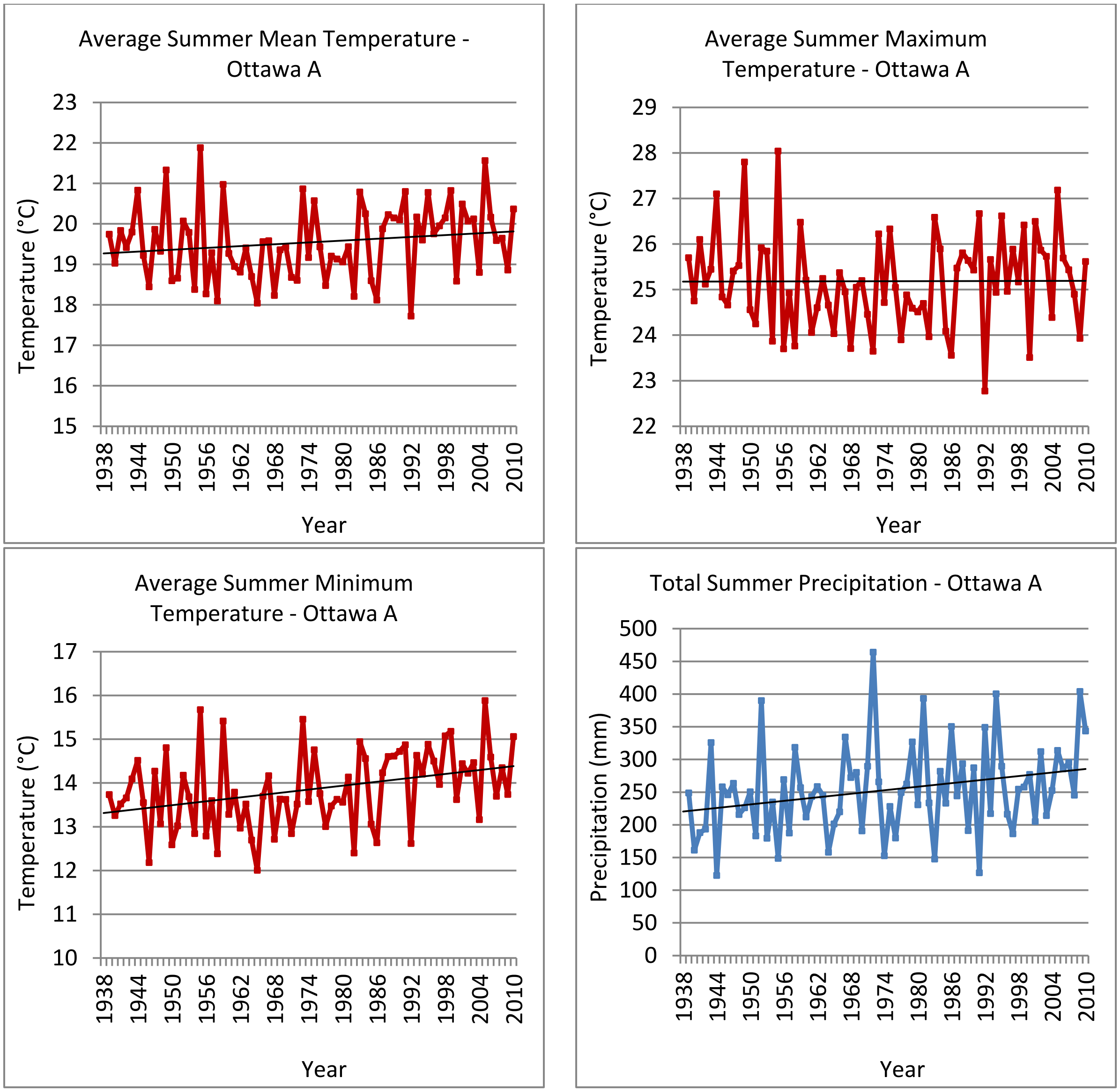

Figure 11: Average summer mean, maximum and minimum temperature (°C) and total summer precipitation (mm) from 1939 to 2010. A trend-line through the data from the Ottawa A weather station (Environment Canada, 2011) shows that average summer mean temperature has **increased 0.5°C**, average summer maximum temperature has **remained unchanged**, average summer minimum temperature has **increased 1.1°C** and total summer precipitation **increased 65 mm** at this location over the 72 years of record.

Fall Temperature and Precipitation

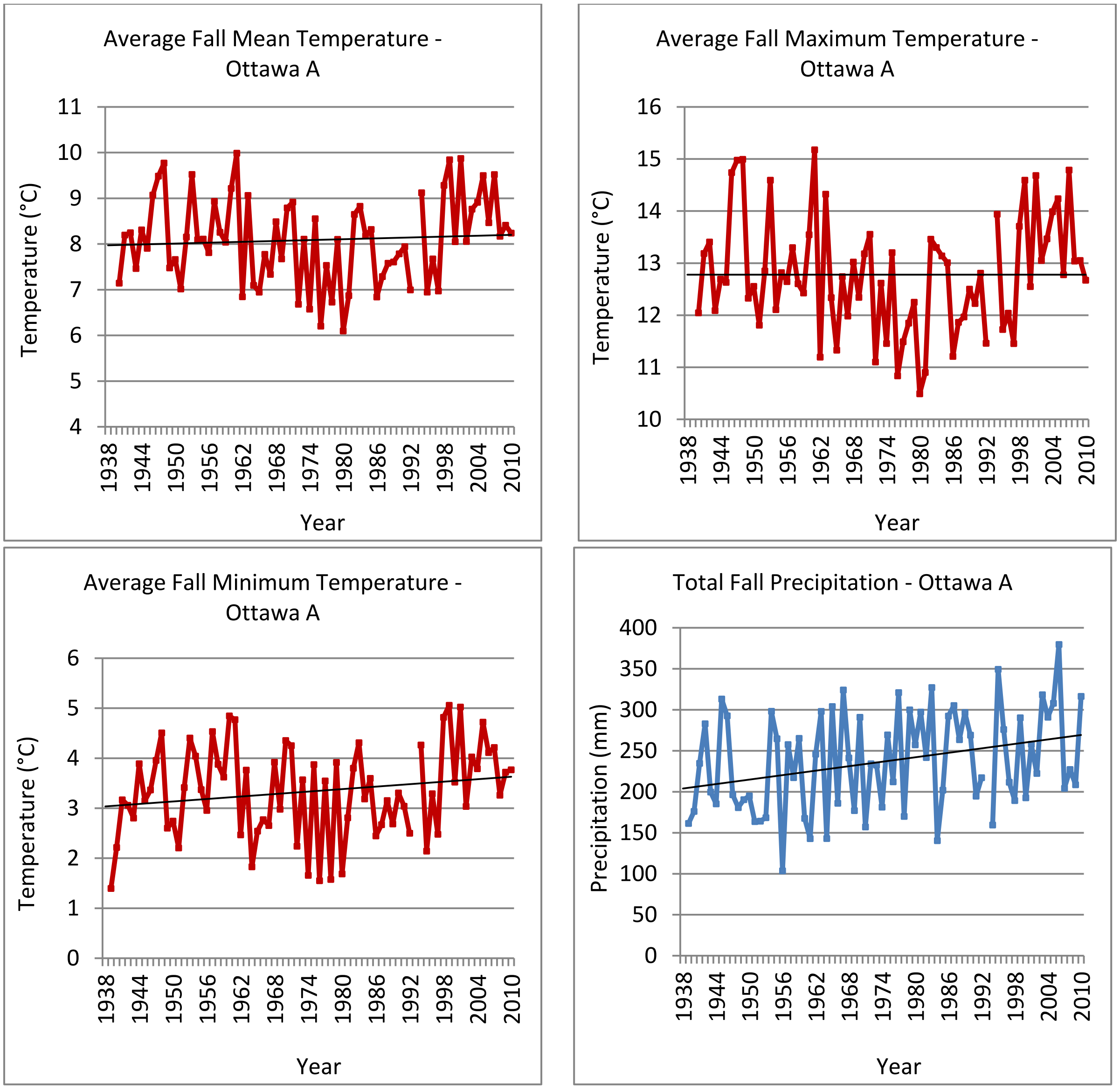

Figure 12: Average fall mean, maximum and minimum temperature (°C) and total fall precipitation (mm) from 1939 to 2010. A trend-line through the data from the Ottawa A weather station (Environment Canada, 2011) shows that average fall mean temperature has **increased 0.3°C**, average fall maximum temperature has **remained unchanged**, average fall minimum temperature has **increased 0.5°C** and total fall precipitation has **increased 66 mm** at this location over the 72 years of record.

The table below (Table 2) summarizes the change in temperature and precipitation for the period of record for each weather station.

Table 2: The following is a summary of changes in temperature and precipitation for the period of record for each weather station.

Climate Variable	Summary Ottawa CDA Amount Change (122 year record)	Ottawa A Amount Change (72 year record)
Annual		
Average Mean Temperature	+ 1.7 °C	+ 1.1 °C
Average Maximum Temperature	+ 0.8 °C	+ 0.9 °C
Average Minimum Temperature	+ 2.7 °C	+ 1.3 °C
Total Precipitation	+ 54 mm	+ 142 mm
Winter		
Average Mean Temperature	+ 3.0 °C	+ 2.2 °C
Average Maximum Temperature	+ 1.9 °C	+ 2.0 °C
Average Minimum Temperature	+ 4.0 °C	+ 2.5 °C
Total Precipitation	+ 44 mm	+ 9 mm
Spring		
Average Mean Temperature	+ 1.8 °C	+ 1.6 °C
Average Maximum Temperature	+ 1.1 °C	+ 1.7 °C
Average Minimum Temperature	+ 2.5 °C	+ 1.3 °C
Total Precipitation	+ 28 mm	+ 15mm
Summer		
Average Mean Temperature	+ 0.9 °C	+ 0.5 °C
Average Maximum Temperature	- 0.4 °C	0 °C
Average Minimum Temperature	+ 2.1 °C	+ 1.1 °C
Total Precipitation	0 mm	+ 65 mm
Fall		
Average Mean Temperature	+ 1.4 °C	+ 0.3 °C
Average Maximum Temperature	+ 0.7 °C	0 °C
Average Minimum Temperature	+ 2.2 °C	+ 0.5 °C
Total Precipitation	+ 70 mm	+ 66 mm

Future Climate

Ensemble Projections for Eastern Ontario

The following maps (Figures 13 – 18) were created by the Canadian Climate Change Scenarios Network at Environment Canada (www.cccsn.ca). The temperature and precipitation maps are ensemble projections of 24 global climate models using a medium emissions scenario. According to the CCCSN (2011), the 'medium' projection represents the mean of the combination of low (B1) and high (A1B) projections, with the 'low' projection representing the all-model mean resulting from the least aggressive emission assumption (the result from the commonly referenced SRES-B1 scenario) and correspondingly, the 'high' projection results indicate projected changes with the most aggressive emission assumption. The maps show the mean change from 1961-1990 to 2040–2070 (or 2050s). Values are summarized in Table 3.

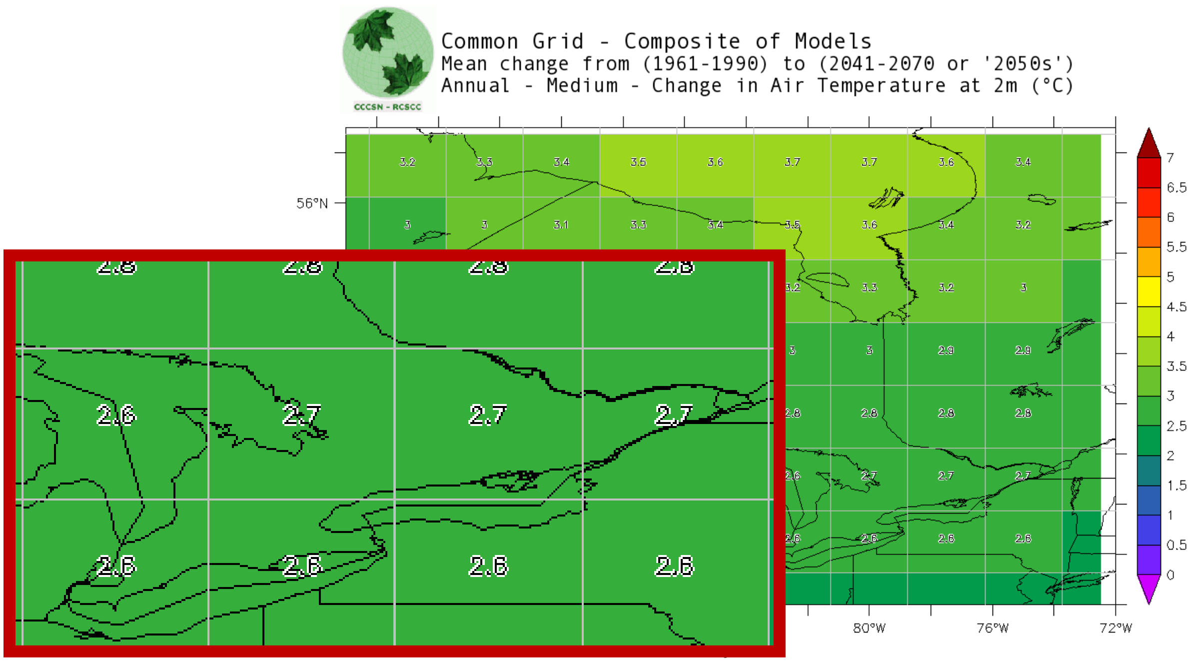

Figure 13: Projected Change in Annual Air Temperature (CCCSN, 2010). Ensemble projection shows a change in mean annual air temperature from 1961–1990 to 2041–2070 or 2050s; medium emissions scenario. Projection for Eastern Ontario shows a 2.7°C increase by the 2050s.

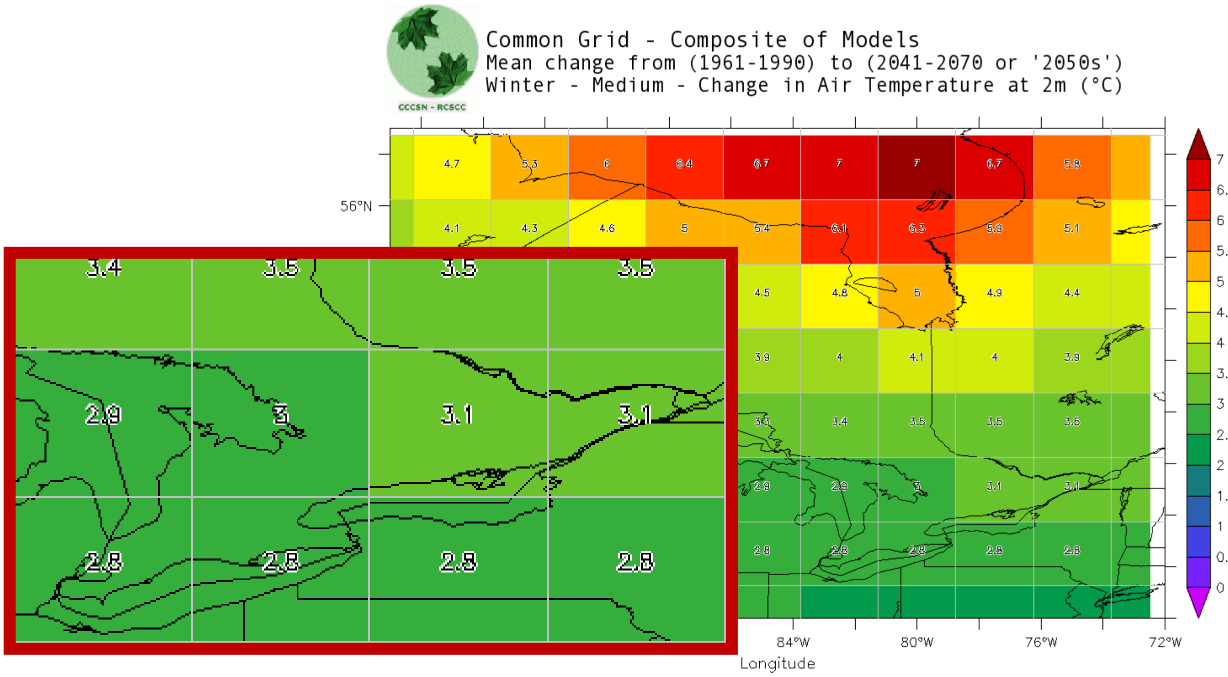

Figure 14: Projected change in winter air temperature (CCCSN, 2010). The ensemble projection shows the change in mean winter air temperature from 1961–1990 to 2041–2070 or 2050s; medium emissions scenario. Projection for Eastern Ontario shows a 3.1C increase by the 2050s.

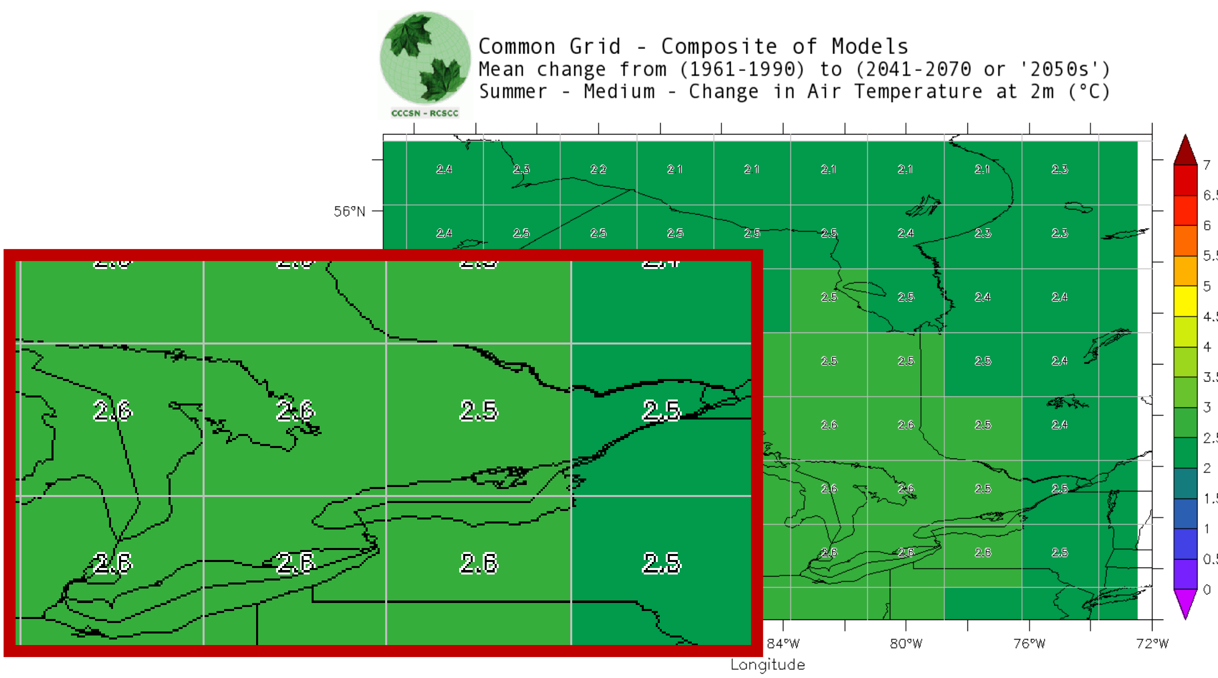

Figure 15: Projected Change in Summer Air Temperature (CCCSN, 2010). The ensemble projection shows the change in mean summer air temperature from 1961–1990 to 2041–2070 or 2050s; medium missions scenario. Projection for Eastern Ontario shows a 2.5°C increase by the 2050s.

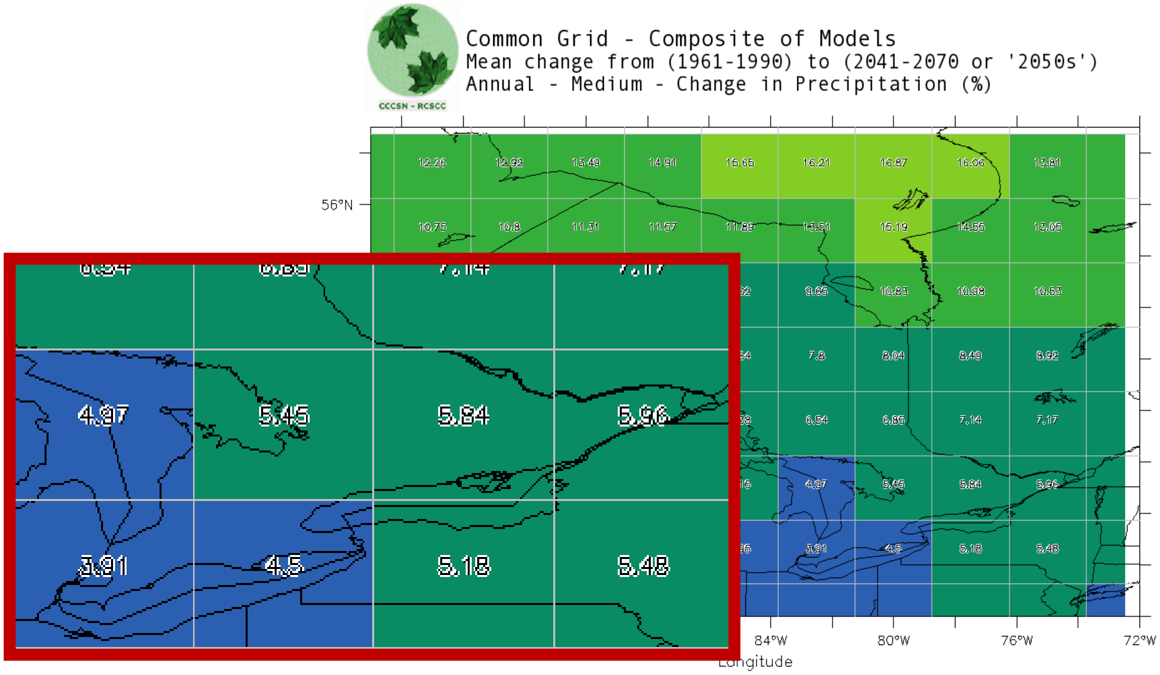

Figure 16: Projected Change in Annual Precipitation (CCCSN, 2010). The ensemble projection shows the change in annual precipitation from 1961–1990 to 2041–2070 or 2050s; medium emissions scenario. Projection for Eastern Ontario shows a 5.8% to 5.9% increase by the 2050s.

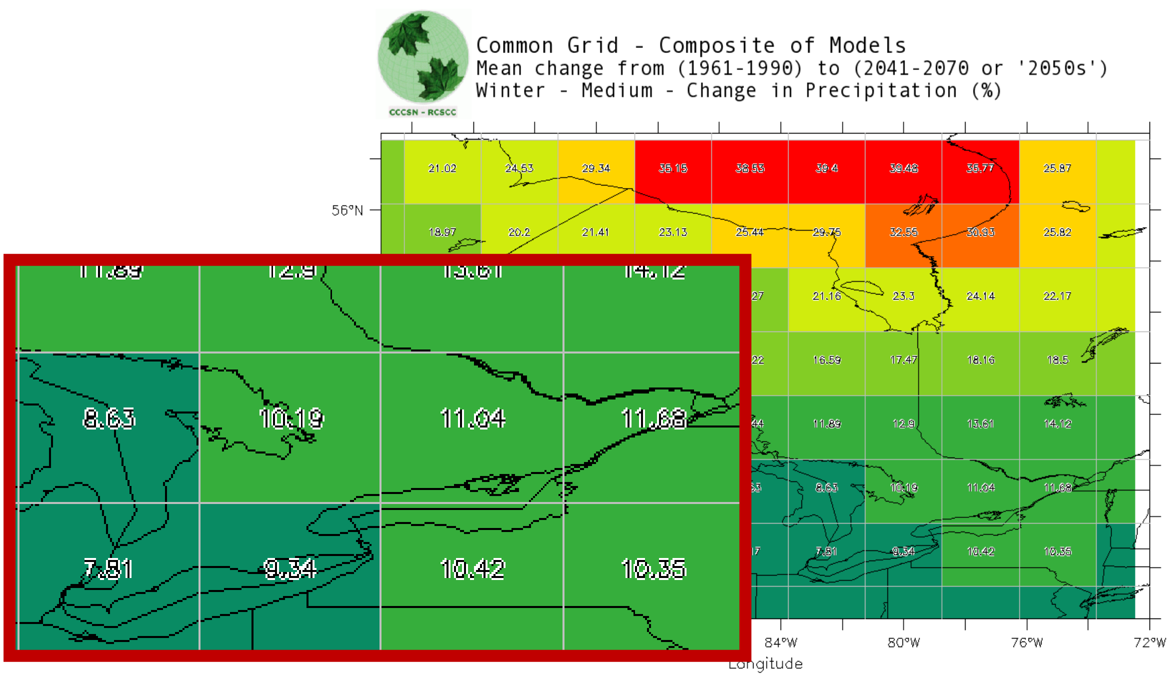

Figure 17: Projected Change in Winter Precipitation (CCCSN, 2010). The ensemble projection shows the change in winter precipitation from 1961–1990 to 2041–2070 or 2050s; medium emissions scenario. Projection for Eastern Ontario shows an 11% to 11.6% increase by the 2050s.

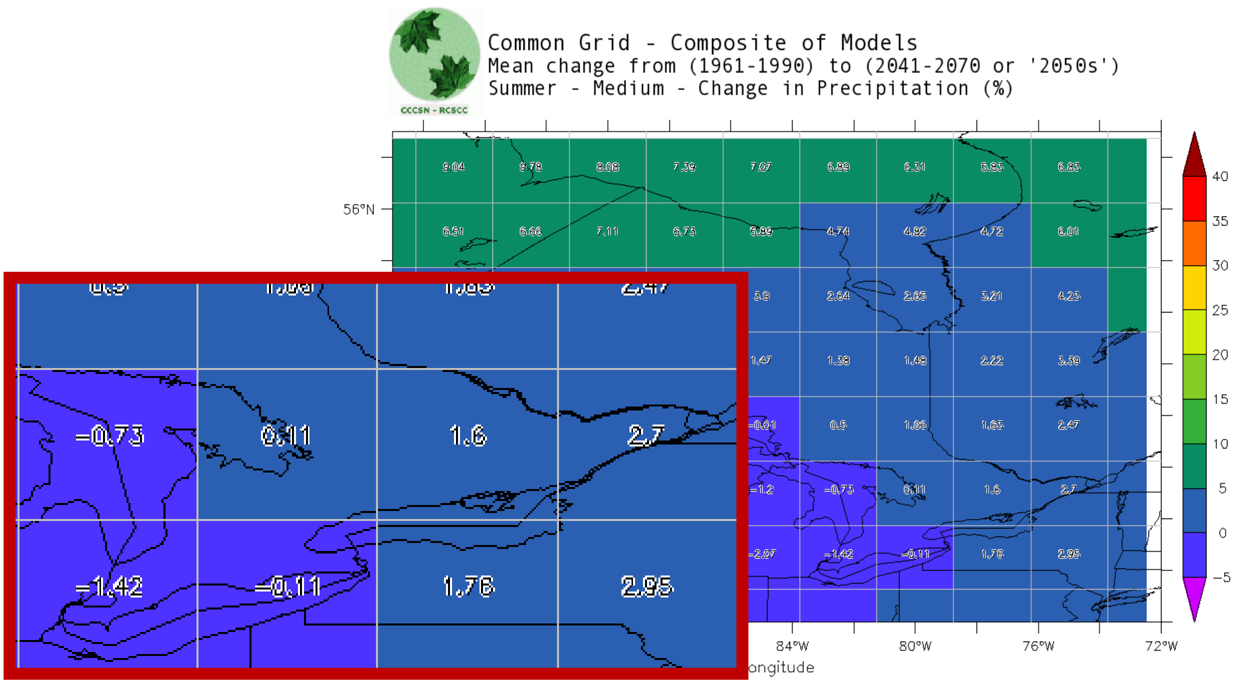

Figure 18: Projected Change in Summer Precipitation. The ensemble projection shows the change in summer precipitation from 1961–1990 to 2041–2070 or 2050s; medium emissions scenario. Projection for Eastern Ontario shows a .1.6% to 2.7% increase by the 2050s.

Table 3: The following is a summary of the projected changes in temperature and precipitation, in Eastern Ontario, for the 2050s.

Summary

Climate Variable	Projected Change – 2050s
Annual Air Temperature	+ 2.7°C
Winter Air Temperature	+ 3.1°C
Summer Air Temperature	+ 2.5°C
Annual Precipitation	+ 5.8 to 5.9%
Winter Precipitation	+ 11 to 11.6%
Summer Precipitation	+ 1.6 to 2.7%

Resources for Eastern Ontario

The following are a few climate change impacts and adaptation resources focused on eastern Ontario.

Casselman, J.M., S. Kunjikutty, P. Lehman, L. Marcogliese, and J. Oblak. 2011. Report – Fish, Fisheries, and Water Resources: Adapting to Ontario's Changing Climate. Report to Natural Resources Canada, Climate Change Impacts and Adaptation Directorate, Study A1367, Ottawa, Canada, in conjunction with Queen's University and Mississippi Valley Conservation. March 2011.

- http://www.mvc.on.ca/images/stories/NRCAN%20report%20Part%201%20of%202%20submitted%2020110330%20Casselman%20et%20al.%20A1367.pdf
- http://www.mvc.on.ca/images/stories/NRCAN%20report%20Part%202%20of%202%20submitted%2020110330%20Casselman%20et%20al%20A1367.pdf
- http://www.mvc.on.ca/conservation-education/climate-change

McLeman, R. Adapting to Climate Change in Addington Highlands, North Frontenac and Region. http://www.addington.uottawa.ca/addington.html

Egginton, P., and Lavender, B. 2009. From Impacts Towards Adaptation: Mississippi Watershed in a Changing Climate.

- http://www.mvc.on.ca/conservation-education/climate-change
- http://www.mvc.on.ca/program/ccreport2009.pdf

Conclusion

Ontario communities are already experiencing the impacts of climate change and will continue to into the future. In order to reduce the negative impacts associated with these changes, communities need to prepare through adaptation. This workshop is meant to help communities understand how climate change will impact their systems, learn what others are doing and discuss the next steps – essentially building the capacity to adapt.

Climate Change Considerations

The following questions provide a means of encouraging discussion of climate change at the local level.

Responses to climate change can be mitigative (reduce greenhouse gas emissions) – i.e. energy conservation, energy efficiency, greenhouse gas reductions, alternative energy sources, carbon capture/storage, and/or adaptive – i.e. managing stormwater/flood protection, water management/operational changes, heat alert plans, drought plans, water budgeting, tree planting and others. It is important to note that some actions, like the use of 'green infrastructure' including green roofs, trees, and swales, are both mitigative and adaptive. It is also important that any adaptation actions taken not increase greenhouse gas emissions – these are known as 'mal-adaptations'.

1. Is there recognition within your community and watershed that changes in climate are affecting and will continue to have an impact on natural and built systems?

2. Has your municipality considered developing a climate change plan (mitigation and/or adaptation)? Has climate change been considered in any planning process?

Excess waste water and extreme weather events leading to flooding have been specifically challenging to cities and conservation authorities across the province. Changes to the timing and extent of peak river/stream flow challenge traditional ways of dealing with the natural waste water.

3. Do you think that changes to temperature and precipitation over the past 20-30 years have imposed greater challenges in managing stormwater? Has your municipality made any changes to reflect that? What barriers are there that may impede structural changes to those systems (budget constraints, limited human resources, lack of technology, lack of time, other priorities, other)?

4. Are there other sectors or components of sectors that would be threatened by climate variability/climate change, i.e. ice fishing, skiing, agricultural operations, forests (fire), local lakes, fish populations, buildings, bridges, groundwater wells, human health and well-being, locally valued species, invasive species or pests, etc?

The Province of Ontario is committed to reductions of greenhouse gases – 6% below 1990 levels by 2014 and 15% by 2020. Water and energy conservation are ways to combat climate change, both on the mitigation and adaptation front. Opportunities also exist for economic growth in the green energy sector through local power generation.

5. Has your community developed any programs or policies related to energy/water conservation or efficiency?

6. Have any local companies expressed an interest in developing green energy (products), i.e. wind, solar, wood pellets, fibre, biomass, etc?

Impediments and facilitators for climate change planning and action exist and can be a function of capacity within a community setting. Although some Ontario communities tend to have fewer resources, they also have inherent strengths that give them an advantage when it comes to facing weather/climate adversity.

7. Are there specific items that would enable mitigation/adaptation planning in your area (specifically for storm water management planning) (climate/weather data, information, tools, human resources, financial support, political support)?

Additional Questions

8. Has climate change been a consideration with emergency management personnel?

9. Are you aware of any benefits that may result from a changed climate and how might your community take advantage of such changes? E.g. extended summer tourism, agricultural opportunities, harvesting of stormwater for irrigation, etc.

Definitions

The definitions are drawn from the Intergovernmental Panel on Climate Change reports (2001, 2007), From Impacts to Adaptation (2008) and the Canadian standard *"Risk Management: Guidelines for Decision-Makers"* (CAN/CSAQ850-97).

Adaptation

Adaptation is initiatives and measures taken 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

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

Adaptation costs

Adaptation costs are the costs of planning, preparing for, facilitating, and implementing adaptation measures, including transaction costs.

Adaptive capacity

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

Barrier

A barrier is 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 change

Climate change in lay terms refers to any change in *climate* over time, whether due to natural variability or as a result of human activity. This usage differs from that in the *United Nations Framework Convention on Climate Change (UNFCCC)*, which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global *atmosphere* and which is in addition to natural climate variability observed over comparable time periods'. See also *climate variability*.

Climate scenario

A climate scenario is 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 scenarios are based on a combination of GHG emissions and patterns of human consumption and growth.

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 event is 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 hazard is 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

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

Impacts (Climate change)

Impacts are 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.

Mean Temperature

Mean temperature is defined as the average of temperature readings taken over a specified amount of time; for example, daily mean temperatures are calculated from the sum of the maximum and minimum temperatures for the day, divided by 2 (Environment Canada, 2008).

Maximum temperature

Maximum temperature is the highest or hottest temperature observed for a specific time interval and minimum temperature is the lowest or coldest temperature for a specific time interval (Environment Canada, 2008).

Precipitation

Precipitation includes any and all forms of water, liquid or solid that falls from clouds and reaches the ground and is expressed in terms of vertical depth of water which reaches the ground during a stated period (Environment Canada, 2008). Total precipitation (mm) is the sum of all rainfall and the water equivalent of the total snowfall observed during the day (Environment Canada, 2008). According to Environment Canada (2008), most ordinary stations compute water equivalent of snowfall by dividing the measured amount by ten; however, at principal stations it is usually determined by melting the snow that falls into Nipher gauges. This method normally provides a more accurate estimate of precipitation than using the "ten-to-one" rule (Environment Canada, 2008).

Projection

A projection is 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

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

Resilience

Resilience is 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

Risk is 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 assessment

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

Risk communication

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

Risk control option

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

Risk estimation

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

Risk evaluation

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

Risk information library

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

Risk management

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

Risk perception

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

Risk scenario

A risk scenario is a defined sequence of events with an associated frequency and consequences.

Vulnerability

Vulnerability is 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.

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