2010

Climate Change and Conservation Authorities in Northern Ontario

Final Report

Ontario Centre for Climate Impacts and Adaptation Resources
OCCIAR

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

Regional Adaptation Collaborative

The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) is a partner in Natural Resources Canada's Regional Adaptation Collaboratives (RACs) Climate Change Program. It is a three year program to help Canadians reduce the risks and maximize the opportunities posed by climate change. The Program helps communities and other stakeholders prepare for and adapt to local impacts posed by changing climate, such as: decreasing fresh water supplies; increasing droughts, floods and coastal erosion; and changing forest, fish and agricultural resources. The goal of the Program is to catalyze coordinated and sustained adaptation planning, decision-making and action, across Canada's diverse regions. The RACs Program is a partnership between the federal government, provinces and territories, working with local governments and organizations.
http://adaptation.nrcan.gc.ca/collab/index_e.php

Acknowledgements

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Climate Change and Conservation Authorities in Northern Ontario

Final Workshop Report

February 16 – 17, 2010

Travelodge Hotel, Sudbury

Ontario Centre for Climate Impacts and Adaptation Resources
at
MIRARCO

Workshop Highlights

- Interest in climate change adaptation at Conservation Authorities in the north is high, however, the level of action on climate change adaptation is higher in Southern Ontario, most likely due to the availability of more resources.
- Conservation Authorities in the north are very interested in local climate data and projections of climate in their watershed.
- The values of Conservation Authorities fits well with the leadership required to respond to the impacts of climate change. They bring the issue of climate change to the community.
- Some municipalities are heavily engaging Conservation Authorities in southern Ontario on the issue of climate change and some are finding it difficult to keep pace. Northern Conservation Authorities should be prepared for this to happen to them.
- Conservation Authorities feel that there needs to be leadership and coordination at and between all levels of government.
- The idea of a business case for climate change is needed as much for Conservation Authorities as it is for communities and the private sector.
- Many municipalities in Ontario have had to “react” to climatic hazards like the extreme rainfall in Sudbury in 2009. For some, these climatic events have been a ‘wake-up call’, realizing that this may become more common in the future and that more or larger areas may be affected with huge implications for the safety of people and property.

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Communication – Day One Wednesday February 17, 2010	
11:45 am – 11:50 am	Welcome
11:50 am – 12:00 pm	Introduction by Conservation Ontario
12:00 pm – 12:30 pm	Lunch
12:30 pm – 12:40 pm	Introduction of Regional Environmental Education Leads by OCCIAR
12:40 pm – 1:25 pm	**Climate Science and Current Knowledge of Climate Change Threats in Northern Ontario** David Pearson, Co-Chair, Ontario's Expert Panel on Climate Change Adaptation
1:25 pm – 1:45 pm	**Roundtable Discussion** – Participants will introduce themselves and talk about challenges they are already facing and also issues they see looming in their watersheds.
1:45 pm – 2:30 pm	**Adaptation and Source Water Protection** Kathy Zaletnik-Hering – Ontario Ministry of the Environment
2:30 pm – 3:15 pm	**Ecosystem Adaptation** Paul Gray – Ontario Ministry of Natural Resources
3:15 pm – 3:30 pm	**Break**
3:30 pm – 4:15 pm	**Tourism and Recreation** Christopher Lemieux – University of Waterloo
4:15 pm – 5:00 pm	**Adaptation in Industry - Natural Resource Sectors** Blair Feltmate, University of Waterloo
5:00 pm – 5:10 pm	**Wrap-up for Day One**

Adaptation Tools and Role of Conservation Authorities – Day Two Day Two – Wednesday February 17, 2010	
8:00 am – 8:30 am	**Welcome to Day Two with a Light Breakfast**
8:30 am – 9:15 am	**Towards Adaptation in Northern Ontario – Tools and Frameworks** Al Douglas, Ontario Centre for Climate Impacts and Adaptation Resources
9:15 am – 10:00 am	**Climate Change and Human Health** (via webcast) Peter Berry and Kaila-Lea Clarke – Health Canada
10:00 am – 10:15 am	**Break**
10:15 am – 11:00 am	**Adaptation Perspectives from other Ontario Conservation Authorities** Don Haley – Toronto Region Conservation Authority
11:00 am – 11:45 am	**Urban Flooding** Dan Sandink, Institute of Catastrophic Loss Reduction
11:45 am – 12:00 pm	**Introduction to afternoon session** Al Douglas, Ontario Centre for Climate Impacts and Adaptation Resources
12:00 pm – 12:45 pm	**Lunch**
12:45 pm – 2:45 pm	Interactive Risk Management Session **Quantifying and Managing Vulnerabilities and Risks in your Watershed** Al Douglas, Ontario Centre for Climate Impacts and Adaptation Resources David Pearson, Co-Chair Ontario's Expert Panel on Climate Change Adaptation
2:45 pm – 3:00 pm	**Working Session Wrap-up**
3:00 pm – 3:45 pm	**Roles and Responsibilities of the Conservation Authority: Discussion** David Pearson, Co-Chair Ontario's Expert Panel on Climate Change Adaptation
3:45 pm	**Closing Remarks**

Presentations

The following are brief summaries of the presentations made at the workshop. Presentations are available for viewing on the www.climateontario.ca website.

Climate Science and Current Knowledge of Climate Change Threats in Northern Ontario
David Pearson, Co-Chair, Ontario's Expert Panel on Climate Change Adaptation

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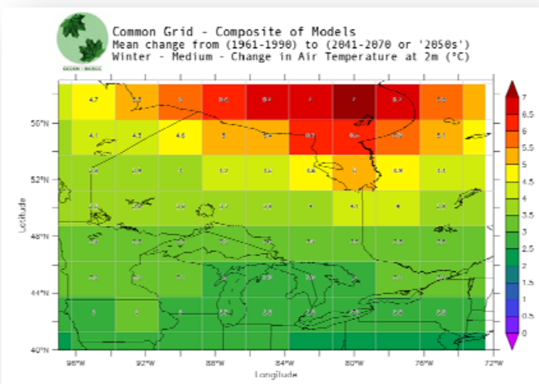
David Pearson began the workshop by giving an overview of climate science and touched on some climate change threats relevant to Northern Ontario. He discussed the last glaciation when Northern Ontario was covered by ice and reminded the audience that the magnitude of the global annual temperature difference between then and now is only about 5°C.

Dr. Pearson continued by talking about the geometry of the earth, the geological past and the ocean and their connection to temperature and carbon dioxide. Looking more recently at the annual temperature trend, across Canada, from 1948 to 2008, warming has occurred, with most of the warming in the northwest. Ontario has experienced warming of between 0.4 and 1.4°C.



The impacts to Northern Ontario will be seen in many sectors. For example, winter tourism is expected to be impacted because of shorter, warmer winters. Less reliable snow conditions, more rain and less snow and later, shorter lake ice cover period will have an impact on cross country skiing and snowmobiling. Downhill skiing operations will have to rely on more snow-making.

Longer ice free periods on lakes will lead to more evaporation. Work done by Bill Keller (2007) suggests that Sudbury lakes may see an increase in the ice free period of up to 9 days by the 2020s, 17 days by the 2050s and 29 days by the 2080s. Increased evaporation may lead to lower lake levels, lower soil moisture, less ground water recharge and lower water table, water quality and quantity issues, loss of wetland habitat and species, loss of spawning beds and shoreline infrastructure issues. In order to reduce and manage the risk of these impacts, Ontario needs to build resilience through adaptation.

Roundtable Discussion

In the roundtable discussion, participants were asked to introduce themselves and talk about challenges they are already facing and also issues they see looming in their watersheds.

Nickel District Conservation Authority
http://www.nickeldistrict.ca/

With respect to climate change, in March 2009 the Nickel District Conservation Authority released a position paper on climate change in the City of Greater Sudbury; in June of 2009, they had a one day session with senior staff; in September a community collaborative was assembled to look at adaptation; and in November the concept of the Greater Sudbury Climate Consortium became a reality. It is a community based initiative and partners include academia, business and the health sector.

With respect to the city, the Nickel District Conservation Authority is bringing them along to future thinking – what adaptation will have to be done.

On July 26, 2009, an isolated storm event deposited 3.5 inches of rain in a 1.5 hour period. The storm resulted in $30 to $40 million in damage which was mostly residential (5km^2 area). Luckily there was no loss of life. The Nickel District Conservation Authority recognizes that events like this one could occur more often into the future.

Mattagami Region Conservation Authority
http://mrca.timmins.ca/

There is not a lot of dialogue with respect to climate change is this region and they do not have any educational facilities to call upon for assistance. However, two events have occurred in their community that has driven their attention to the impacts of climate change. The first is that they were required to address climate change in their source water protection plans. The second is the OCCIAR workshop that was held in Timmins which looked at the impact of climate change on forestry and mining. The Mattagami Region Conservation Authority received the workshop report and is planning on sharing it with the Mayor and council.

The Mattagami Region Conservation Authority has begun to take small steps with respect to environmental education programs and is planning on promoting climate change through information brochures and story boards (e.g. alternative energy information).

Lakehead Region Conservation Authority
http://www.lakeheadca.com/

The Lakehead Region Conservation Authority is situated at the head of Lake Superior. Working with Lakehead University, their Source water protection plan took climate change into account.

The Lakehead Region Conservation Authority is aware of local climate change impacts including less snow, ice forming later in the year and longer shipping seasons. The floodway in Thunder Bay has also been operational more often in the last 10 years because of the spring freshet and intense rain.

The City of Thunder Bay's local environmental agency, Earthwise, has been proactive in education the public about climate change impacts and adaptation.
http://www.thunderbay.ca/Living/Environment/EarthWise_Thunder_Bay/Background.htm

Sault Ste Marie Region Conservation Authority
http://www.ssmrca.ca/

The Sault Ste Marie Region Conservation Authority is at the 'hub of the Great Lakes' and is beginning to consider climate change impacts and mitigation measures. They are beginning the climate change component of their source water protection plan and have severe data gaps. They have noticed that severe events are more common and will look at this with respect to infrastructure (e.g. flood control channels, flood forecasting). The Sault Ste Marie Region Conservation Authority is interested in the impacts of climate change on the shoreline.

Driven by a decline in water quality due to sediments washing into the system, and at the strong urging of the Conservation Authority, the City of Sault Ste Marie undertook a stormwater management plan study.

The Sault Ste Marie Region Conservation Authority will hire an engineer to help with climate change issues. They feel that climate change will impact recreation and tourism in the area (including conservation areas). They have in the past and are presently working with educators, boy and girl scouts, the Envirothon and various community groups (events).

North Bay – Mattawa Conservation Authority
http://www.nbmca.on.ca/

Most of the things happening in the North Bay – Mattawa Conservation Authority are mitigative as they are popular to do and have economic value (e. g. water metering). There is a strong move to more energy efficient lighting, methane power generation in the landfill (compost versus methane). They are working on their source water protection plan.

A series of weather events have given North Bay 'a push'. Two years ago, 2 rural communities received 150 mm of rain over a 4 hour period of time. This event affected 1500 to 2000 people and damaged infrastructure ($3,500,000.00). If this occurred in the city there would have been massive damage.

The North Bay – Mattawa Conservation Authority is particularly concerned about the Lake Nipissing shoreline which is prone to erosion. It is also beginning to build capacity within their group by coming to workshops like this one.

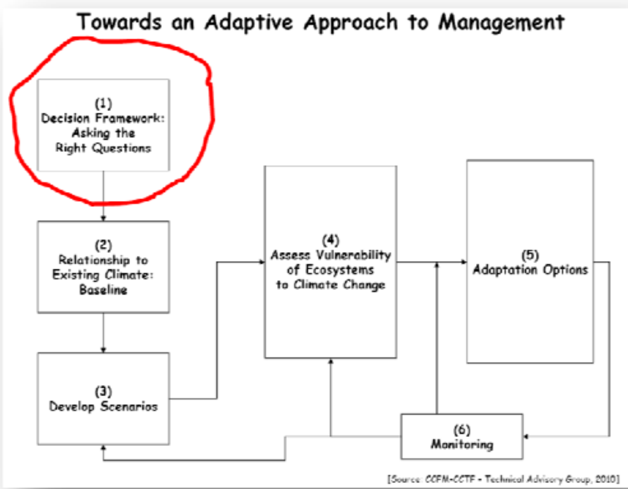
Ecosystem Adaptation

Climate Change and Ontario's Ecosystems: an Adaptive Approach to Management

Paul Gray – Ontario Ministry of Natural Resources

We love to travel and visit ecosystems and as the population increases, the demand for access to resources will continue to increase. We need to begin dealing with climate change. There are two sides of climate change, mitigation and adaptation, and although different, they are connected.

Decision frameworks can aid in adaptation. The first step of a decision framework is 'asking the right questions'. It's important to remember that there are always different values sets and perspectives to consider (e. g. species, administrative, industrial, watersheds, ecosystems). We also have to determine if we are ready to adapt and do we have leadership. Tools that help include strategic planning and adaptive management.



After the questions are asked and answered, the next step involves asking how the future will look. This involves developing relationships to existing climate baselines and developing scenarios. Since the future depends on how people behave, the models are uncertain. We have to consider a range of possibilities (good, bad and moderate scenarios).

The next step is assessing the vulnerability of ecosystems to climate change. Some species will adapt and others will not (i.e. moose, Eastern Bluebird, invasive earthworms, fish). There will also be impacts in other areas, such as fire management, permafrost and Lyme disease.

The next step is developing adaptation options, which involves thinking, money and experts. With respect to ecosystems there are three perspectives: 1) human adaptation to changing ecosystems; 2) ecosystem adaptation; and 3) human activities that influence adaptation.

The last step in this iterative process is monitoring after adaptations have been set up.

Tourism and Recreation: Changing the Way we Play: Climate Change, Tourism and Recreation

Christopher Lemieux – University of Waterloo

Dr. Lemieux began his presentation by talking about different impact pathways such as mitigation which will increase the cost of travel in order to offset carbon emissions; direct changes in climate that may alter the length and quality of the tourism season; and altering environmental resources.

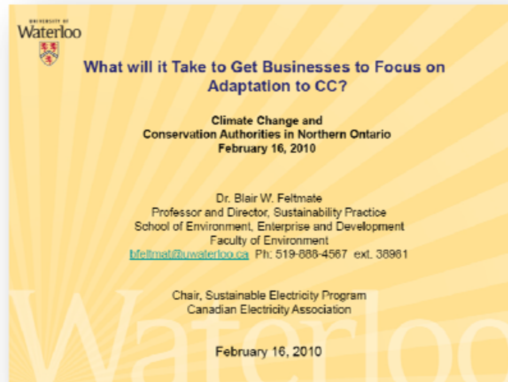
Seasonality and the relationship between climate and activities are very important. Variation within one year could have major impacts to tourism (e. g. tornado at Halfway Lake in 2002). In 2001, Collingwood experienced its longest ski season in 60 years, increasing revenues 18%. Above normal winter temperatures delayed opening of the Rideau Canal Skateway by six weeks in 2001 and in 2006 snowmobile trails remained closed until late January. Low water levels in the Great Lakes in 2002 resulted in inaccessible docks and launch ramps. Warmer summer temperatures in 2005 contributed to an increase in day trips to provincial parks by 30%.

Changes in weather and resulting impacts on natural resources such as altered lake effect snow patterns, reduced snow cover and snow depth and reduced ice cover and ice thickness will shorten the winter tourism season for skiing, snowmobiling and ice fishing. For example, it is projected that the Nordic skiing season at Horseshoe Valley in Ontario could see a shortened season by 52% in the 2020s, 65% in the 2050s and 86% in the 2080s. Following a low emission scenario, snowmobiling in Sudbury could be shortened by 24% in the 2020s and 33% in the 2050s; however, under a worst case scenario those decreases could rise to 52% in the 2020s and 95% in the 2050s. Activities that require natural snow and ice, such as Nordic skiing, snowmobiling and ice fishing are highly vulnerable to climate change. Technological and economic barriers limit the use of snowmaking as an adaptation option.

Extended and improved warm-weather season could provide opportunities as well as pose threats to summer tourism. Ontario provincial parks could see an increase in park visitation of 11 to 27% by the 2020s and 15 to 56% by the 2050s. It will also increase the ecological stress of the park, exacerbate crowding at popular locations, increase the financial costs of additional visitors and increase maintenance costs. Increased heat may also prevent people from visiting parks altogether.

Climate change represents a multifaceted challenge to the tourism sector, providing opportunities and posing threats, with different emission scenarios leading to very different futures. Rural tourism is dependent on environmental resources which make it more vulnerable to climate change; however, the net impact on tourism in Ontario still remains uncertain.

Adaptation in Industry - Natural Resource Sectors
What will it take to get Businesses to Focus on Adaptation to CC?
Blair Feltmate, University of Waterloo



Dr. Feltmate began his presentation by stating that not much is happening across industry sectors with respect to climate change. He stated that there are limitations that need to be addressed before the private sector is to embrace climate change.

First of all, many business leaders are still not convinced that climate change is real. The challenge to convince them is enormous and the science needs to be published in business literature in a ‘user-friendly’ form.

For those who accept that climate change is real, there is a need for industry specific climate change adaptation guidance documents. Industry needs key issues that have a high severity and high probability of occurrence identified. In addition to the direct impacts, high probability cascading impacts also need to be identified. For example, how will climate change affect the demand on electricity of other sectors (mining, forestry) and how will more rigorous regulation impact electricity generation?

The third limitation is that the business case for climate change adaptation is not clear. Researchers must identify how adaptation will create value on an industry-specific basis. Dr. Feltmate used an example from the Canadian Electricity Association’s (CEA) Environmental Commitment and Responsibility Program. The business case made three arguments: 1) sustainable development is good business; 2) sustainable development is already ‘in practice’ in many member companies; and 3) they are conspicuous by omission as others are doing it. From this, the CEA produced the Sustainable Electricity program.

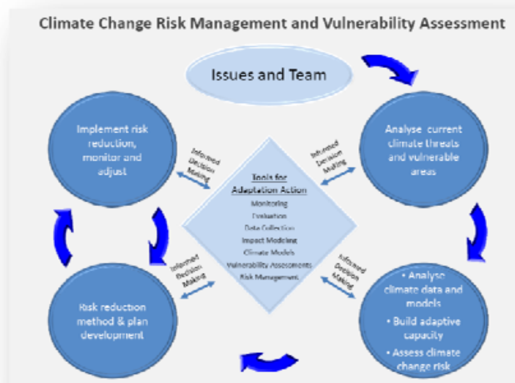
Dr. Feltmate concluded by stating: 1) messaging that climate change is real must come from scientists, in a user-friendly form, in the literature that business leaders read; 2) climate change must be presented to industry from a severity/probability perspective – this must be done on an industry-specific basis; 3) attempts should be made to identify not only the direct impacts of climate change, but also the cascading impacts; and 4) business must be presented with a strong business case to act on/adapt to climate change.

Towards Adaptation in Northern Ontario – Tools and Frameworks

Al Douglas, Ontario Centre for Climate Impacts and Adaptation Resources

We understand the impacts of climate change - it is now time to adapt and build resilience. While we continue to emit CO_2, and emissions track worse than the IPCC's worst case emission scenario, adaptation becomes more important. Historical climate trends and future climate projections can help us understand climate change. Climate data and observations of climatic hazards (i.e. winter roads, water levels, ice cover, flooding, etc) drive the need for adaptation.

Adaptation is happening in Ontario. For example, the Region of Peel, in conjunction with the Toronto Region and Credit Valley Conservation Authorities, issued a call for proposal to develop a strategic plan for climate change (mitigation and adaptation) and many other Conservation Authorities and municipalities are developing both formal and informal adaptation plans.



There are several methods and tools that support adaptation: sensitivity analyses, impact assessments, vulnerability assessments, risk management, adaptive management and others. Vulnerability analysis identifies current vulnerabilities, ascertains how they have been coped with in the past and with climate change in mind, determines how they will be more vulnerable in the future. The risk management approach, to be used in the afternoon session, comes from a standard risk management process. OCCIAR has seen the benefit of combining the risk management and vulnerability assessments together.

All methods have underlying tenets. For example: understand the risks, thresholds and uncertainties and prioritize risks; address risks associated with today's climate vulnerability and extremes; use adaptive capacity to cope with uncertainty; recognize the value of no or low regrets and win-win adaptation options; avoid actions that limit future adaptation; and review the effectiveness of adaptation decisions.

There are many guidebooks available to assist communities with adaptation as well as protocols for industries, such as Engineers Canada's PIEVC protocol.

Adaptation Perspectives from other Ontario Conservation Authorities
Compilation of Climate Change Initiatives within Southern Ontario Conservation Authorities
Don Haley – Toronto Region Conservation Authority

Many Conservation Authorities in the south are involved in addressing climate change, both from a mitigation and adaptation perspective.

Mississippi Valley Conservation has conducted climate change adaptation outreach and education workshops, has completed a study of climate change impacts on water control structures and reservoir operating policies and is collaborating with Queen's University to understand the relationship between fish, fisheries and water management in a changing climate.

The Toronto and Region Conservation Authority is involved in many climate change initiatives. "Meeting the Challenge of Climate Change: TRCA Action Plan for the Living City" was released in 2008 and it reviews all areas of Toronto and Region Conservation Authority in the context of climate change. In addition, the Toronto and Region Conservation Authority is using climate change scenarios in watershed planning and has participated in the PIEVC pilot study on the vulnerability of flood control dams to climate change.

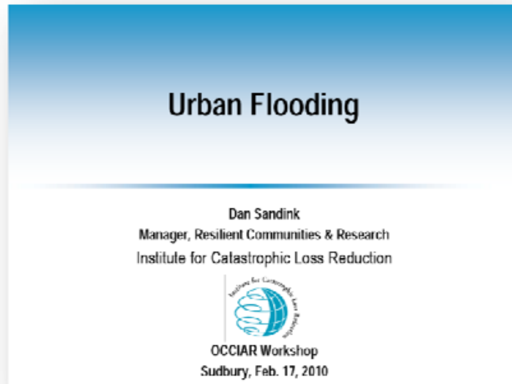
The Credit Valley Conservation Authority is also involved in many climate change initiatives, such as assessing threats and vulnerabilities related to floodplains, infrastructure and natural heritage systems, reducing its carbon footprint and mainstreaming climate change into Credit Valley Conservation Authority's planning and regulatory functions.

The Grand River Conservation Authority is creating adaptive capacity by locating and protecting key recharge areas with groundwater modeling, enhancing low water response programs in anticipation of more severe drought, and incorporating weather radar data in flood forecasting.

The Upper Thames River Conservation Authority participated in the CFCAS project "Assessment of Water Resources Risk and Vulnerability to Changing Conditions", the CCIAP project "Climate Change and Extreme Rainfall-related Surface Runoff Risks in Ontario" and reported on "Seasonal Flood Changes under Climate Change in the Upper Thames Watershed" engaging a local consultant.

Urban Flooding

Dan Sandink, Institute of Catastrophic Loss Reduction



The idea of stormwater management in the storm sewer era (1880 – 1970) was to get water off surfaces as quickly as possible. Moving into the Best Management Practice Era (1990 - present), management of stormwater began to consider water quality and quantity.

There are several types of urban floodingone of which is overland flooding. Overland flooding is caused by extreme rain and occurs outside of formally defined floodplains. Overland flow routes into the home include windows, doors, reverse sloped driveways and this type of flooding is not insurable. Infiltration flooding occurs at groundwater levels, through cracks in foundation walls and is also not insurable. Sewer backup is an insurable loss in Canada.

Payouts for urban flooding have been significant. For example, payouts for the storm in the GTA in 2005 totaled $500 million,including $247 million for sewer backup. In Northern Ontario, the NW Ontario/49th Parallel storm caused $31 million in infrastructure damage.

With respect to climate change, the City of Greater Sudbury participated in the PIEVC pilot study for road infrastructure and the MTO conducted a study of climate change impacts on highway drainage infrastructure standards.

Homeowners play an important role when it comes to taking steps to reduce urban flooding. Homeowner level actions include: maintaining eavestroughs and downspouts, disconnecting downspouts, maintaining window wells, sealing ofcracks in the foundation, installing a sump pump, installing backwater values to the sanitary sewer and lot grading. There are guides available to help homeowners, and some municipal governments have incentive programs to help absorb some of the costs of installing backwater values, sump pumps and downspout disconnections. It is a challenge to affect behavior and despite the guides and incentives, homeowners have not taken action. This may be because homeowners believe they are covered under their home insurance policy, even though they are not.

Risk Assessment Process - Results

This portion of the workshop consisted of a facilitated session geared at introducing the risk management approach to climate change adaptation. Delegates were given the following case study that presented a situation that drove attention to the impacts of climate change and ultimately to assessing and managing climate risks. Al Douglas from OCCIAR introduced the case study and the purpose of the session. He then led delegates through the process. The results from the risk process are reported in this section and follow the case study.

Case Study – Source Water

As Chair of the Source Protection Committee (SPC), your role is to guide and oversee the process of identifying vulnerabilities in, and threats to, drinking water sources in your source protection area as well as developing protective measures to ensure safe drinking water. Your area of responsibility, located in northern Ontario, is approximately 3000 km^2 in size and is comprised of 2 watersheds, one of which has a majority of its area within the city limits. The source protection area has many small lakes and rivers within its bounds. Approximately half of the city's population draws its drinking water from a lake that is centrally located with others depending on a mix of other surface water (35%) and ground water (15%). Drinking water systems within the city include a large municipal system drawing water from the lake, a small municipal ground water system on the edge of the city in the smaller of the two watersheds and many private systems drawing water from wells and smaller lakes.

The city's population has risen from 50,000 to 63,000 over the past 8 years and is optimistically expected to continue to rise with tourism, mining, forestry and government services leading the economic growth.

A conceptual water budget prepared for the area highlights significant vulnerabilities under drought conditions. Weather monitoring stations are not well placed in the area and are not spatially representative; however, precipitation trends show decreases of 12%-15% over the past 25 years. Average annual temperature has increased by 1.3 degrees Celsius over the same time period. In addition to the trends of temperature and precipitation, you have also noted other local observations (with accuracy):

- Decreased periods of ice cover on local lakes and rivers;
- Shorter winter seasons and earlier arrival of the spring melt;
- Much more variability in the weather, especially winter thaws and winter rainfall;
- More extreme rainfall events in the summer.

You are aware of some of the regional climate modeling done for other source protection areas but no regional models and little data exists for your area. Projections of climate for your area come from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN) web page and show that under the A1B scenario, average annual temperature is expected to rise by 3 degrees Celsius compared with the 1961 – 1990 average by the 2050s. The same projections indicate that precipitation may decrease by 17% into the same time period.

Your source protection team is in the final stages of preparing your Assessment report but feel that the impacts of climate variability/climate change have not been adequately addressed in the process. You realize the importance of accounting for climate change in the context of this planning process and decide to undertake an assessment of the risks posed by climate variability and change. Your initial focus will be on water quantity, specifically how drought may affect the water budget, with a secondary focus on drought and water quality. The goal of the exercise is to understand how climate may enhance existing threats to source water and identify what new threats may arise as a result of climate change.

Getting Started

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 team should include:

Conservation Authority
Municipality (engineering, planning, politicians)
Industry Representatives (forestry, mining, aggregate, power generation, tourism)
Environmental Representatives
Community Representatives (NGO's)
Health Unit
Operating authorities outside of municipality
First Nations
Social sector/Economic sector
MNR, MOE, Health, MMAH
Academics
Facilitator

The group focused on a series of climate hazards that might occur in one event. The climate hazards they identified included:

- **Increased frequency of extreme precipitations and storms**
- Winter thaws (seasonal variability), freeze thaws
- Flooding
- **Water shortages - drought**

- Increased frequency of wind
- Increased evapotranspiration (increased temperature and wind)
- Ice events

The group decided that water shortages and drought (due to a decrease in annual average precipitation and an increase in wind and evapotranspiration) and extreme precipitation could impact drinking water. Higher order impacts resulting from drought (Figure 1 and 2) and extreme precipitation (Figure 3) included:

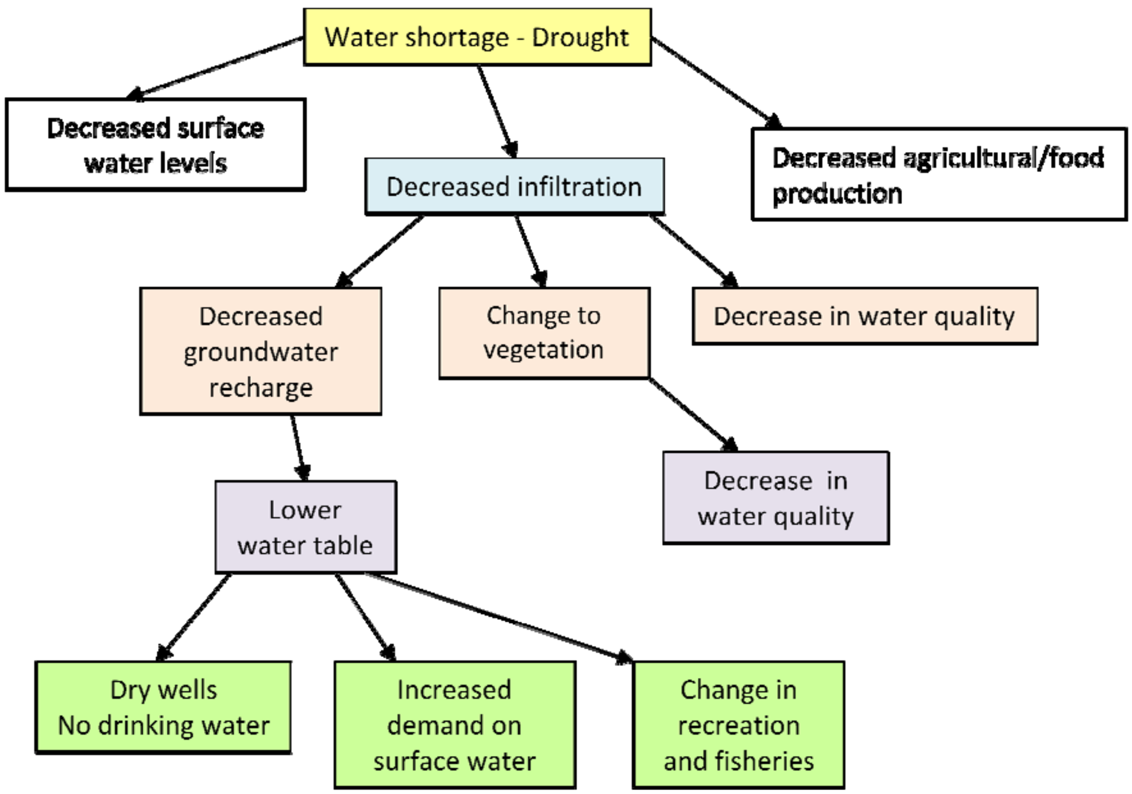


Figure 1: Impact tree – Decreased infiltration resulting from water shortage and drought.

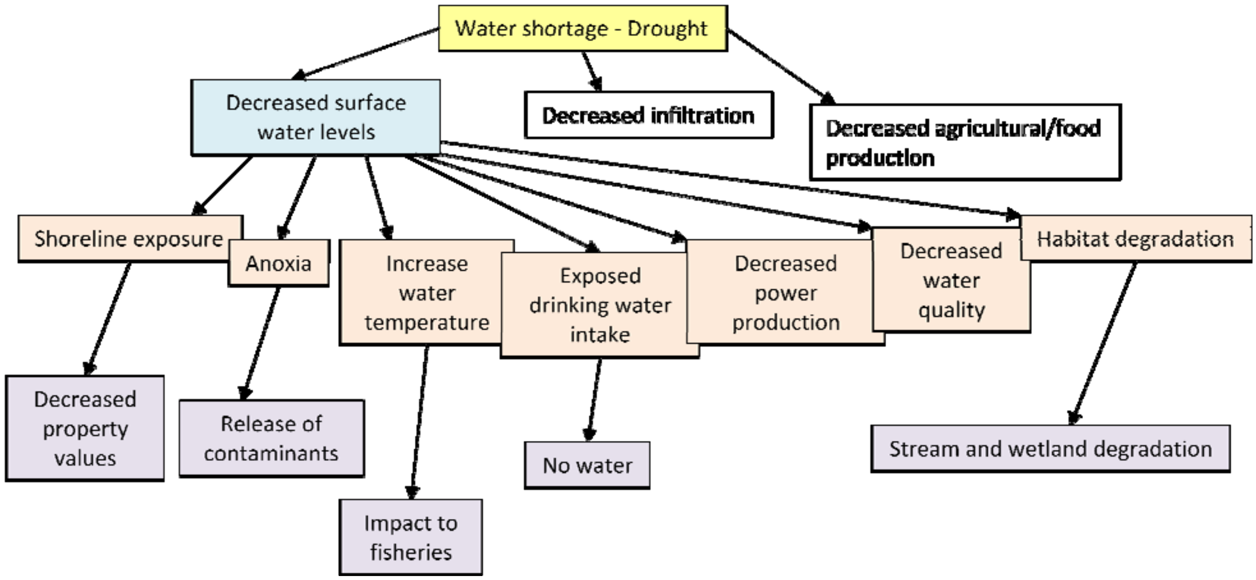


Figure 2: Impact tree – Decreased surface water levels due to water shortage and drought.

Figure 3: Impact tree – flooding due to extreme precipitation.

The next step was to estimate the risk of each of the high order impacts. This was done by considering the severity of the impact and the probability of occurrence.

Risk = Severity x Probability

The higher order impacts chosen were public infrastructure, threat to public safety, degradation of water quality and lower water table. Risk was estimated 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 estimated for each impact, all of the risks were then prioritized.

Table 1: Risk Assessment Matrix

		Public Safety	Public Infrastructure	Degraded Water Quality	Lower water table
Severity of Impact (1 to 5)	Economic Impact	1	4/5	5	4/5
	Social Impact	4/5	4/5	4/5	3
	Environmental Impact	5	3/4	4/5	3
Probability of Occurrence (1 to 5)		4	5	4	3
Prioritized Risk (subjective assessment)		40 to 44	55 to 70	52 to 60	30 to 33

1 = lowest priority   5 = highest priority

The impact with the highest priority was public infrastructure.

The next step was to identify some adaptive strategies to reduce the risk to public infrastructure. The risk control options identified included:

- Reduce the amount of runoff
- Reduce the number of beavers
- Residential retrofit
- Municipal retrofit
- Well-established and practiced contingency plans (e.g. early warning, emergency response)
- Increased permeability e.g. green roofs, grass
- Stormwater management plans
- Infrastructure upgrades
- Back-up capacity
- Relocate

The second priority identified was risk of degraded water quality. The risk control options to reduce the risk of degraded water quality include:

- Stormwater management
- Engineered wetlands
- Land reclamation and increased vegetation
- Properly installed, maintained wells
- Septic maintenance (home owner)
- Contaminant control
- Drinking water back-up supply
- Restricting activities on surface water
- Education
- Dynamics between flood

The last step was to determine what or who the 'enablers' might be to implement actions. The group identified the following 'enablers':

- Budget
- Political will
- Expertise
- Legislative framework
- Credibility
- Education and outreach
- Broad community engagement, understanding and support

- Recognition of issue by other sectors
- Effective data gathering and assessment capabilities

While delegates were somewhat reluctant to speak at the start of the process, specific questions allowed the group to respond with excellent insights on key areas of risk and potential adaptation measures. The group saw value in learning about the process and was hopeful to return to their home location and test the process in the near future.

Concluding Remarks

Dr. David Pearson

When going through the steps of the risk assessment and developing impact trees, other areas are identified that are not traditionally handled by Conservation Authorities. There is a need to find out where the climate change expertise is in your community. Conservation Authorities can be a good resource beyond source protection. Climate change is becoming a bigger issue and this exercise today along with the SWP assessment report including climate change, makes Conservation Authorities more valuable within the community. Conservation Authorities will certainly continue to play a large leadership role in northern communities in the context of climate change adaptation planning.

Resources

From Impacts to Adaptation: Canada in a Changing Climate 2007
http://adaptation.nrcan.gc.ca/assess/2007/index_e.php

Climate Change Projections for Ontario: Practical Information for Policymakers and Planners
http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@ofri/documents/document/mnr_e005587.pdf

Climate Change and Ontario's Provincial Parks: Towards an Adaptation Strategy
http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@climatechange/documents/document/276924.pdf

Environmental Commitment and Responsibility Program Annual Report. 2007.
http://cea.lixar.net/media/Annual%20Reports/2007%20ECR%20Annual%20Report%20Eng.pdf

The Power from Within
Sustainable Electricity: Inaugural Annual Report, 2008
http://www.sustainableelectricity.ca/media/pdfs/CEA_SE_AR_e_final_mr.pdf

From Impacts Towards Adaptation: Mississippi Watershed in a Changing Climate. 2009. Paul Egginton and Beth Lavender
http://www.mvc.on.ca/program/ccreport2009.pdf

Meeting the Challenge of Climate Change: TRCA Action Plan for The Living City
http://www.trca.on.ca/dotAsset/16642.pdf

Assessment of Water Resources Risk and Vulnerability to Changing Climate Conditions
http://www.eng.uwo.ca/research/iclr/fids/cfcas-climate.html

Climate Change and Extreme Rainfall-related Surface Runoff Risks in Ontario
http://www-pcmdi.llnl.gov/ipcc/project_detail.php?ipcc_subproject_id=602

Conservation Authority Webpage Addresses and Climate Change Contact

- http://www.mvc.on.ca/ - Paul Lehman
- http://www.trca.on.ca/ - Ryan Ness / Don Haley
- http://www.creditvalleycons.com/ - John Kinkead
- http://www.grandriver.ca/ - Dwight Boyd

- http://www.thamesriver.on.ca/ - Mark Helsten

Adapting to Climate Change: An Introduction for Canadian Municipalities
http://www.gnb.ca/0009/0369/0018/0006-e.pdf

Preparing for Climate Change: A Guidebook for Local, Regional and State Governments
http://cses.washington.edu/db/pdf/snoveretalgb574front.pdf

Climate adaptation: Risk uncertainty and decision-making
http://www.ukcip.org.uk/images/stories/Pub_pdfs/Risk.pdf

Cities preparing for Climate Change: A Study of Six Urban Regions
http://www.cleanairpartnership.org/pdf/cities_climate_change.pdf

An Overview of the Risk Management Approach to Adaptation to Climate Change in Canada
http://adaptation.nrcan.gc.ca/pdf/NobleBruceEgener2005_e.pdf

Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities
http://adaptation.nrcan.gc.ca/projdb/pdf/176a_e.pdf

Appendix A - 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 or capturing it through various sequestration methods. 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 primary focus of this workshop is on the latter approach.

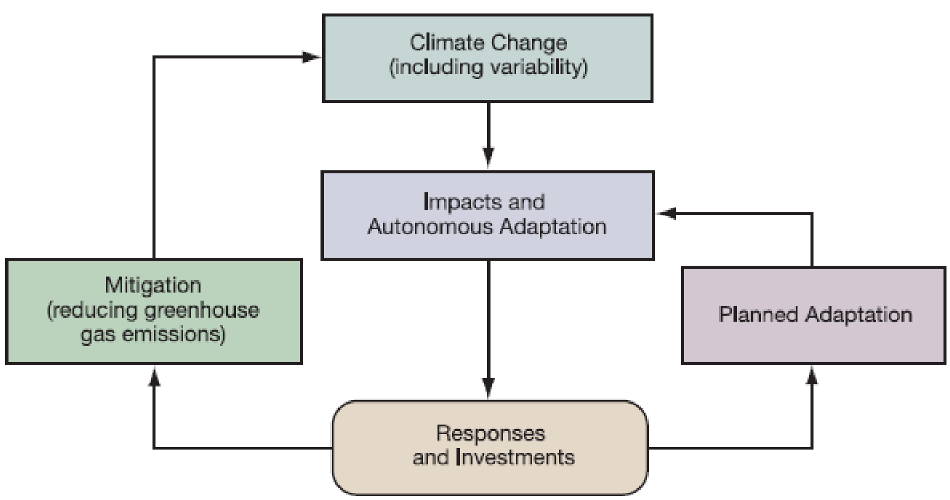


Figure 4: Adaptation and mitigation in the context of climate change (*modified from* Smit et al., 1999 cited in Lemmen et al., 2008).

Impacts and Adaptation

There is 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.

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, 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.

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

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.

Ontario Centre for Climate Impacts and Adaptation Resources

The Ontario Centre for Climate Impacts and Adaptation Resources 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 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; create and foster partnerships with stakeholder groups; and support the work of Ontario's Expert Panel on Climate Change Adaptation. The Centre will also be a hub for climate change impacts and adaptation activities, events and resources.

The objectives of today's workshop are to:

- Present the global and local context of climate change and help increase awareness of the potential impacts of climate change in northern Ontario and the need for resilience-building in the area;

- Identify what municipalities/counties and Conservation Authorities can do and are doing to both help mitigate and adapt to climate change;

- Present different methods of adaptive planning and facilitate an interactive climate change risk assessment framework; and

- Introduce the Ontario Centre for Climate Impacts and Adaptation Resources and its role in developing resources and communicating climate change throughout the province of Ontario.

Historic Climate and Climate Trends for Sault Ste. Marie

The following is a compilation and summarization of weather and climate data for Sault Ste. Marie, Ontario. Data were obtained from Environment Canada.

Daily Weather

Daily climate data from Sault Ste. Marie A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and precipitation (Environment Canada, 2008). Seasonal climate values (winter –DJF and summer -JJA) were calculated by averaging the monthly data. In the following section, temperature and precipitation data for the years 1962 to 2008, are displayed annually and seasonally (summer and winter) with line charts (Figures 5 to 7) and include mean, maximum and minimum temperature and annual precipitation.

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 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 includes any and all forms of water, liquid or solid, that falls from clouds and reaches the ground and is expressed in terms of the vertical depth of water that 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).

Historical Mean Temperature and Precipitation Data for Sault Ste. Marie

Annual

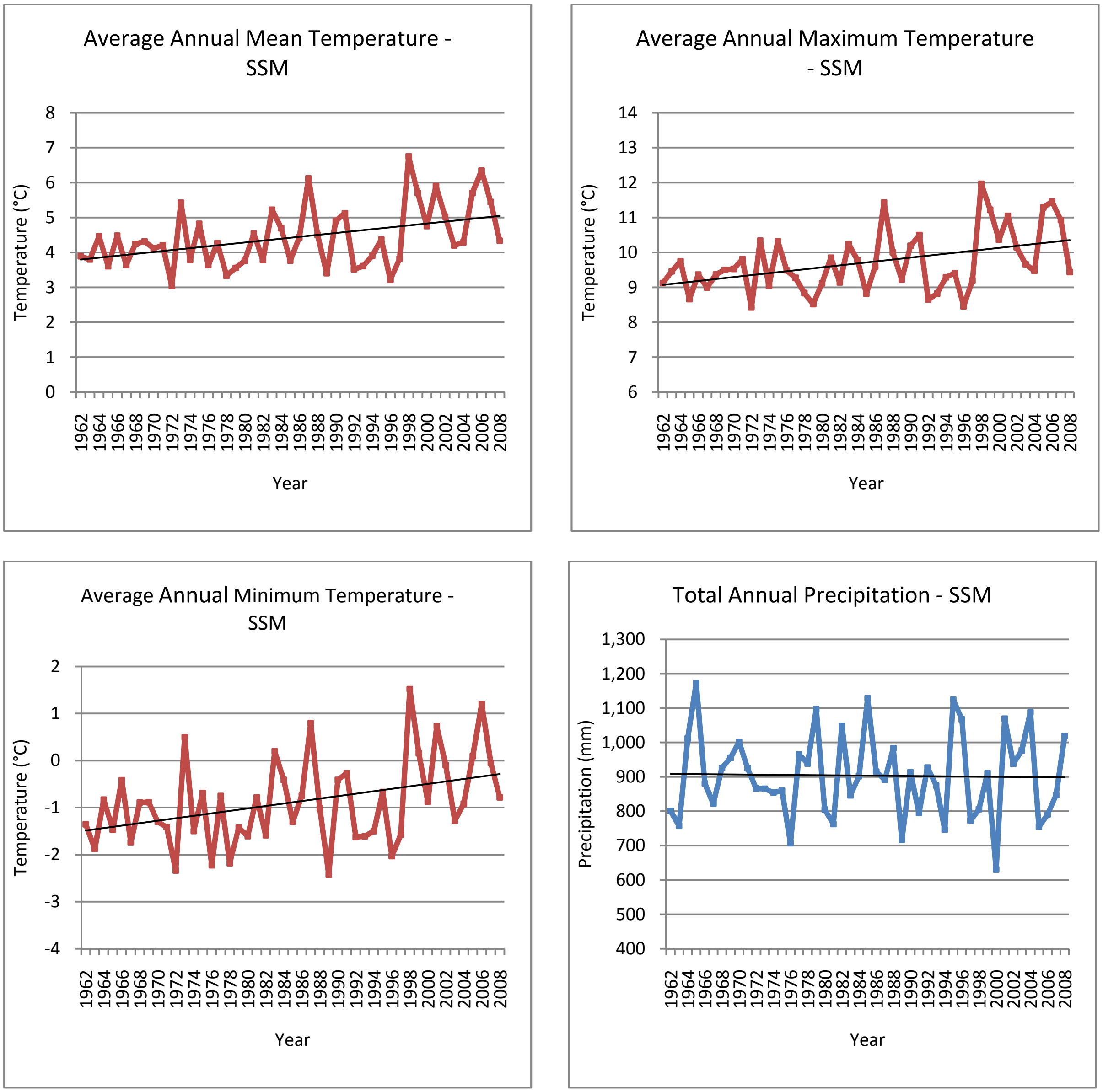


Figure 5: Average annual temperature (°C) from 1962 to 2008. Data from Sault Ste Marie A (Environment Canada, 2008) shows that the average annual mean temperature has increased 1.2°C, the average annual maximum temperature has increased 1.3°C, the average annual minimum temperature has increased 1.2°C and the total annual precipitation decreased by 10 mm over the 47 years of record

Winter

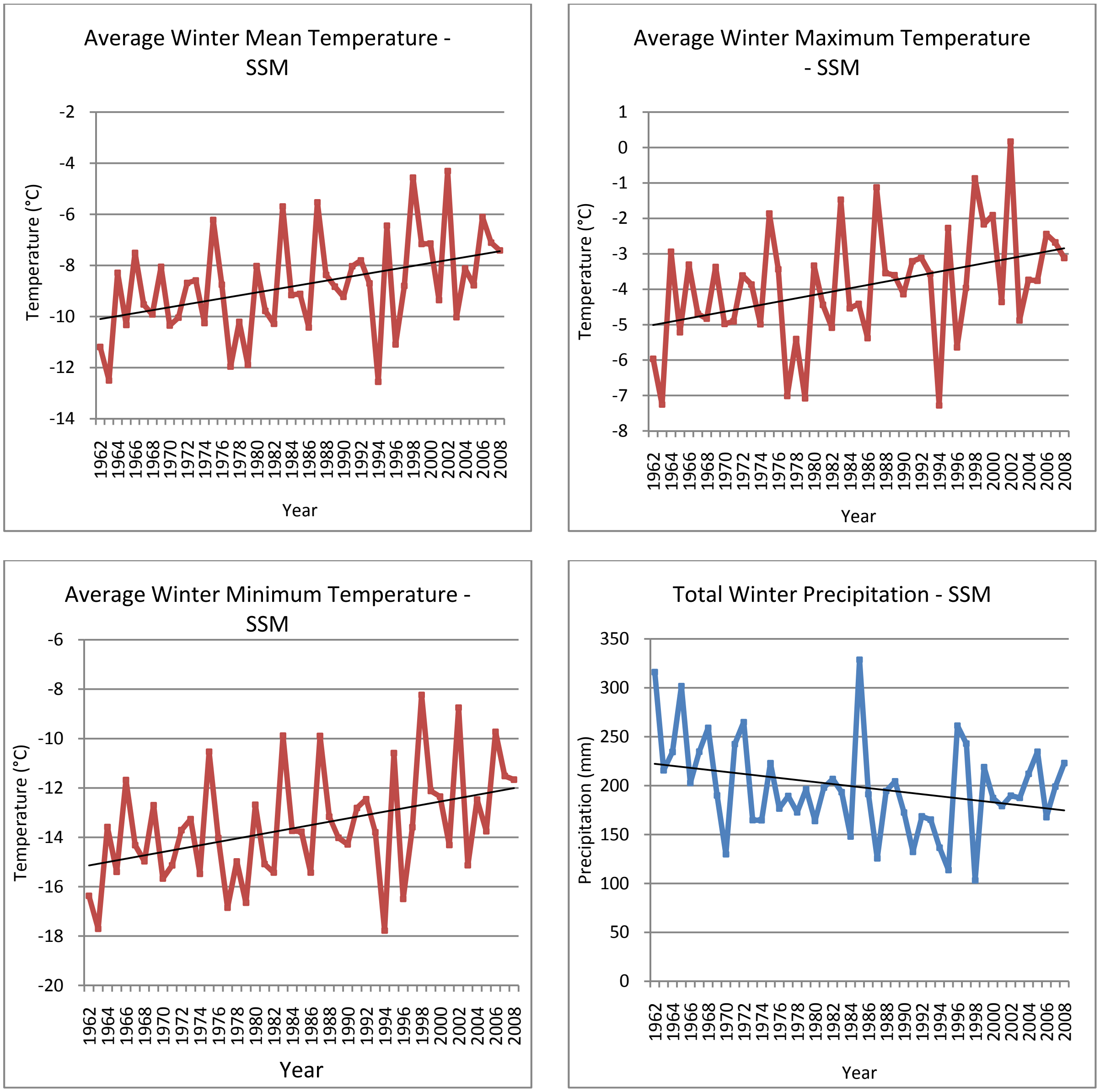


Figure 6: Average winter temperature (°C) from 1962 to 2008. Data from Sault Ste Marie A (Environment Canada, 2008) shows that average winter mean temperature at this location has increased 2.7°C, average winter maximum temperature has increased 2.2°C, average winter minimum temperature and total winter precipitation has decreased by 48mm, over the 47 years of record

Summer

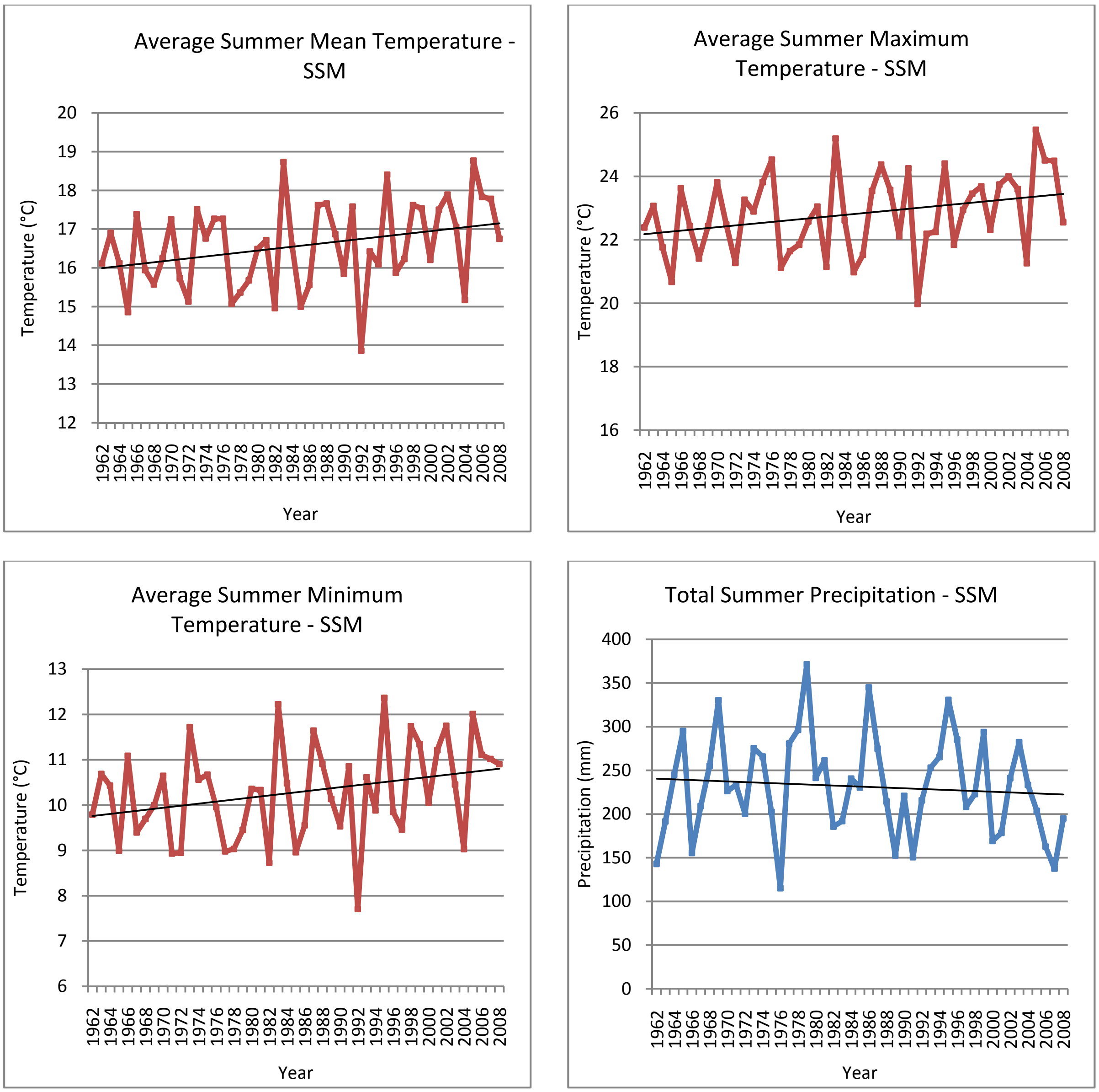


Figure 7: Average summer temperature (°C) from 1962 to 2008. Data from Sault Ste Marie A (Environment Canada, 2008) shows that the average summer mean temperature has increased 1.2°C, average summer maximum temperature has increased 1.2°C, average summer minimum temperature has increased 1.0°C and total summer precipitation has decreased by 18 mm over the 47 years of record

Future Climate Projections for Sault Ste. Marie

Future climate projections were obtained from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). The CCCSN describes climate change as a difference over a period of time (with respect to a baseline or a reference point) and corresponds to a statistically significant trend of mean climate or its variability, persistent over a long period of time (Environment Canada, 2007). Reference periods of typically 3 decades long (1971-2000) are of sufficient length to adequately represent the climate of the period, and can be used to compare fluctuations of climate between one period and another (Environment Canada, 2007).

Projections from Global Climate Models (GCMs) exhibit a great deal of climate variability. Because of this, the IPCC (2001a) has recommended using at least 30 year averaging periods for GCM output (Environment Canada, 2007). Output generated by climate models are typically as follows: the 2020s (2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099) (Environment Canada, 2007).

The climate scenarios produced for Sault Ste. Marie, Ontario were created using the Third Generation Coupled Global Model (CGCM3), version T47. The T47 version has a surface grid whose spatial resolution is roughly 3.75 degrees lat/long and 31 levels in the vertical (Environment Canada, 2005). Data is displayed for the B1 and A2 emission scenarios and is compared to the period of 1971-2000.

Emission scenarios (B1 and A2) are described as follows (IPCC, 2007 cited in Environment Canada, 2007).

A2

The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population (15 billion by 2100). Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1

The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

Temperature

Table 2: Change in mean temperature, extreme maximum temperature and extreme minimum temperature data compared to 1971-2000 for Sault Ste. Marie, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007).

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-AIB**		**SR-A2**	
		Change in Mean Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-8.8	2.3	3.7	2.9	4.4	2.8	4.1
Spring	2.9	1.9	3.3	2.4	3.7	2.4	3.5
Summer	16.4	1.3	2.1	1.5	2.6	1.5	2.5
Autumn	6.8	1.5	2.3	1.7	2.9	1.7	2.9
Annual	4.3	1.8	2.9	2.2	3.4	2.1	3.3
		Change in Extreme Maximum Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	15.4	1.2	1.8	1.4	2.4	1.3	2.3
Spring	31.8	1.6	2.3	1.8	2.9	1.8	2.9
Summer	36.8	1.4	2.2	1.7	2.7	1.4	2.4
Autumn	32.8	1.3	2	1.4	2.8	1.6	2.7
Annual	36.8	1.4	2.2	1.7	2.7	1.4	2.4
		Change in Extreme Minimum Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-38.7	4.4	5.7	5	6.6	5	6.2
Spring	-35.6	5	7.8	5.9	8.3	5.9	8
Summer	-1.8	-0.1	0.7	0.1	1.2	0.1	1.1
Autumn	-21.7	1.2	1.9	1.4	2.5	1.4	2.4
Annual	-38.7	4.4	5.7	5	6.6	5	6.2

Precipitation

Table 3: Change in precipitation, extreme maximum precipitation and water surplus and deficit data compared to 1971-2000 for Sault Ste. Marie, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007)

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-A1B**		**SR-A2**	
	Change in Total Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	187.9	26.3	50.1	64.3	83.8	36	54.8
Spring	191.7	6.7	30.4	21.5	36.9	14.1	38
Summer	239.8	-9.4	-35.5	-13.8	-24.8	-38.5	-43.6
Autumn	268.8	-20.4	1.9	23	-4.5	-2.9	32.7
Annual	888.3	3.1	46.8	94.8	90.7	8.6	81.9
	Change in Extreme Maximum Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	382.8	49.1	95.9	126.7	166	69	105.7
Spring	375.9	69.5	112	98.6	131.5	77.4	131.6
Summer	490.5	0	-53	-9.6	-25.5	-61.9	-65.5
Autumn	511.2	-30.5	12.7	54.2	-0.6	4.1	74.6
Annual	1760.4	88.2	167.5	270	271.3	88.7	246.4
	Change in Mean Water Surplus/Deficit (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Surplus	455	-12	33	75	68	1	70
Deficit	50	14	36	15	37	31	49

Historic Climate and Climate Trends for Sudbury

The following is a compilation and summarization of weather and climate data for Sudbury, Ontario. Data were obtained from Environment Canada.

Daily Weather

Daily climate data from Sudbury A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and precipitation (Environment Canada, 2008). Seasonal climate values (winter –DJF and summer -JJA) were calculated by averaging the monthly data. In the following section, temperature and precipitation data, for the years 1956 to 2008, are displayed annually and seasonally (summer and winter) with line charts (Figures 8 to 10) and includes: mean, maximum and minimum temperature and annual precipitation. Data was missing from 1992 and 1993. Annual means could not be calculated for these years. Winter means could not be calculated for 1992 and 1993. Annual mean for precipitation could not be calculated for 2008.

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 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 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).

Historical Mean Temperature and Precipitation Data for Sudbury

Annual

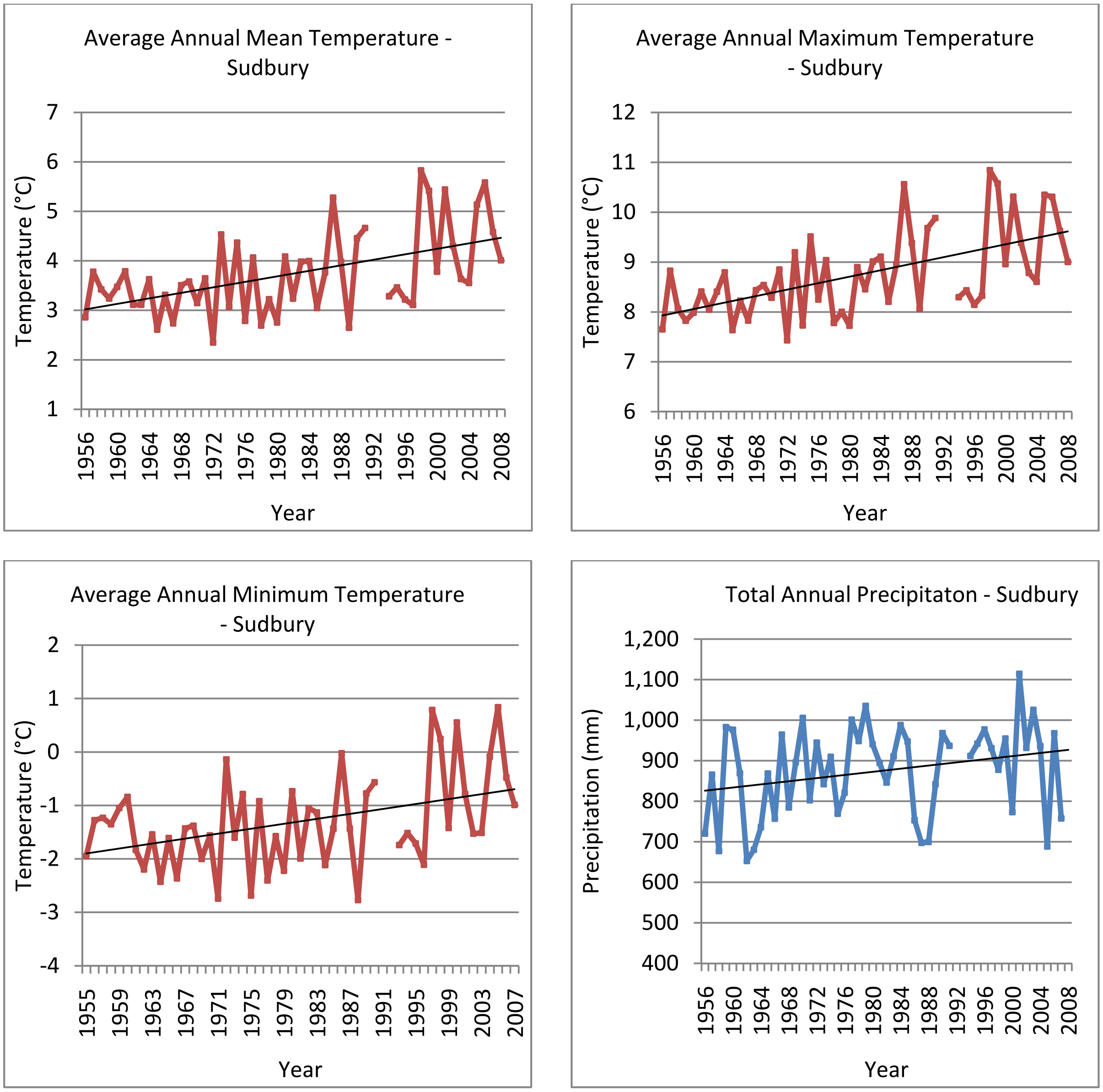


Figure 8: Average annual temperature (°C) from 1956 to 2008. Data from Sudbury A (Environment Canada, 2008) shows that the average annual mean temperature has increased 1.5°C, average annual maximum temperature has increased 1.7°C , average annual minimum temperature has increased 1.2°C, and the total annual precipitation has increased 100 mm over the 53 years of record

Winter

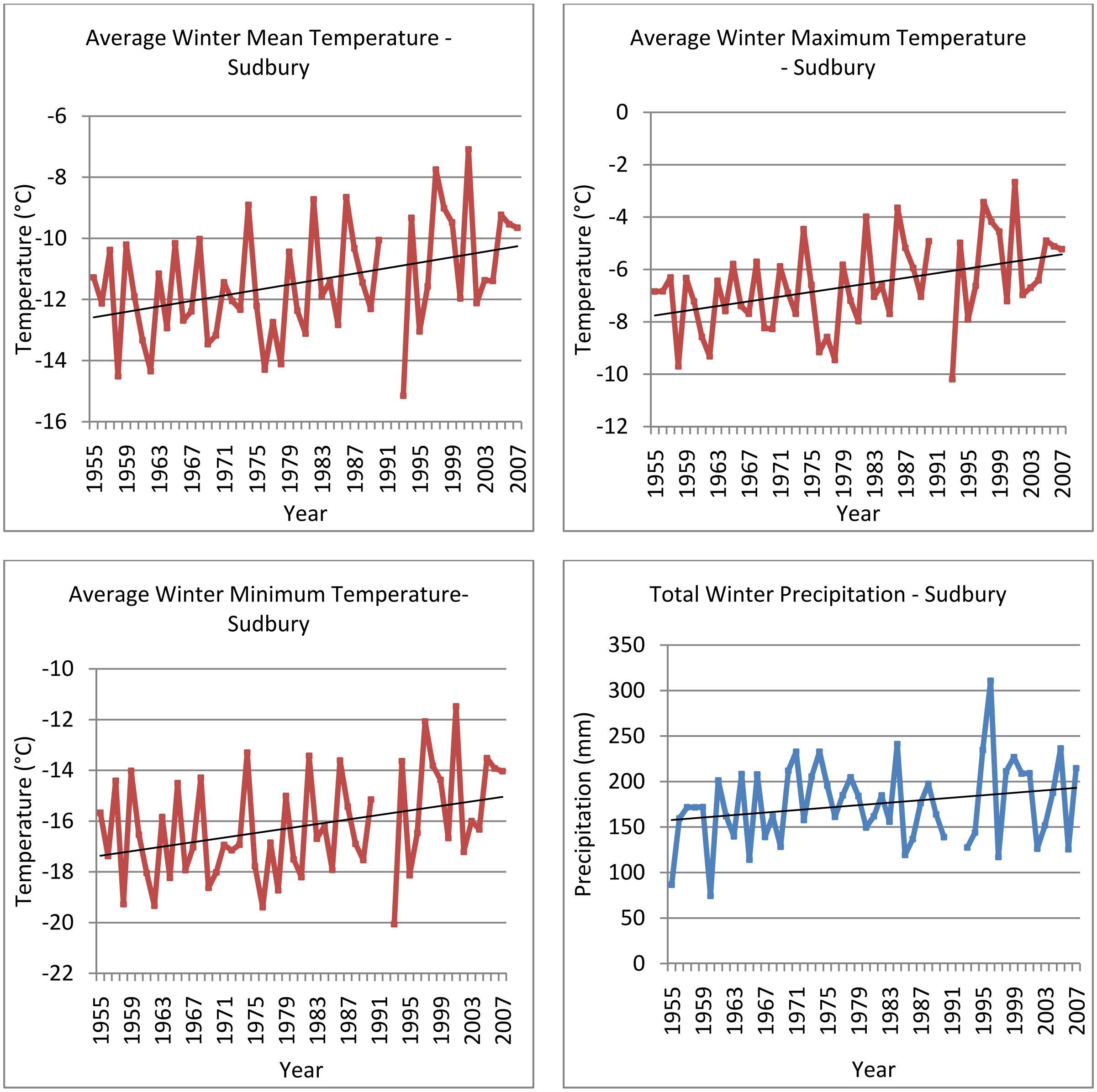


Figure 9: Average winter temperature (°C) from 1956 to 2008. Data from Sudbury A (Environment Canada, 2008) shows that the average winter mean temperature at this location has increased 2.4°C, average winter maximum temperature has increased 2.4°C , average winter minimum temperature has increased 2.4°C, and total winter precipitation has increased 38 mm over the 53 years of record

Summer

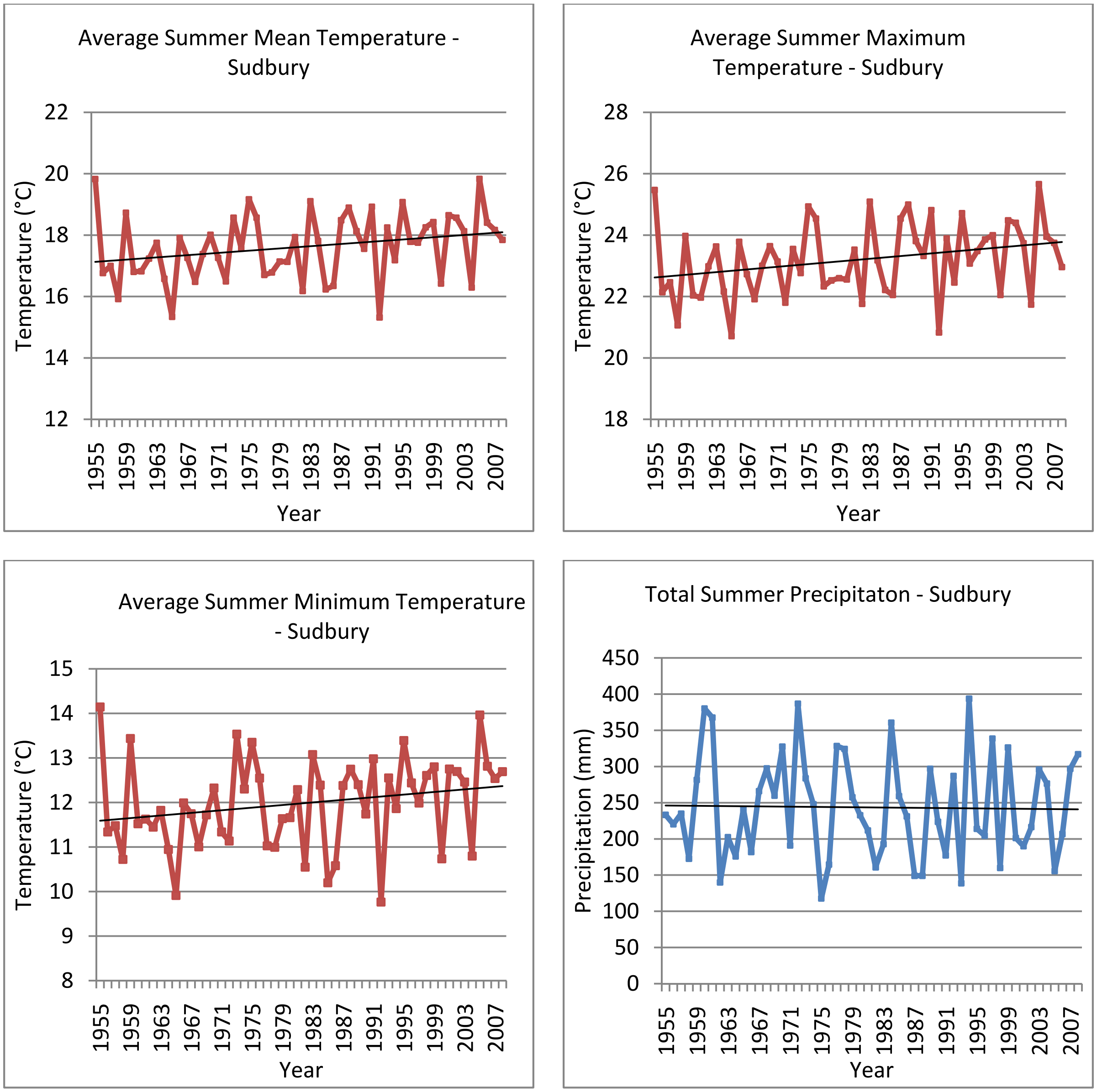


Figure 10: Average summer temperature (°C) from 1956 to 2008. Data from Sudbury A (Environment Canada, 2008) shows that the average summer mean temperature at this location has increased 1.0°C, average winter maximum temperature has increased 1.2°C , average summer minimum temperature has increased 0.8°C, and total summer precipitation has decreased 6 mm over the 53 years of record.

Future Climate Projections for Sudbury

Future climate projections were obtained from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). The CCCSN describes climate change as a difference over a period of time (with respect to a baseline or a reference point) and corresponds to a statistically significant trend of mean climate or its variability, persistent over a long period of time (Environment Canada, 2007). Reference periods of typically 3 decades long (1971-2000) are of sufficient length to adequately represent the climate of the period, and can be used to compare fluctuations of climate between one period and another (Environment Canada, 2007).

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Temperature

Table 4: Change in mean temperature, extreme maximum temperature and extreme minimum temperature data compared to 1971-2000 for Sudbury, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007).

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-AIB**		**SR-A2**	
		Change in Mean Temperature (°C)					
	1961-1990	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-11.4	1.4	2.8	1.9	3.8	1.6	3.2
Spring	3	1.3	2.8	1.8	3.1	1.9	3.2
Summer	17.6	1.5	2.2	1.6	2.8	1.7	2.9
Autumn	5.5	1.4	2.1	1.6	2.8	1.5	3
Annual	3.7	1.4	2.5	1.7	3.1	1.7	3.1
		Change in Extreme Maximum Temperature (°C)					
		2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	17.2	2	3.6	2.6	4.6	2.2	3.9
Spring	33.9	2.2	2.6	2.2	3.5	2.4	3.7
Summer	38.3	1.4	2.5	1.4	2.8	1.9	3
Autumn	31.1	1.2	2.1	1.3	2.8	1.8	2.9
Annual	38.3	1.4	2.5	1.4	2.8	1.9	3
		Change in Extreme Minimum Temperature (°C)					
		2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-39.3	2	3.6	2.7	5.2	2.3	4.6
Spring	-30.2	2	4.6	2.5	4.6	3.1	4.7
Summer	-1.6	1.8	2.5	1.9	3.3	2	3.4
Autumn	-23.8	1	1.6	0.9	2.3	1	2.2
Annual	-39.3	2	3.6	2.7	5.2	2.3	4.6

Precipitation

Table 5: Change in precipitation, extreme maximum precipitation and water surplus and deficit data compared to 1971-2000 for Sudbury, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007)

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-A1B**		**SR-A2**	
	Change in Total Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	185.1	-4.4	13.2	14	40.9	3.8	28
Spring	208.3	8.2	26.1	17.8	31.9	17.7	34.6
Summer	244.8	2.4	-19.7	2.6	-20.5	-30.7	-29.8
Autumn	259.9	-5.8	0.7	16.1	6.5	5	30.7
Annual	898.1	0.4	20.3	50.4	58.7	-4.3	63.5
	Change in Extreme Maximum Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	339.8	-6.2	24.7	29.7	86.2	7.4	54.9
Spring	470	23.2	63.8	45.6	74.9	48.1	76.9
Summer	528.7	16.7	-27.5	21.8	-29.9	-50.3	-49
Autumn	456.5	94.4	107.3	142.9	118.1	116.6	168.5
Annual	1795	128.2	168.2	240	249.4	121.9	251.2
	Change in Mean Water Surplus/Deficit (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Surplus	484	-50	-36	-21	1	-35	8
Deficit	62	16	35	17	48	36	56

Historic Climate and Climate Trends for North Bay

The following is a compilation and summarization of weather and climate data for North Bay, Ontario. Data were obtained from Environment Canada.

Daily Weather

Daily climate data from North Bay A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and precipitation (Environment Canada, 2008). Seasonal climate values (winter –DJF and summer -JJA) were calculated by averaging the monthly data. In the following section, temperature and precipitation data, for the years 1939 to 2008, are displayed annually and seasonally (summer and winter) with line charts (Figures 11 to 13) and include mean, maximum and minimum temperature and annual precipitation. Data was missing from 1992 and 1993. Annual means could not be calculated for these years. Winter means could not be calculated for 1992 and 1993 and summer means could not be calculated for 1993.

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 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 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).

Historical Mean Temperature and Precipitation Data for North Bay

Annual

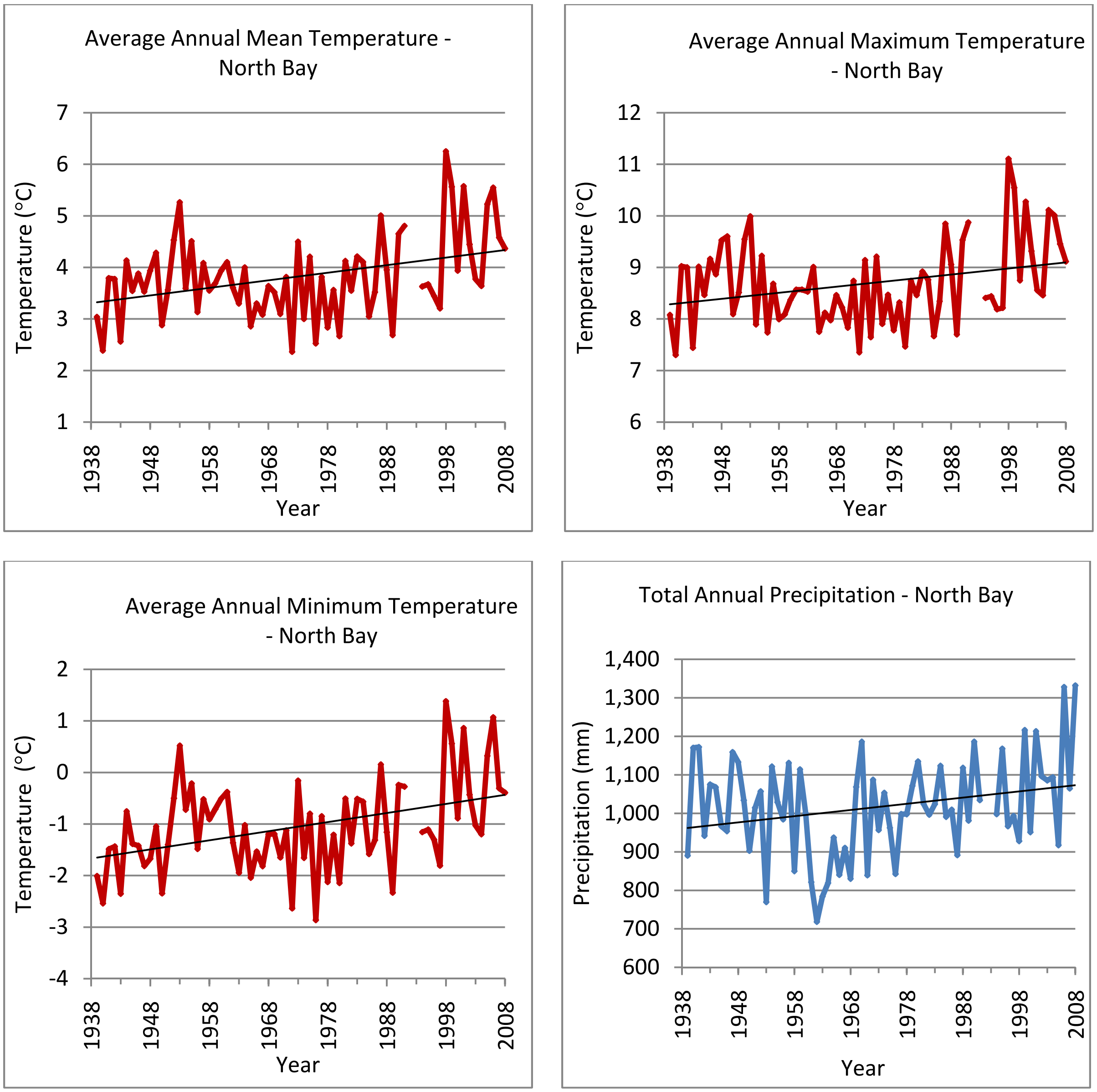


Figure 11: Average annual temperature (°C) from 1938 to 2008. Data from North Bay A (Environment Canada, 2008) shows that the average annual mean temperature at this location has increased 1.0°C, average annual maximum temperature has increased 0.9°C , average annual minimum temperature has increased 1.3°C, and total annual precipitation has increased 110 mm over the 71 years of record

Winter

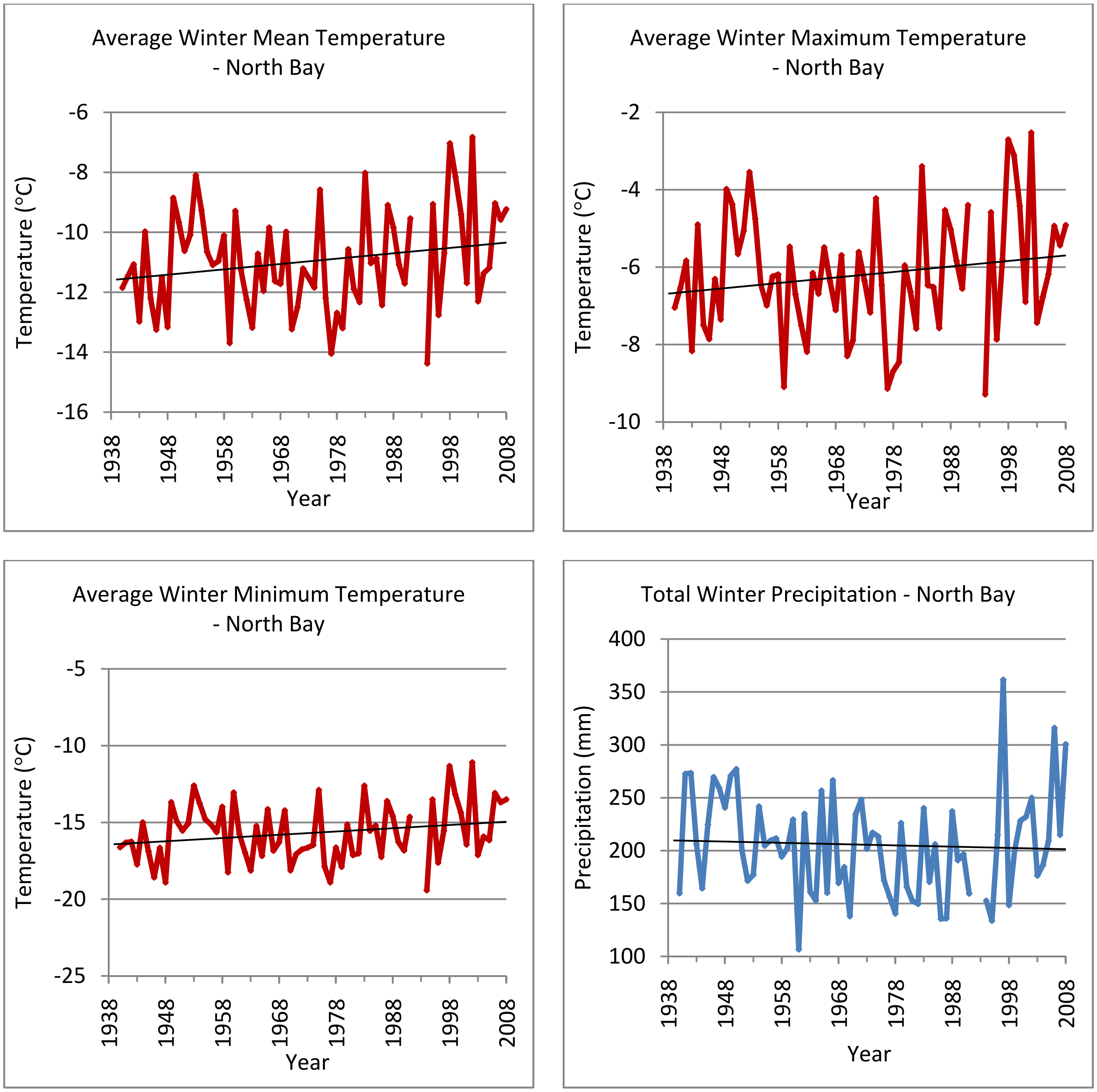


Figure 12: Average winter temperature (°C) from 1938 to 2008. Data from North Bay A (Environment Canada, 2008) shows that the average winter mean temperature at this location has increased 1.3°C, average winter maximum temperature has increased 1.0°C , average winter minimum temperature has increased 1.4°C, and total winter precipitation has decreased 10 mm over the 71 years of record

Summer

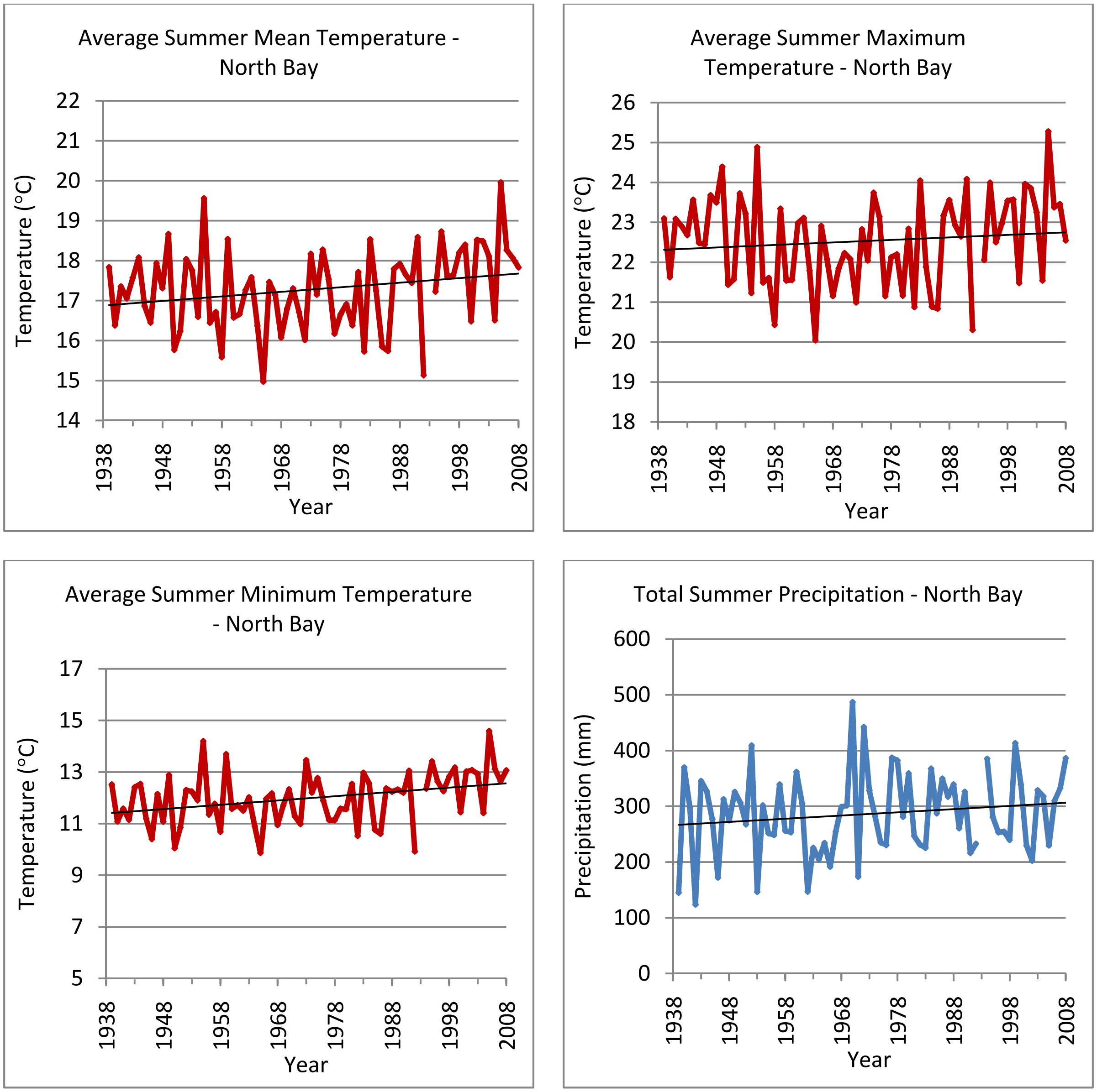


Figure 13: Average summer temperature (°C) from 1938 to 2008. Data from North Bay A (Environment Canada, 2008) shows that the average summer mean temperature at this location has increased 0.8°C, average summer maximum temperature has increased 0.4°C , average summer minimum temperature has increased 1.1°C, and total summer precipitation has increased 40 mm over the 71 years of record.

Future Climate Projections for North Bay

Future climate projections were obtained from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). The CCCSN describes climate change as a difference over a period of time (with respect to a baseline or a reference point) and corresponds to a statistical significant trend of mean climate or its variability, persistent over a long period of time (Environment Canada, 2007). Reference periods of typically 3 decades long (1971-2000) are of sufficient length to adequately represent the climate of the period, and can be used to compare fluctuations of climate between one period and another (Environment Canada, 2007).

Projections from Global Climate Models (GCMs) exhibit a great deal of climate variability. Because of this, the IPCC (2001a) has recommended using at least 30 year averaging periods for GCM output (Environment Canada, 2007). Output generated by climate models are typically as follows: the 2020s (2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099) (Environment Canada, 2007).

The climate scenarios produced for North Bay, Ontario were created using the Third Generation Coupled Global Model (CGCM3), version T47. The T47 version has a surface grid whose spatial resolution is roughly 3.75 degrees lat/long and 31 levels in the vertical (Environment Canada, 2005). Data is displayed for the B1 and A2 emission scenarios and is compared to the period of 1971-2000.

Emission scenarios (B1 and A2) are described as follows (IPCC, 2007 cited in Environment Canada, 2007).

A2
The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population (15 billion by 2100). Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1
The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

Temperature

Table 6: Change in mean temperature, extreme maximum temperature and extreme minimum temperature data compared to 1971-2000 for North Bay, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007).

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-AIB**		**SR-A2**	
		Change in Mean Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-11	1.1	2.8	1.8	3.9	1.3	3.3
Spring	3.2	1	2.8	1.6	3.1	1.8	3.2
Summer	17.2	1.4	2.2	1.5	2.7	1.7	2.9
Autumn	5.6	1.4	2.1	1.5	2.8	1.5	3
Annual	3.8	1.2	2.4	1.6	3.1	1.5	3.1
		Change in Extreme Maximum Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	21.4	-5.9	-5.2	-5.8	-4.5	-5.8	-4.5
Spring	31.6	2.1	2.8	2.2	3.8	2.4	3.9
Summer	35.4	2	2.5	1.9	3.2	1.9	3.4
Autumn	31	-0.7	0.2	-0.7	0.9	-0.2	0.9
Annual	35.4	2	2.5	1.9	3.2	1.9	3.4
		Change in Extreme Minimum Temperature (°C)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-38.4	1.9	3.9	2.8	5.5	2.1	4.8
Spring	-30	1.4	4	2	4.2	57.6	4.2
Summer	-2.1	2	2.6	2.2	3.6	2.1	3.6
Autumn	-23.7	1	2	1.2	2.7	1.1	2.7
Annual	-38.4	1.9	3.9	2.8	5.5	2.1	4.8

Precipitation

Table 7: Change in precipitation, extreme maximum precipitation and water surplus and deficit data compared to 1971-2000 for North Bay, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007)

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-A1B**		**SR-A2**	
	Change in Total Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	190.2	9.2	30	23.1	57.3	14.1	41.4
Spring	220.4	14.4	33.6	26.9	35.1	36.6	43.9
Summer	295.3	2.1	-16.7	-0.6	-22	-24.7	-25.4
Autumn	301	-8.1	-19.9	-12.6	-12	-8.9	21.3
Annual	1006.9	17.7	27.1	36.8	58.5	17.1	81.1
	Change in Extreme Maximum Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	436.1	-41.8	-0.2	-13.9	55.5	-31.3	24.1
Spring	454.4	11	47.2	32.4	47.3	50.3	67.2
Summer	587.1	59.1	14.9	51.6	3.7	-5.2	-6
Autumn	509.7	-22.2	-41.6	-29.8	-23.1	-23.8	29.1
Annual	1987.3	6.2	20.3	40.3	83.4	-10.1	114.4
	Change in Mean Water Surplus/Deficit (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Surplus	586	-49	-45	-32	-11	-42	1
Deficit	32	12	24	13	35	23	36

Historic Climate and Climate Trends for Timmins

The following is a compilation and summarization of weather and climate data for Timmins, Ontario. Data were obtained from Environment Canada.

Daily Weather

Daily climate data from Timmins Victor Power A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and precipitation (Environment Canada, 2008). Seasonal climate values (winter –DJF and summer -JJA) were calculated by averaging the monthly data. In the following section, temperature and precipitation data, for the years 1956 to 2008, are displayed annually and seasonally (summer and winter) with line charts (Figures 14 to 16) and include mean, maximum and minimum temperature and annual precipitation. Data was missing from 1979, 1992 and 1993. Annual means could not be calculated for these years. Winter and summer means could not be calculated for 1992 and 1993.

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 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 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).

Historical Mean Temperature and Precipitation Data for Timmins

Annual

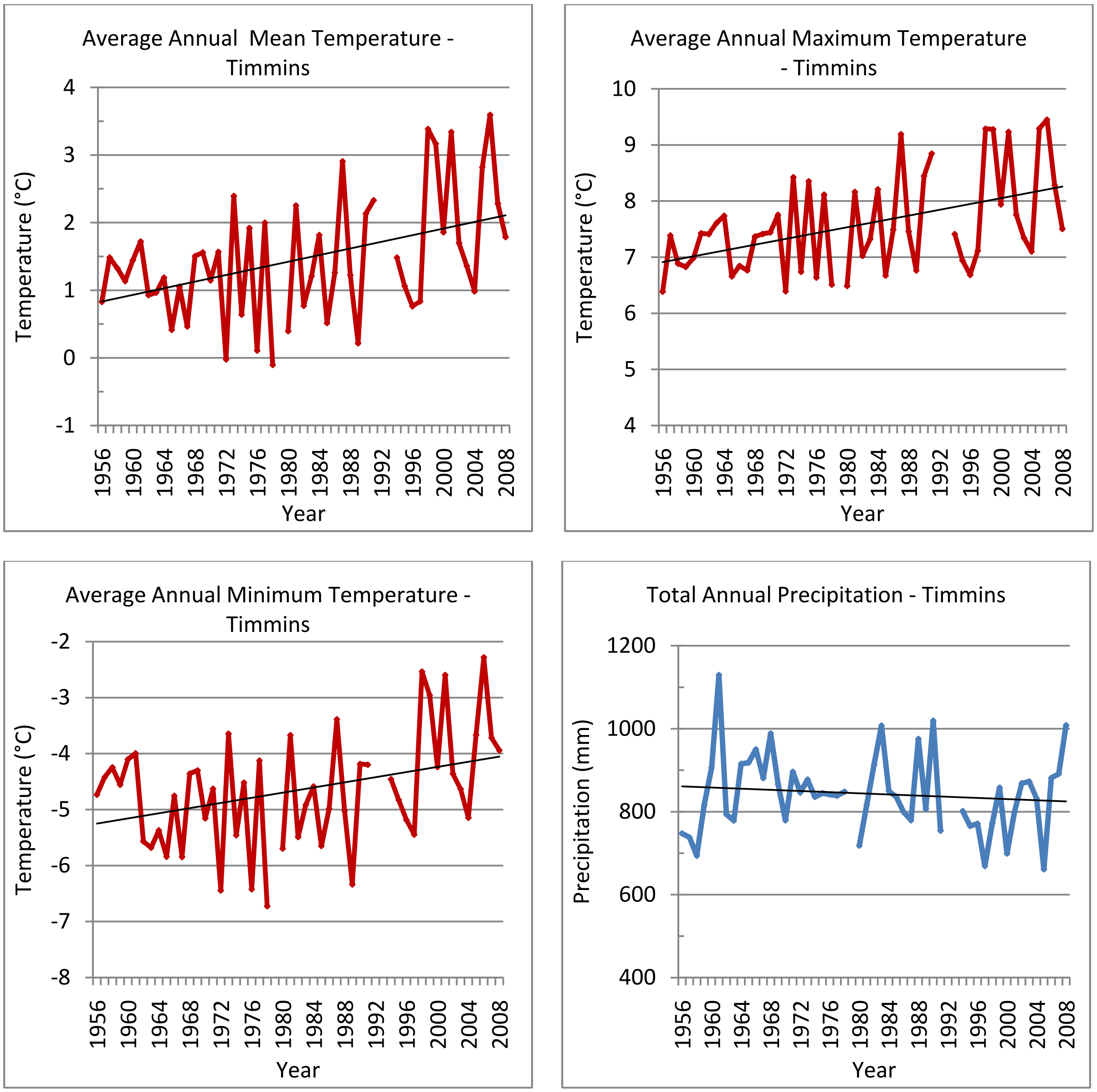


Figure 14: Average annual temperature (°C) from 1956 to 2008. Data from Victor Power A (Environment Canada, 2008) shows that the average annual mean temperature at this location has increased 1.3°C, average annual maximum temperature has increased 1.4°C , average annual minimum temperature has increased 1.3°C, and total annual precipitation has decreased 35 mm over the 53 years of record.

Winter

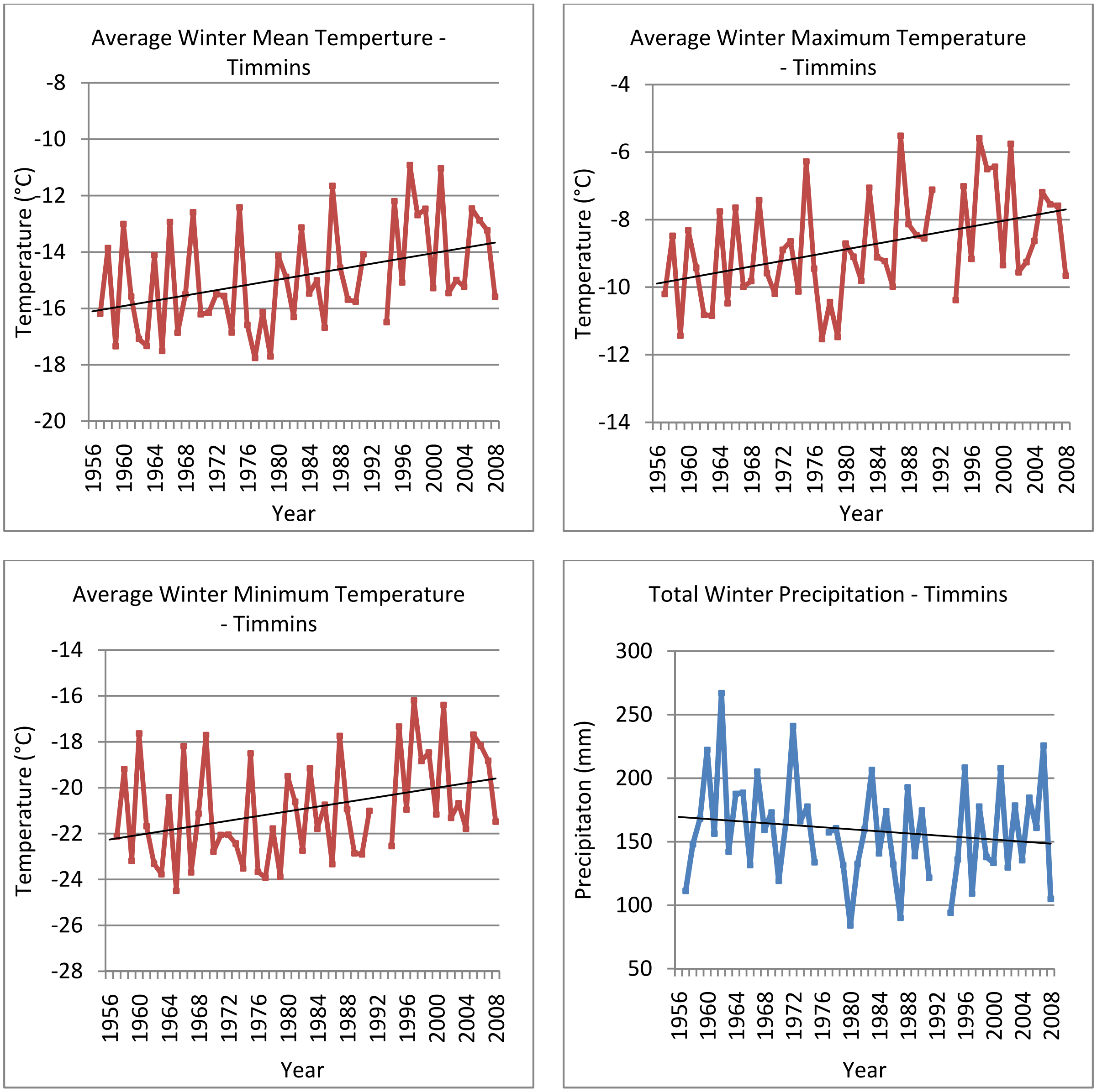


Figure 15: Average winter temperature (°C) from 1956 to 2008. Data from Victor Power A (Environment Canada, 2008) shows that the average winter mean temperature at this location has increased 2.4°C, average winter maximum temperature has increased 2.2°C , average winter minimum temperature has increased 2.7°C, and total winter precipitation has decreased 96 mm over the 53 years of record.

Summer

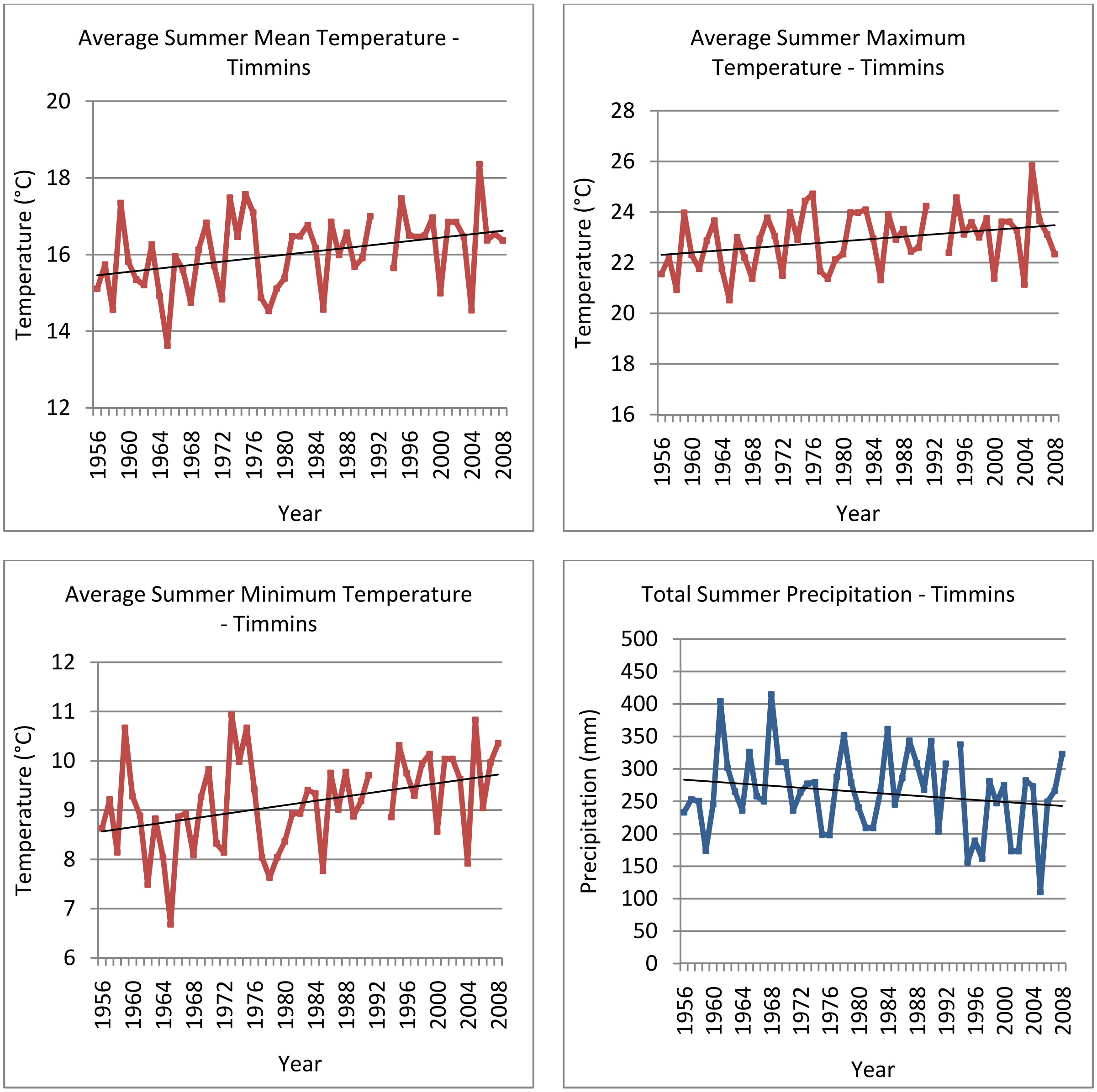


Figure 16: Average summer temperature (°C) from 1956 to 2008. Data from Victor Power A (Environment Canada, 2008) shows that the average summer mean temperature at this location has increased 1.2°C, average summer maximum temperature has increased 1.2°C , average summer minimum temperature has increased 1.1°C, and total summer precipitation has decreased 42 mm over the 53 years of record.

Future Climate Projections for Timmins

Future climate projections were obtained from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). The CCCSN describes climate change as a difference over a period of time (with respect to a baseline or a reference point) and corresponds to a statistical significant trend of mean climate or its variability, persistent over a long period of time (Environment Canada, 2007). Reference periods of typically 3 decades long (1971-2000) are of sufficient length to adequately represent the climate of the period, and can be used to compare fluctuations of climate between one period and another (Environment Canada, 2007).

Projections from Global Climate Models (GCMs) exhibit a great deal of climate variability. Because of this, the IPCC (2001a) has recommended using at least 30 year averaging periods for GCM output (Environment Canada, 2007). Output generated by climate models are typically as follows: the 2020s (2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099) (Environment Canada, 2007).

The climate scenarios produced for Timmins, Ontario were created using the Third Generation Coupled Global Model (CGCM3), version T47. The T47 version has a surface grid whose spatial resolution is roughly 3.75 degrees lat/long and 31 levels in the vertical (Environment Canada, 2005). Data is displayed for the B1 and A2 emission scenarios and is compared to the period of 1971-2000.

Emission scenarios (B1 and A2) are described as follows (IPCC, 2007 cited in Environment Canada, 2007).

A2

The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population (15 billion by 2100). Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1

The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

Temperature

Table 8: Change in mean temperature, extreme maximum temperature and extreme minimum temperature data compared to 1971-2000 for Timmins, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007).

	AR4 (2007), CGCM3T47 - Run 1						
	Observed	**SR-B1**		**SR-AIB**		**SR-A2**	
	Temperature (°C)	**Change in Mean Temperature (°C)**					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-15	1.4	3.2	1.8	4.2	2	3.6
Spring	1	0.9	2.6	1.4	2.8	1.8	3
Summer	15.9	1.5	2.1	1.7	2.7	1.7	2.9
Autumn	3.4	1.7	2.4	1.9	3.0	1.8	3.2
Annual	1.3	1.4	2.6	1.7	3.2	1.8	3.2
	Temperature (°C)	**Change in Extreme Maximum Temperature (°C)**					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	14.2	1.3	2.1	1.4	2.6	1.3	2.5
Spring	32.5	2.7	3.2	2.3	3.9	2.6	4
Summer	38.9	1.5	2.3	1.5	2.5	1.7	2.9
Autumn	32.2	1.5	2.4	1.7	2.9	2.1	3.1
Annual	38.9	1.5	2.3	1.5	2.5	1.7	2.9
	Temperature (°C)	**Change in Extreme Minimum Temperature (°C)**					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-44.2	0.7	2.9	1.3	4	1.4	3.5
Spring	-37.8	1.2	3.8	1.7	3.6	2.5	3.9
Summer	-3.2	2	2.7	2.3	3.5	2.2	3.6
Autumn	-33.9	1.4	2.4	1.4	2.8	1.5	2.9
Annual	-44.2	0.7	2.9	1.3	4	1.4	3.5

Precipitation

Table 9: Change in precipitation, extreme maximum precipitation and water surplus and deficit data compared to 1971-2000 for Timmins, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007)

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-A1B**		**SR-A2**	
		Change in Precipitation (mm)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	151.9	4.6	39.3	59.8	62.6	31.5	66.5
Spring	181.4	85.5	113.4	53.9	71.4	28.4	37.3
Summer	263.8	30.1	33.4	36.7	61.6	37.2	41.2
Autumn	234.1	-33.4	-8.7	21.1	33.8	4	40.6
Annual	831.2	86.8	177.4	171.4	229.3	101.1	185.6
		Change in Extreme Maximum Precipitation (mm)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	267.5	38.1	109.7	137.1	147.3	85.1	152.7
Spring	379.8	184.3	254.5	109.6	146	59.2	267.4
Summer	592.5	30.3	38.3	43.7	95.1	47	54.7
Autumn	449.1	-45	3.5	59	78.5	22.9	100.7
Annual	1688.9	207.8	406	349.3	466.9	214.2	387.8
		Change in Mean Water Surplus/Deficit (mm)					
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Surplus	413	17	83	105	135	36	103
Deficit	37	-5	-1	-7	-9	-6	3

Historic Climate and Climate Trends for Thunder Bay

The following is a compilation and summarization of weather and climate data for Thunder Bay, Ontario. Data were obtained from Environment Canada.

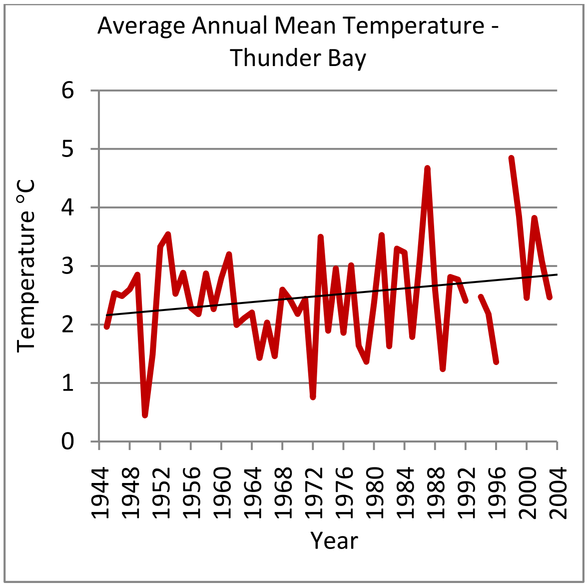
Daily Weather

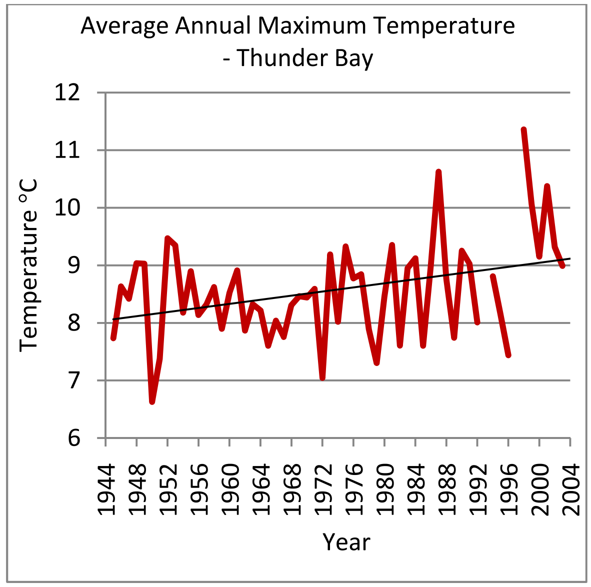
Daily climate data from Thunder Bay A weather station, obtained from Environment Canada, was averaged to obtain monthly values for temperature and precipitation (Environment Canada, 2008). Seasonal climate values (winter –DJF and summer -JJA) were calculated by averaging the monthly data. In the following section, temperature and precipitation data, for the years 1945 to 2004, are displayed annually and seasonally (summer and winter) with line charts (Figures 17 to 19) and include mean, maximum and minimum temperature and annual precipitation. Temperature data was missing from 1993, 1997 and 2004. Annual means could not be calculated for these years. Winter means could not be calculated for 1993 and 2004 and summer means could not be calculated for 1993 and 1997. Precipitation data was missing from the years 1993, 1995, 1996, 1997, 1998 and 2004. Annual means could not be calculated for these years. As well, winter means could not be calculated for 1993, 1995, 1996, 1997, 1998 and 2004 and summer means could not be calculated for 1993, 1996 and 1997.

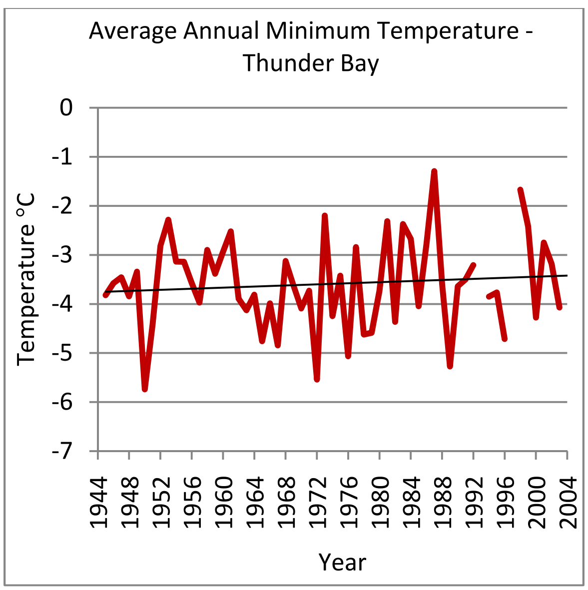
Mean temperature is defined as the average of temperature readings taken over a specified amount of time For example, daily mean temperatures are calculated from the sum of the maximum and minimum temperatures for the day, divided by 2 (Environment Canada, 2008). Maximum temperature is the highest or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

Historical Mean Temperature and Precipitation Data for Thunder Bay

Annual







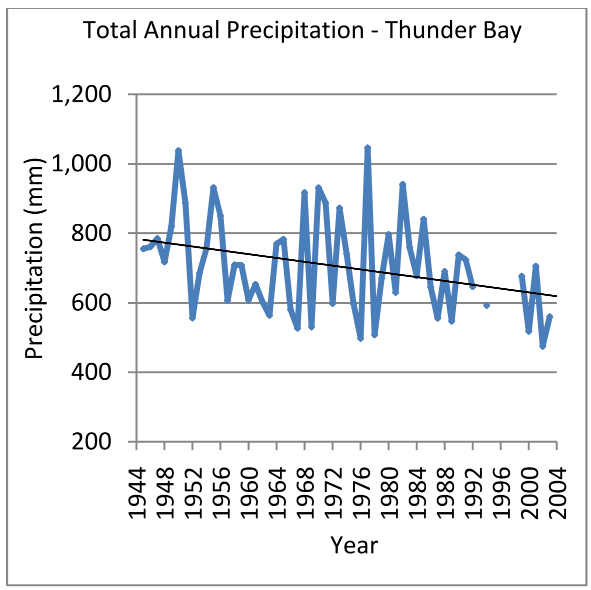


Figure 17: Average annual temperature (°C) from 1945 to 2004. Data from Thunder Bay A (Environment Canada, 2008) shows that the average annual mean temperature at this location has increased 0.7°C, average annual maximum temperature has increased 1.1°C , average annual minimum temperature has increased 0.3°C, and total annual precipitation has decreased 160 mm over the 60 years of record.

Winter

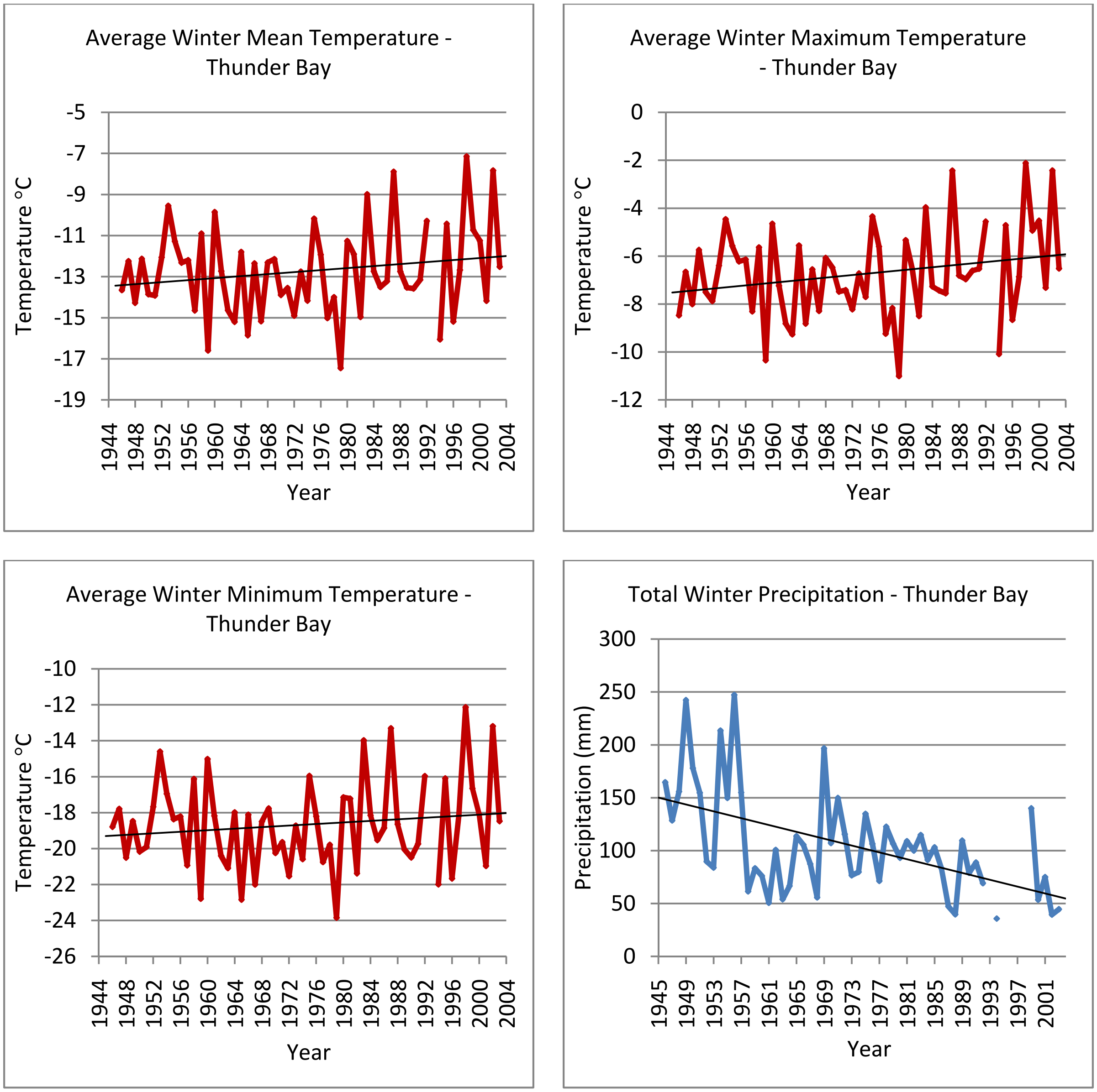


Figure 18: Average winter temperature (°C) from 1945 to 2004. Data from Thunder Bay A (Environment Canada, 2008) shows that the average winter mean temperature at this location has increased 1.4°C, average winter maximum temperature has increased 1.6°C , average winter minimum temperature has increased 1.6°C, and total winter precipitation has decreased 96 mm over the 60 years of record.

Summer

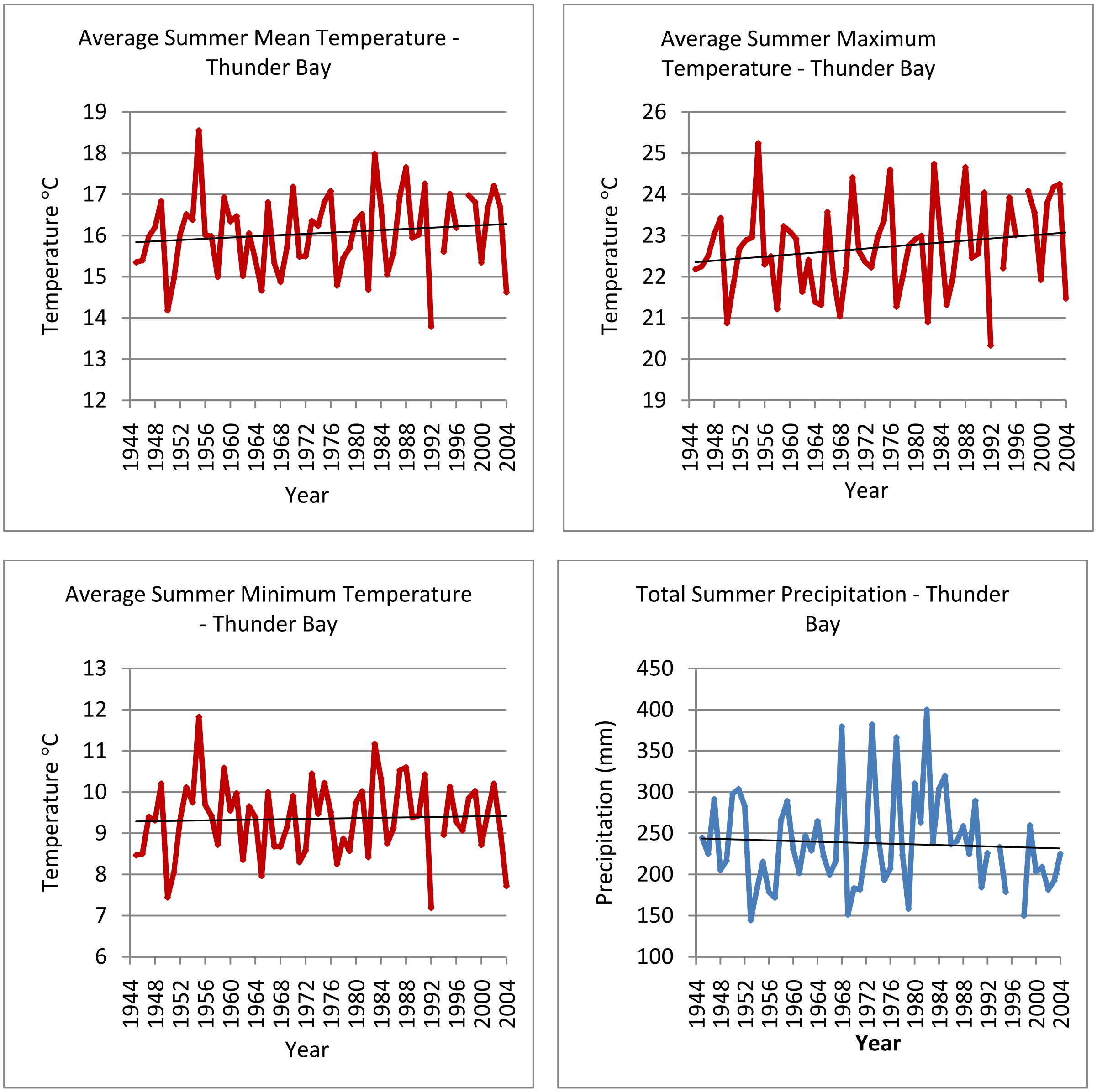


Figure 19: Average summer temperature (°C) from 1945 to 2004. Data from Thunder Bay A (Environment Canada, 2008) shows that the average summer mean temperature at this location has increased 0.5°C, average summer maximum temperature has increased 0.8°C , average summer minimum temperature has increased 0.1°C, and total summer precipitation has decreased 12 mm over the 60 years of record.

Future Climate Projections for Thunder Bay

Future climate projections were obtained from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN). The CCCSN describes climate change as a difference over a period of time (with respect to a baseline or a reference point) and corresponds to a statistical significant trend of mean climate or its variability, persistent over a long period of time (Environment Canada, 2007). Reference periods of typically 3 decades long (1971-2000) are of sufficient length to adequately represent the climate of the period, and can be used to compare fluctuations of climate between one period and another (Environment Canada, 2007).

Projections from Global Climate Models (GCMs) exhibit a great deal of climate variability. Because of this, the IPCC (2001a) has recommended using at least 30 year averaging periods for GCM output (Environment Canada, 2007). Output generated by climate models are typically as follows: the 2020s (2010-2039), the 2050s (2040-2069), and the 2080s (2070-2099) (Environment Canada, 2007).

The climate scenarios produced for Thunder Bay, Ontario were created using the Third Generation Coupled Global Model (CGCM3), version T47. The T47 version has a surface grid whose spatial resolution is roughly 3.75 degrees lat/long and 31 levels in the vertical (Environment Canada, 2005). Data is displayed for the B1 and A2 emission scenarios and is compared to the period of 1971-2000.

Emission scenarios (B1 and A2) are described as follows (IPCC, 2007 cited in Environment Canada, 2007).

A2

The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population (15 billion by 2100). Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1

The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

Temperature

Table 10: Change in mean temperature, extreme maximum temperature and extreme minimum temperature data compared to 1961-1990 for Thunder Bay, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007).

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-AIB**		**SR-A2**	
		Change in Mean Temperature (°C)					
	1961-1990	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-13.1	2.1	3.3	2.1	4.3	2.2	3.6
Spring	2	1.5	2.6	1.8	2.9	1.9	2.8
Summer	16	1.7	2.3	2	2.9	2	3.2
Autumn	4.6	1.6	2.1	1.7	2.7	1.6	2.7
Annual	2.4	1.7	2.5	1.9	3.2	1.9	3.1
		Change in Extreme Maximum Temperature (°C)					
		2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	12.2	2.3	3.5	1.8	3.7	2.1	3
Spring	35.2	2.3	2.6	2.4	3.2	2.3	3.5
Summer	40.3	1.3	2.1	1.5	2.4	2	2.7
Autumn	31.7	1.9	2.4	2.3	3.3	2.3	3.2
Annual	40.3	1.3	2.1	1.5	2.4	2	2.7
		Change in Extreme Minimum Temperature (°C)					
		2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	-40.4	2.5	4.4	3	5.5	2.8	4.4
Spring	-32.8	2	3.6	1.8	3.5	2.2	3
Summer	-1.7	1.9	2.8	2.2	3.3	2.4	3.6
Autumn	-30.6	1.6	1.9	1.3	2.8	1.6	2.5
Annual	-40.4	2.5	4.4	3	5.5	2.8	4.4

Precipitation

Table 11: Change in precipitation, extreme maximum precipitation and water surplus and deficit data compared to 1961-1990 for Thunder Bay, Ontario. Projected values are obtained using AR4 (2007), CGCM3T 47 – Run 1 for each of the emission scenarios A2, A1B and B1 (Environment Canada, 2007)

	AR4 (2007), CGCM3T47 - Run 1						
	Observed Data	**SR-B1**		**SR-A1B**		**SR-A2**	
	Change in Total Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	97	0.1	8.1	15.9	25.7	14.4	28.1
Spring	157.2	7.6	27.7	17.3	35.2	15.6	28.4
Summer	252.4	-0.9	9.3	6.9	8	5.5	10.7
Autumn	196.7	-4.6	11.5	10.7	24.8	-8.3	25.5
Annual	703.3	2.3	56.6	50.7	93.3	27.2	92.6
	Change in Extreme Maximum Precipitation (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Winter	252.8	0.9	21	39.6	67	36.2	72.9
Spring	414.3	21.7	70.9	46.5	90.3	40.5	73.2
Summer	540.9	-0.6	20	16.8	22.2	15.1	22.8
Autumn	554.8	-7.9	28.8	21.6	71.1	-25.8	65.7
Annual	1762.8	14	140.6	124.5	250.6	65.9	234.6
	Change in Mean Water Surplus/Deficit (mm)						
	1971-2000	2011-2040	2041-2070	2011-2040	2041-2070	2011-2040	2041-2070
Surplus	303	-41	-2	8	21	-12	23
Deficit	51	15	17	14	18	15	24

Risk Assessment Process

The purpose of the following section on the risk assessment/management process 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 almost always addresses issues and problems that are influenced by the climate now. Climate is not the primary driver in most cases, and identifying and reducing the contribution to the problem from the <u>other</u> 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 potential loss and the greatest probability of occurring are handled first, and risks with lower probability of occurrence and lower potential 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

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

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 upon 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.

RISK COMMUNICATION

Step 1: Initiation

- Define problem, opportunity and risk issue(s)
- Identify risk management team
- Assign responsibility, authority and resources
- Identify stakeholders and initiate consultation process

END — GO BACK — Next Step / Take Action

Step 2: Preliminary Analysis

- Define scope of decision(s)
- Identify hazards using risk scenarios
- Begin stakeholder analysis
- Start risk assessment library

END — GO BACK — Next Step / Take Action

Step 3: Risk Estimation

- Define methodology for estimating frequency and consequences
- Estimate frequency of risk scenarios
- Estimate consequences of risk scenarios
- Refine stakeholder analysis through dialogue

END — GO BACK — Next Step / Take Action

Step 4: Risk Evaluation

- Estimate and integrate benefits and costs
- Assess stakeholder acceptance of risk

END — GO BACK — Next Step / Take Action

Step 5: Risk Control

- Identify feasible risk control options
- Evaluate risk control options
- Assess stakeholder acceptance of proposed action(s)
- Evaluate options for dealing with residual risk
- Assess stakeholder acceptance of residual risk

END — GO BACK — Next Step / Take Action

Step 6: Implementation

- Develop implantation plan
- Implement control and financing strategies
- Establish monitoring process, sunset and/or terminate

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

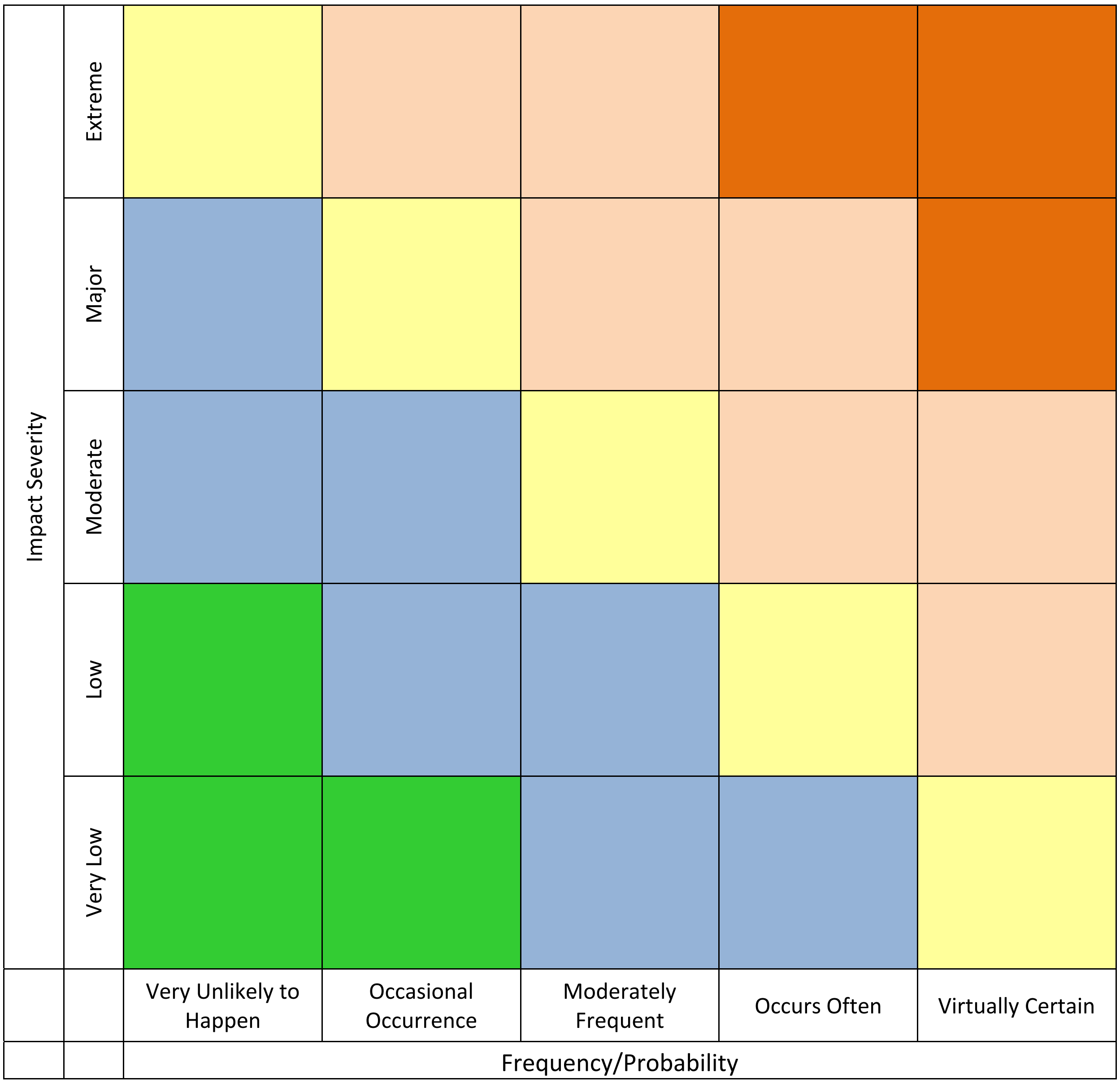
For each one of these extremes (in practice it may only be feasible to choose one extreme, such as "heavy summer precipitation"), identify the impacts and hazards that current climate (and therefore future climate) extremes could cause through a "risk scenario". This scenario would include low and higher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



Extreme risk: Immediate controls required	**High risk**: High priority control measures required	**Moderate risk**: Some controls required	**Low risk**: Controls not likely required	**Negligible risk:** Do not require further consideration

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 – Setting the Stage

Case Study 1: Flooding

As the senior water resources engineer at the local Conservation Authority, you are responsible for managing local storm water reservoirs and responding to flooding in your area. At 2:00 am you receive a phone call stating that the water level of the river running through town is very high. Upon arrival, you notice that the water has breached the top of the river bank and has flooded the road. Residential homes and a gas station are located just 'downstream' of the flowing water. A combination of melting snow and heavy spring rain has resulted in copious amounts of water unable to escape via over-land drainage routes.

Four hours later the rain has stopped. The road, gas station and 25 homes now are flooded by 3 feet of water.

You already know that the 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 the drainage basin in the area. That request was rejected and since then, 3 events have taxed the infrastructure to the point where the integrity of other municipal infrastructure has been compromised. Plans for community expansion (200 new homes) in areas that are now flooded is expected to begin later this year.

A week later you are preparing your report for the municipal 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 the city's infrastructure and land use in the area. 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) and much more variability in the weather;
- 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 - Source Water Protection

As Chair of the Source Protection Committee (SPC), your role is to guide and oversee the process of identifying vulnerabilities in, and threats to, drinking water sources in your source protection area as well as developing protective measures to ensure safe drinking water. Your area of responsibility, located in northern Ontario, is approximately 3000 km^2 in size and is comprised of 2 watersheds, one of which has a majority of its area within the city limits. The source protection area has many small lakes and rivers within its bounds. Approximately half of the city's population draws its drinking water from a lake that is centrally located with others depending on a mix of other surface water (35%) and ground water (15%). Drinking water systems within the city include a large municipal system drawing water from the lake, a small municipal ground water system on the edge of the city in the smaller of the two watersheds and many private systems drawing water from wells and smaller lakes.

The city's population has risen from 50,000 to 63,000 over the past 8 years and is optimistically expected to continue to rise with tourism, mining, forestry and government services leading the economic growth.

A conceptual water budget prepared for the area highlights significant vulnerabilities under drought conditions. Weather monitoring stations are not well placed in the area and are not spatially representative; however, precipitation trends show decreases of 12%-15% over the past 25 years. Average annual temperature has increased by 1.3 degrees Celsius over the same time period. In addition to the trends of temperature and precipitation, you have also noted other local observations (with accuracy):

- Decreased periods of ice cover on local lakes and rivers;
- Shorter winter seasons and earlier arrival of the spring melt;
- Much more variability in the weather, especially winter thaws and winter rainfall;
- More extreme rainfall events in the summer.

You are aware of some of the regional climate modeling done for other source protection areas but no regional models and little data exists for your area. Projections of climate for your area come from Environment Canada's Canadian Climate Change Scenarios Network (CCCSN) web page and show that under the A1B scenario, average annual temperature is expected to rise by 3 degrees Celsius compared with the 1961 – 1990 average by the 2050s. The same projections indicate that precipitation may decrease by 17% into the same time period.

Your source protection team is in the final stages of preparing your Assessment report but feel that the impacts of climate variability/climate change have not been adequately addressed in the process. You realize the importance of accounting for climate change in the context of this planning process and decide to undertake an assessment of the risks posed by climate variability and change. Your initial focus will be on water quantity, specifically how drought may affect the water budget, with a secondary focus on drought and water quality. The goal of the exercise is to understand how climate may enhance existing threats to source water and identify what new threats may arise as a result of climate change.

Table 12: Risk Assessment Template for case study.

Risk Assessment Matrix

		Impacts				
Severity of Impact (1 to 5)	Economic Impact					
	Social Impact					
	Environmental Impact					
Probability of Occurrence (1 to 5)						
Prioritized Risk (subjective assessment)						

Prioritized Risk = Severity x Probability

Additional Climate Change Considerations

Responses to climate change can either be mitigative – energy conservation, energy efficiency, greenhouse gas reductions, alternative energy sources, carbon capture/storage; or adaptive – managing stormwater/flood protection, heat alert plans, drought plans, water budgeting, tree planting and others.

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?

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

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 northern 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, $$, 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

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 trans- actions, 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.

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.

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Notes

Appendix B – Evaluations

Climate Change Workshop Evaluation Summary

A total of fifteen conference participants completed the evaluation.

1. **Were the presentations clear and concise?**

   A very high number of respondents (over 90%) said that the presentations were clear and concise.

2. **How would you rate the quality of the material presented?**

   Most of the presentations fell into the very high or high category (87.5 %).

3. **Did the material presented meet your expectations?**

   Forty two percent of participants indicated that the material *very highly* met their expectations, and the same amount of people indicating that a *high* level of expectations had been met. Seventeen percent indicated a neutral level, and no one indicated a low or very low level. One respondent said that they had no expectations.

4. **Risk Assessment Break-out Sessions:**

   Close to 100% of the responses for all questions relating to the breakout session were in the "*very high"* and "*high"* categories.

   The total number of responses in each category is noted below;

   a. Did you find the breakout sessions useful?

Very high	High	Neutral	Low	Very low
5	**9**	**1**		

   b. Was the facilitator able to convey instructions clearly to all participants?

Very high	High	Neutral	Low	Very low
8	**7**			

   c. Did the facilitator lead the participants sufficiently through the breakout sessions?

Very high	High	Neutral	Low	Very low
8	**6.5**	**.5**		

Comments:

“No slight on the presenter -- a difficult and complex topic to convey in a one and a half hour session.”

“Steps one and two higher order/lower order and the necessity/usefulness of doing that is unclear”

“Well done!”

“The breakout session tended to veer away from the “source water protection” scenario however the session was helpful for understanding the overall process”

“Excellent facilitators and topics, knowledgeable, experienced, good communication skills.”

Overall Workshop Comments

The feedback on the conference was extremely positive! Based on the following comments many more of these events should be held for a variety of sectors. Considering the depth of information explored during this process it is reasonable that a full day be dedicated to this task alone (a follow-up session was suggested). It was also recommended that the workshop should be provided directly to local municipal governments if not already done! There was also a request for webinars to share information and skills with other stakeholders.

Quoting participants:

“Kudos to your workshop. Information presented and links made available on the subject of climate change was/is excellent.”

“Overall an excellent session. Kudos to the organizers and speakers. A great deal of new information and very well-balanced. Suggests that a follow-up session be planned. Congratulations!”

“Very worthwhile, interesting! I'm glad I was invited. Great workshop!

“Good idea to have a case study and work through. Very helpful to find out about what climate change initiatives are being done in various C.A.s”

“Well organized! Excellent presenters. Very informative. Should be provided directly to local municipal governments if not already done!

“Good start on integrating climate change into local C.A. business! I agree-a big opportunity for CA's”

“Excellent and thought-provoking speakers”

"Super I learned a lot. Set up, from general to C.A. Specific was good strategy, for learning and incorporating methods to use the new skills/knowledge.

"Interactive/contentious topics after lunch (or strategies) would've been useful to help keep people engaged during a very long day -- always a challenge in this type of programming. Future. Webinars for sharing information and skills with other partners/players/stakeholders would be helpful.

Climate Change Adaptation - Evaluation Summary

A total of nine conference participants completed the evaluation.

Please note: for all the questions below the range of knowledge indicated is as follows;

1	2	3	4	5
Not knowledgeable				Very Knowledgeable

1. **On a scale of 1 to 5, how knowledgeable is your organization/group about climate change?**

   Eight of nine respondents stated that their knowledge of climate change was in the medium to low range, i.e., more than 50% indicating a level II.

2. **To your knowledge, has climate change been discussed in any formal way within your organization/group (meetings, motions, within reports, etc)?**

   Two thirds of respondents indicated that they had discussed climate change within their group, one third of these as a result of their participation in the source water protection assessment report process. Others as a result of high level reporting... with no consistency; and infrastructure needs... monitoring long and short-term effects.

3. **On a scale of 1 to 5, how knowledgeable is your organization/group about <u>climate change mitigation</u> (activities or policies aimed at reducing greenhouse gas emissions)?**

   One hundred percent of respondents stated that their knowledge of climate change mitigation was in the medium to lower range, with a 50-50 split over the two and three levels.

4. **On a scale of 1 to 5, how knowledgeable is your organization about climate change adaptation (impacts reduction).**

   Forty four percent of participants saw themselves as less than knowledgeable in the area of climate change adaptation, while 56% saw their knowledge level in this area as intermediate (3).

5. **To what extent is your organization aware of how your community/watershed might be vulnerable to the impacts of climate change?**

Only two (less than 20%) of the respondents saw themselves above the midline in awareness category. Forty four percent low level in indicated a low level of awareness (<3).

6. **Are you aware of ways in which your community/watershed might be able to reduce its vulnerability to the climate change that is already underway**?

   A rather high 78% of respondents indicated that they were not aware of current practices intended to reduce vulnerability to climate change in their community or watershed. Of the remaining 22% who were aware one participants answers came with a "but"…" are not sure of our vulnerability. There will be change but to what extent? The challenge will be to mesh what we do locally to support what is happening globally"

   "Increase in the planning within watersheds, water conservation, educational programs. … stewardship programs increase in the planning within watersheds"

7. **In which areas does your organization see a need for continued support and knowledge improvement or sharing?**

   "information sharing, regional workshop, modeling, updated mapping, develop (models?) low flow)"

   "I think the organization needs support and knowledge from the basis to the important ones, methodologies, policies and knowledge."

   "to improve weather data"

“unfortunately everything from a to z. it is not a topic that has seen a lot of dialogue. Our northern authorities should work collectively with northern support and consultation.

“data collection, what would be valuable? What are the potential impacts? How can we reduce vulnerability?”

“Increase in support for staff capacity”

“More information to all agencies”

“Climate change data gathering and sharing. Climate data and trends for Northern Ontario”