CLIMATE CHANGE AND WATERSHED MANAGEMENT

PROCEEDINGS OF A SYMPOSIUM HELD NOVEMBER 10, 1999,

AT

BLACK CREEK PIONEER VILLAGE,

TORONTO, AND SPONSORED BY

Environment Canada Environnement Canada

Ontario

Acknowledgements

The Symposium on Climate Change and Watershed Management was held to broaden the awareness of local municipal and natural resource professionals about the need to identify and develop appropriate adaptive management techniques to deal with the impacts of climate change in the Toronto area. Even with the achievement of the emission reduction targets established by the Kyoto Protocol, we will be living in a world with twice the 10,000 year average of CO_2 concentrations in the atmosphere by early in the 21st century. This change will result in significant alterations to both the global and local climates, with unavoidable impacts on the local ecosystem that will touch everything from natural heritage, agriculture, and the need for water and energy conservation, to building codes, land use planning, storm water management, transportation planning, greenspace management, and socio-economic norms. While still at the formative stages, the call for the early implementation of adaptive management is being heard from several sources. The Planning Committee wishes to thank the following agencies and individuals for their support and participation in this important endeavour:

Environment Canada
- John Mills, Regional Director General, Environment Canada - Ontario Region
- Carr McLeod, Director, Meteorological Service of Canada, Ontario Region
- Don MacIver, Meteorological Service of Canada, Environment Canada
- Heather Auld, Atmospheric Science Branch, MSC, Ontario Region*

Government of Ontario
- Terry Stopps, Manager, Air Policy and Climate Change Branch, MOE
- Alexandra Campbell, Air Policy and Climate Change Branch, MOE*
- Marnie Vandierendonk, Air Policy and Climate Change Branch, MOE*
- Donna Wales, Climate Change Program Co-ordinator, MNR
- Joe Perrotta, Senior Planner, Ministry of Municipal Affairs and Housing

City of Toronto
- Joan King, Councillor
- Jack Layton, Councillor

Keynote Presentations
- Dr. James Bruce, Global Change Strategies International Inc
- Robert Walker, EBNFLO Environmental

The Toronto and Region Conservation Authority
- Dick O'Brien, Chair
- Craig Mather, CAO
- Brian Denney, Director, Watershed Management
- Dave Dyce, Manager, Resource Science
- Jane Clohecy, Manager, Development Services
- Don Haley, Co-ordinator, Floodplain Management*
- Andrew McCammon, Project Co-ordinator*

**Member of the Planning Committee*

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Executive Summary

These proceedings seek to capture the presentations and discussions that took place at the November 10, 1999 Symposium on Climate Change and Watershed Management, as well as the recommendations made by the Planning Committee following the Symposium.

More importantly, they seek to expand on the original goal of the Symposium: reaching and informing municipal and natural resource managers, as well as members of the public, on the need for the early implementation of adaptation management: dealing with how climate change may impact the Toronto area.

This version of the proceedings differs from the one sent to all attendees of the Symposium, as well as to other municipal and natural resource managers in the Toronto area, in that it includes an Appendix containing all of the flip-chart notes from the breakout groups. While the Planning Committee hopes each person will read the whole Proceedings, the key elements of the Symposium could be described as follows:

A **Attention on climate change** is divided into three areas: developing sound science; "mitigation", which means lessening human impacts on the atmosphere and the climate through emission reductions; and "adaptation", which means finding ways to live with a changing climate before the results of mitigation can begin to appear. Unfortunately, the least advanced of these areas of interest, and the one of direct interest to municipal and natural resource managers, is adaptation;

B **Recent scientific opinion**, led by the Intergovernmental Panel on Climate Change, is that Global Climate Change is happening and will present practical challenges to local ecosystems, including the prospects of more severe weather, longer droughts, higher temperatures, changes in local bio-diversity, and reduced ground and surface water quantity, quality, and temperature. These changes will impact everything from the natural landscape to human health, built infrastructure, and socio-economic norms;

C **The fundamental reality about climate change**, and the reason adaptation is so important, is that even if we achieve the emission reductions of the Kyoto Protocol, we will still be living in a world with twice the historic averages of CO_2 by between 2020 and 2050. In fact, the real goal of the emission reduction targets of the Kyoto Protocol is not to reduce total emissions, but merely to delay the doubling of the historic averages by twenty years. Regardless of when we hit the two times carbon dioxide level, this alteration of our atmosphere will drive climate change;

D **As the science of climate change modelling begins to move** from the global to the regional and local levels, as described in three keynote presentations, we are just beginning to perceive what the local impacts might be. Therefore, we are also just beginning to understand the areas where we will need adaptation strategies;

E The three keynote presentations, as described beginning on page 8, can be summarized as follows:

DR. JAMES BRUCE, providing an overview of Global Climate Change, stated that the world is warming, and that weather patterns may become more influenced by El Nino and La Nina, which will mean that central Canada will probably have long periods of hotter, drier conditions, with more frequent severe weather events, followed by periods of cooler, wetter weather. Municipal and natural resource managers should therefore extend existing risk management frameworks to watershed and bio-diversity management. Specific suggestions were that these professionals:

- review design criteria for storm sewers and floodplain mapping in light of both upstream developments and changing climate;
- strengthen water conservation programs to save both water and energy; and,
- develop drought contingency plans in municipalities that do not use Great Lakes waters;

HEATHER AULD, speaking on Regional Trends and Impacts, stated that a generally hotter and drier climate, punctuated by the possibility of more severe weather events, would challenge municipal infrastructure and building codes, alter the existing bio-diversity of southern Ontario, present eco-system and public health problems, and alter water availability, water temperature, water quality, shorelines, wetlands, and fisheries. Environment Canada's Integrated Mapping and Assessment Project suggests, for example, that a slight increase in average temperature would increase bio-diversity in Ontario, which would have policy implications for conservation and the management of invasive species. In addition, farmers would be tempted by longer and warmer growing seasons to expand into more intensive agricultural production, converting woodlots and wetlands while increasing their demand for irrigation. The net change would mean less forest cover and less water availability in a landscape with a reduced capacity for water retention. The results of the IMAP study underscore the importance of monitoring, detecting, and predicting the results of subtle warming on aquatic and terrestrial environments, and suggest that municipal and natural resource managers may need to adopt new ways of thinking about how and where natural resources need to be protected;

ROBERT WALKER, addressing Watershed Level Implications, described three climate change scenarios he had modelled for the future of the Moira / Trent watersheds using climate estimates supplied by the Canadian General Circulation Model and by applying climate data from Washington, DC, and Dodge City, Kansas. All three scenarios suggest that a reduced snowpack, less run-off, and frequent summer droughts dominate the possible futures for the Moira / Trent. The data in the modelling reveal the following climate change scenarios:

General Circulation Model	similar amount of precipitation 18% less annual flow 25% more phosphorus
Washington scenario	33% more precipitation 16% less annual flow 80% more phosphorus
Kansas City scenario	27% less precipitation 83% less flow 360% more phosphorus

In addition, a lack of ice cover, a decrease in the annual spring freshette, increased water temperature, a loss in wetlands, and reduced water quality would affect overall eco-system health, while socio-economic impacts would include disruptions to the boating, cottage, and tourist segments of the local economy as well as possible limits to future water-takings. All of these impacts require new approaches to watershed management and a significant effort at developing adaptive responses to climate change;

F A Panel of Experts dealing with Practical Implications suggested that climate change will present sweeping challenges to municipal and natural resource managers for a wide range of responsibilities. At the broadest level, new provincial and professional guidelines might come into play for everything from land use planning and water takings to having to develop new natural heritage and other scientific inventorying and monitoring protocols. Specific impacts will probably be felt with respect to habitat and bio-diversity management; changes in water availability, quality, quantity, and stormwater management, and; the impact of climate change on both operations budgets and public recreation. Practitioners will also need to ensure both more education and social marketing around public expectations as well as to provide support to and encourage leadership on climate change from politicians; and,

G A strategic assessment of the Adaptation Suggestions from the Breakout Groups consists of the following:

- there are over-arching social needs for improved climate change science, public education and awareness, political leadership, new legislative and regulatory mechanisms, and professional guidelines for climate change mitigation and adaptation;

- all government agencies need to set emission reduction targets for their own operations, as well as to identify goals for local carbon sequestration; and,

- municipal and natural resource professionals need to develop and incorporate local climate change scenarios into their long range management strategies, identify potential impacts, establish climate change benchmarks, and develop appropriate adaptation strategies for everything from natural heritage, water and energy conservation, agriculture, and greenspace management to building codes, land use planning, transportation and transit planning, stormwater management, and more, as detailed on pages 21 - 23.

In conclusion, at a time when key national programs are being developed to help Canadians reduce the emission of greenhouse gases, **the Planning Committee notes the corresponding need for national, provincial, and regional programs to help Canadians address the early implementation of adaptive management to deal with the unavoidable impacts of local climate change,** and recommends the following to help Canadians develop the appropriate adaptation strategies:

1) an increased focus on the development of local climate change scenarios. These scenarios should be developed using a variety of approaches, be funded by a partnership of governmental and other organizations, and involve municipal and natural resource practitioners in their development in order to identify possible local impacts;

2) substantial changes to federal and provincial strategies and guidelines for groundwater, surface water, water conservation, land use planning, energy conservation, and transportation to help society reduce emissions and adapt to the expected impacts of climate change;

3) improved communication and co-ordination within municipalities between those departments dealing with policy and planning issues and those dealing with water, stormwater, sewage, energy, transportation, and the natural landscape; and,

4) extensive social marketing from all levels of government, as well as from professional organizations, about the need for new expectations, changed behaviours, and improved technologies for both mitigation and adaptation strategies to deal with climate change.

Participants of the Symposium: l to r, Alexandra Campbell (MOE), Don Haley (TRCA), Carr McLeod (EC), Joan King (City of Toronto), Andrew McCammon (TRCA), Heather Auld (EC), Dick O'Brien, (TRCA), James Bruce, (GCSI Inc), Bruce Walker (EBNFLO), Jane Clohecy (TRCA), Craig Mather (TRCA), John Mills (EC).

Opening Messages

Attendees were welcomed to the Symposium by speakers from several levels of government, including:

Craig Mather	Co-chair of the Symposium and CAO of the host organization, The Toronto and Region Conservation Authority
Carr McLeod	Co-chair of the Symposium and Director, Meteorological Service of Canada, Environment Canada, Ontario Region
Dick O'Brien	Chair, The Toronto and Region Conservation Authority
John Mills	Regional Director General, Environment Canada, Ontario Region
Jim Hamilton	Director, Natural Resource Information Branch, Ontario Ministry of Natural Resources, and
Joan King	Councillor, City of Toronto.

Both in Canada and internationally, attention on climate change is divided into three areas: developing sound science; "mitigation", which means lessening human impacts on the atmosphere and the climate through emission reductions; and "adaptation", which means finding ways to live with the reality of a changing climate before the results of mitigation can begin to appear. As most work in Canada to date has centred on developing science and mitigation, the Symposium on Climate Change and Watershed Management was held to bring together 100 professionals from municipal and natural resource organizations to contemplate what global climate change might mean locally, and what adaptation will mean in their fields.

Will temperature changes alter local bio-diversity? Will our stormwater regimes be adequate? Will our cold water streams become warm and acidic? Will we have enough water for Great Lakes shipping, recreational boating, drinking, agriculture, industry, lawns, and sewage dilution?

All speakers indicated the need for sound science and inter-agency co-operation, and described their agency's interests in understanding climate change and dealing with it through both mitigation and adaptation. It was stated that even if Canada and all other developed countries meet the goals of the Kyoto Protocol to reduce the emissions of greenhouse gases by 6 - 12 % of their 1990 levels between 2008-2012, it is quite clear that we will be living in what we can call a **two times CO_2 world**. This will be a very different world. Globally, it will be hotter and drier, but with significant regional variations in climatic and temperature norms. Precipitation will probably fall less frequently but with greater intensity, requiring new approaches to water quantity, water quality, and other natural resources management issues.

While most attendees of the Symposium were familiar with many of the key elements of climate change and no general introduction was presented at the Symposium, the section that follows provides a backgrounder on climate change for readers less familiar with the issue.

Backgrounder on Climate Change

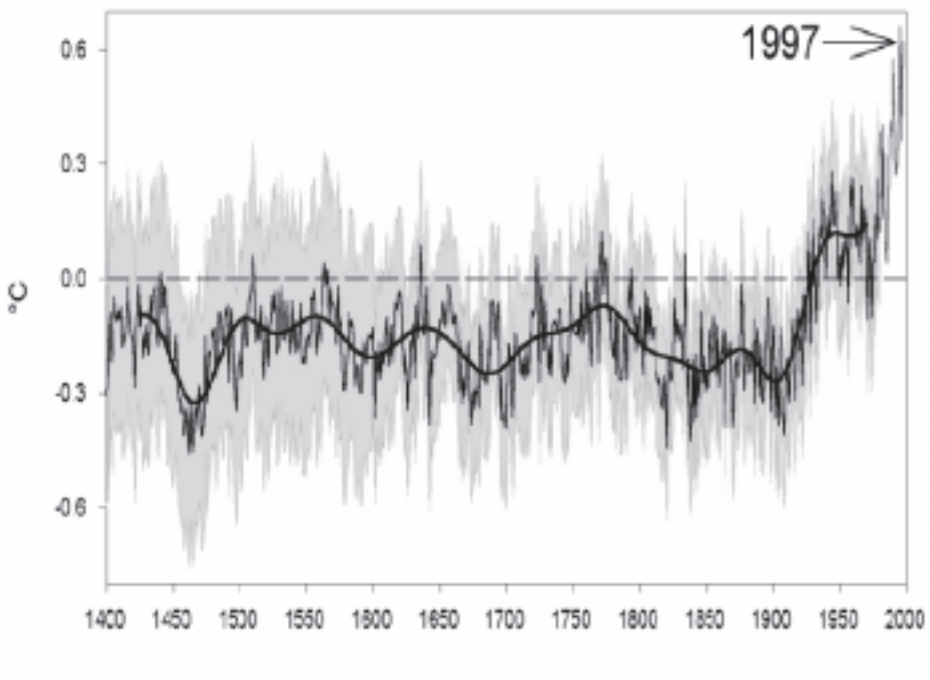
Following years of debate, and with many more science and policy discussions surely to come, climate change is starting to be recognized as a serious threat to the current environmental and socio-economic norms of planet earth.

From the original disputes over the mere existence of the greenhouse effect, whether the planet was entering a new ice age or heating up, and whether more or less cloud cover would generate more or less rainfall, climate change has become a focus of global scientific study and policy considerations, as demonstrated by the UN's Inter-governmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change, which led to the Kyoto Protocol.

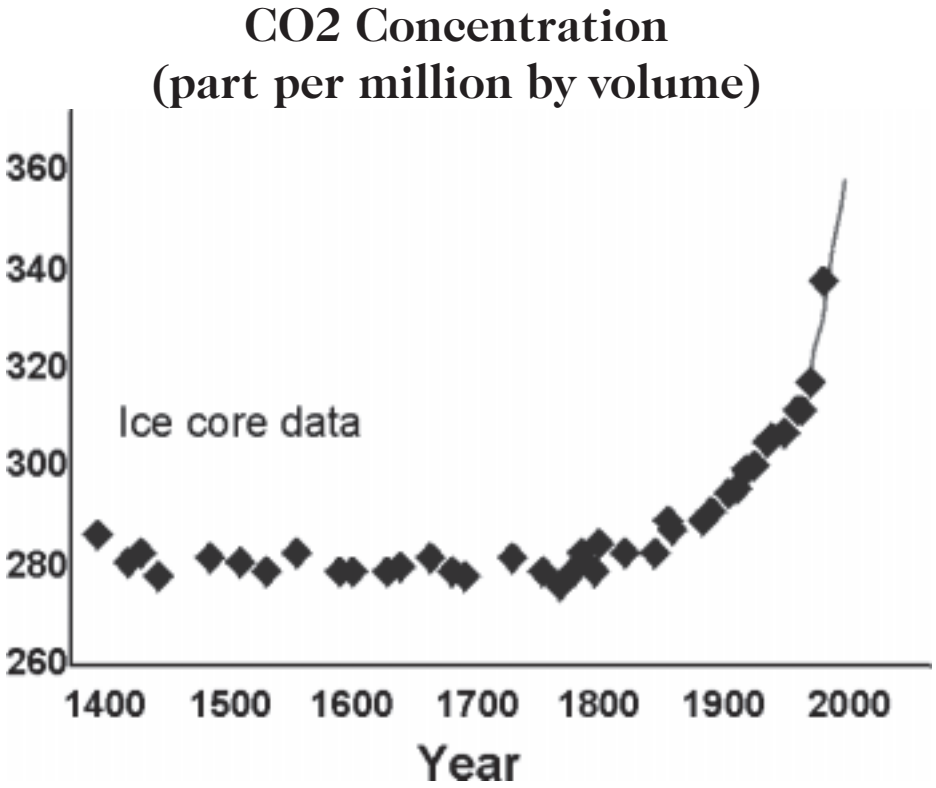
Significant facts that may help individuals and organizations understand climate change include the following:

◆ while ice core samples and other scientific readings show that there are many historic fluctuations in the Earth's climate and temperature caused by natural events, the current average global temperature appears to be warming, and is now similar to that of around 1100 AD, when the Vikings took advantage of moderate temperatures and their naval superiority to plunder parts of Europe, discover Greenland, and place a short-lived settlement at L'Anse aux Meadows, Newfoundland;

Global Mean Temperature (reconstructed from proxy data)



◆ prior to the industrial revolution, the number of people on the planet and our patterns of consumption had little effect on the global atmosphere. Ice core samples from the end of the last ice age to approximately 1700 AD show consistent concentrations of carbon dioxide at around 260 parts per million and those of methane around 700 parts per billion. Since the industrial revolution, however, human numbers, the human life span, and the effect of human technology have all expanded. Deforestation, bio-mass burning, agriculture, the use of nitrogenous fertilizers and other chemicals, and the combustion of carbon-based fuels are changing the composition of the atmosphere.



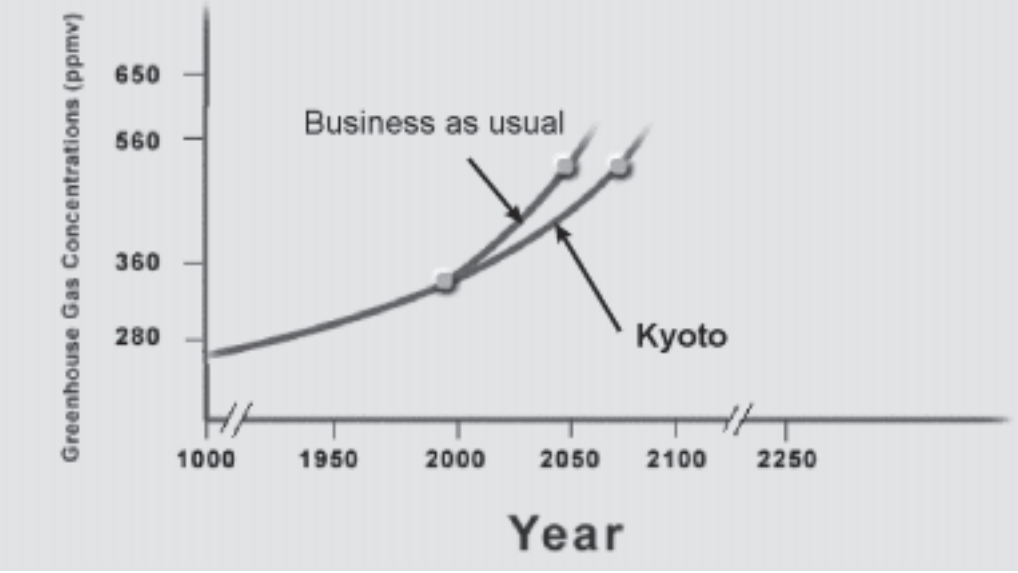
◆ current and projected key atmospheric concentrations, in parts per billion and as provided by Thomas Graedel and Paul Crutzen in an article appearing in Scientific American, are as follows:

SUBSTANCE	1900	2000	2030
Carbon Dioxide	290,000	350,000	400 - 550,000
Methane	900	1,700	2,200 - 2,500
Nitrous Oxide	285	310	330 - 350
Sulphur Dioxide	.03	03 - 50	.03 - 50
CFC's	0	3	2.4 - 6

◆ while there is inadequate space here to delve into the impact of those and other chemicals on the atmosphere, their cumulative impact, and the inter-activity of the atmosphere and the hydrologic cycle, it should be noted that changed atmospheric concentrations will impact air quality, global temperature, and the relative acidity of precipitation, thereby impacting human health and property as well as natural flora and fauna. In addition, hotter local temperatures, as is probable in much of Canada, will result in both a greater deposition of air-borne pollutants to the hydrologic cycle and a higher biological oxygen demand (BOD) in receiving waters. It should also be noted that there are damaging relationships between ozone reduction and climate change, some of which may be unique in the Canadian arctic;

◆ the most important element that emerges from the chart above is that we are headed toward living in a world, around 2030, that will have twice the level of carbon dioxide as has been the norm for the last 10,000 years. In fact, the goal of the emission reduction targets of the Kyoto Protocol is not to reduce total emissions but merely to delay the doubling of the historic averages by twenty years. Regardless of when we hit the two times carbon dioxide level, this increased carbon dioxide will improve the efficiency of the greenhouse effect and as a result raise the overall temperature of the planet; and,

Kyoto is an Important First Step (delays doubling by about 20 years)



◆ while there are many scientific unknowns about which land masses will be warmer or drier and which will receive more or less precipitation, it is clear that the average global temperature will be warmer, and that the oceans will be warmer. On a planet where the oceans are the drivers of global weather patterns, and where the atmospheric conditions will have changed, global climate change presents six main challenges:

CHALLENGE	POSSIBLE IMPACTS
Local weather will be **less predictable.**	Short term weather forecasts will be less accurate.
Local weather will be **more variable.**	Longer periods of drought or rainfall. Farm crops may be harmed due to lack of rain and/or need more irrigation.
Local weather will be **more severe.**	More hurricanes and tornadoes; another ice storm; more heavy or "century" storms with increased erosion and other associated damages.
Local **temperature changes.**	Effects on plant life, wildlife, agriculture, and bio-diversity.
Changes in local **air and water quality.**	Human health and socio-economic impacts; challenges to terrestrial and aquatic life.
Overall rise in global temperature.	The migration of agricultural zones, the migration of pests and diseases such as malaria, and the flooding of low-lying coastal areas due to raised ocean levels.

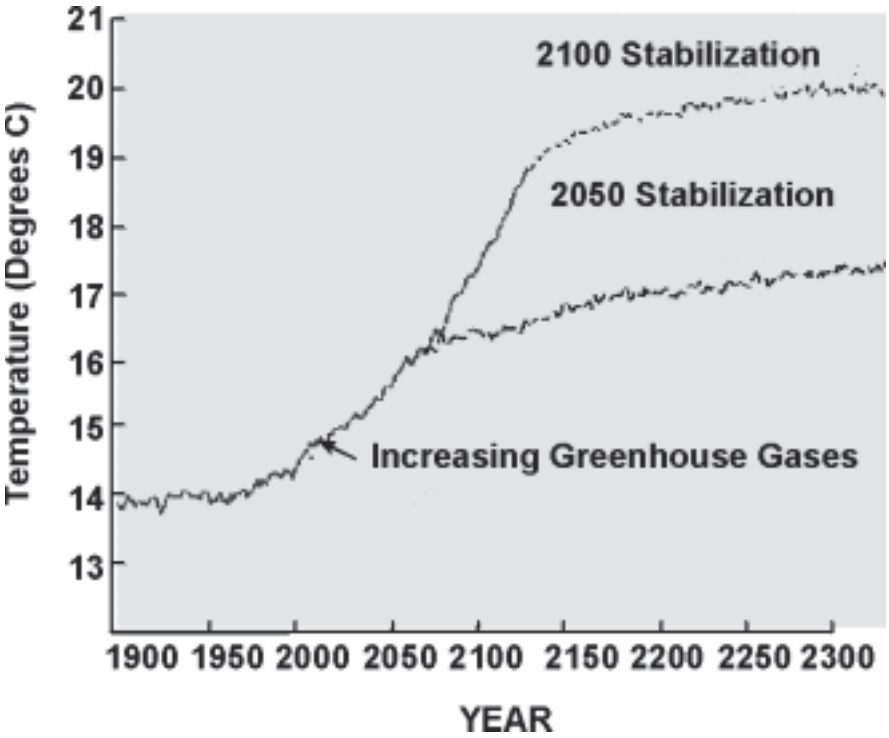
The Canadian Context

As a supporter of international conventions on protecting the atmosphere, maintaining biological diversity, and reducing greenhouse gas emissions, Canada has played a meaningful role in global climate change for over a decade. For example, Toronto hosted the 1987 UN State of the Atmosphere Conference; the treaty limiting chemicals that damage the ozone layer is called the Montreal Protocol, and; Canada has been a key participant on the Inter-governmental Panel on Climate Change (IPCC).

At the IPCC, Canadian participation helped develop the concepts of mitigation and adaptation, where “mitigation” means lessening human impacts on the atmosphere and the climate through emission reductions and “adaptation” means finding ways to live with the reality of a changing climate before the results of mitigation can be expected to appear.

These terms are important. Recent findings from the IPCC suggest that there is a thirty year delay between the release of greenhouse gases, the heating of the planet, and climatic changes based on a warmer ocean. The IPCC has also noted that greenhouse gases have long retention times in the atmosphere, meaning that it may take centuries for any reduction in emissions to be reflected in a return to the historically normal levels of CO_2.

Emission Reduction and Stabilization Scenarios



Even after atmospheric concentrations are stabilized, the climate will still change

Given these facts and the current growth in population and energy use, it is quite clear that we will soon be living in an atmosphere with two times the historic levels of CO_2. In fact, even the achievement of the emission reduction targets in the Kyoto Protocol will not keep CO_2 to twice the 10,000 year norm, and some scientists are already modelling climate change scenarios on a three times CO_2 level.

As stated earlier, the Symposium on Climate Change and Watershed Management was held to bring together 100 professionals from municipal and natural resource organizations to contemplate what global climate change might mean locally, and what adaptation will mean in their fields. **If the world is going to change, and it is going to change, how much will it change, and how do we cope with the changes?**

At a time when key national programs are being developed to help Canadians reduce their emissions of greenhouse gases, the Planning Committee notes that there is also a need for national, provincial, and regional programs to help Canadians adapt to a changing climate. As the professionals who will have to deal with local adaptation are municipal and natural resource managers, the Planning Committee suggests that these professionals obtain the necessary scientific, policy, and financial supports required to address the early implementation of adaptation management for climate change, and provides a few specific recommendations on page 24.

Global Climate Change

DR. JAMES P. BRUCE
Global Change Strategies International, Inc.
O.C., FRSC, D.E.S., M.A., B.A.
Phone / Fax 613-232-7979 / 613-232-3993
E-mail: jpbruce@sympatico.ca

BIOGRAPHY

Dr. Bruce is a senior associate of Global Change Strategies International, Inc. His more than 40 year career has been in the fields of meteorology, climate, water resources, disaster mitigation, and environmental management, initially in flood warning and control programs in Ontario. He has served in senior executive positions within the Canadian Government and UN organizations. From 1986-1989, Dr. Bruce was Director of Technical Cooperation and Acting Deputy Secretary-General of the World Meteorological Organization, Geneva. He recently completed terms as co-chair of the Intergovernmental Panel on Climate Change (IPCC) Working Group III on economics and as chair of the Canadian Climate Program Board. He now is a member of the Canadian Climate Program Board and Vice Chair of the Board of the International Institute for Sustainable Development. He also serves as Canadian Policy Representative, Soil and Water Conservation Society. Recent awards include:

- Doctorate of Environmental Studies (honoris causa 1994), University of Waterloo;
- Massey Medal of the Canadian Geographical Society (1996);
- Officer of the Order to Canada (1997); and,
- Fellow of the Royal Society of Canada (1997).

PRESENTATION

Dr. Bruce provided an assessment of likely future climate conditions in Southern Ontario with continued global emissions of greenhouse gases, with attention to the probable future extremes and variations in climate, the linkage between El Nino and La Nina conditions and weather impacts upon Canada, and probable implications for municipalities, based on a Municipal Risks Assessment undertaken for the National Municipalities Table on Climate Change. Key elements included:

◆ Global mean temperatures over past millennium show fairly steady values to 1900 and rapid warming since, especially since 1970. World is 0.7^0 warmer than at beginning of this century - Canada averaging more than 1^0 warmer. Over southern Ontario it is 0.2 - 0.4^0 per decade from 1961 to 1990 or 0.6^0 to 1.2^0 over that period.

◆ Most recent projections by Canadian atmosphere-ocean model show Ontario warming is in the range of 3 to 5^0 C warmer in the mid 2000's than in the 1971-1990 period.

◆ Another way to look at climate change is to correlate the connection between El Nino and La Nina events in the Pacific with Canadian weather patterns. If the theoretical and modeling research is correct, we can expect longer, more intense droughts during El Nino punctuated by occasional La Nina wet weather conditions sometimes leading to flooding during La Nina. The pattern is especially strong for lower water supplies on average to the upper Great Lakes.

◆ A third approach, from the Geophysical Fluid Dynamics laboratory at Princeton, suggests that the greatest moisture deficits on average are likely to occur between 40 and 55^{0}N - covering most of Ontario. Rain events are likely to become more intense during El Nino. During La Nina, we should prepare for greater variability of climate and occasional flood years. The Canadian model suggest that return periods will be halved, i.e. a 20-year storm will become a 10-year event.

◆ What does all this data mean for Canada?

- In larger watersheds, total area can mask the flood potential of a short duration heavy rain. Smaller watersheds and impervious urban areas, however, will be much more prone to flash flooding, with concomitant problems associated with storm sewer regimes and an increase in soil erosion from agriculture.

- Greater frequency of high rain intensities will also mean more nutrients washed into waterways and the Great Lakes. Urban catchments, for example, contribute much more soluble reactive phosphorus when rainfall is greater than about 23mm/day.

- The record of losses and payouts from both insurance and governments due to climate-related disasters, showing a rapid increase since the early 1980s, will probably continue.

For municipalities, some specific measures for adaption should be seriously considered. These are outlined extensively in a report prepared earlier this year for the Municipalities Table on Climate Change by Global Change Strategies Inc. Suggestions include:

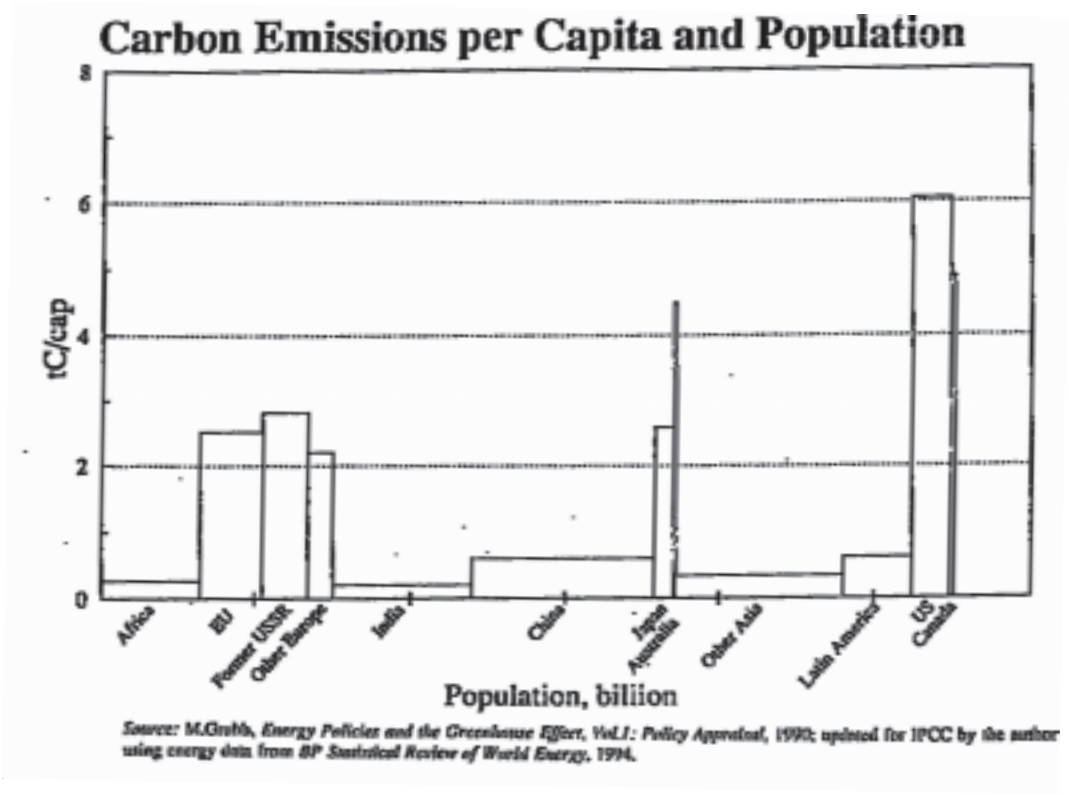
- reviewing design criteria for storm sewers and floodplain mapping in light of both upstream developments and changing climate;

- strengthening water conservation programs to save both water and energy; and

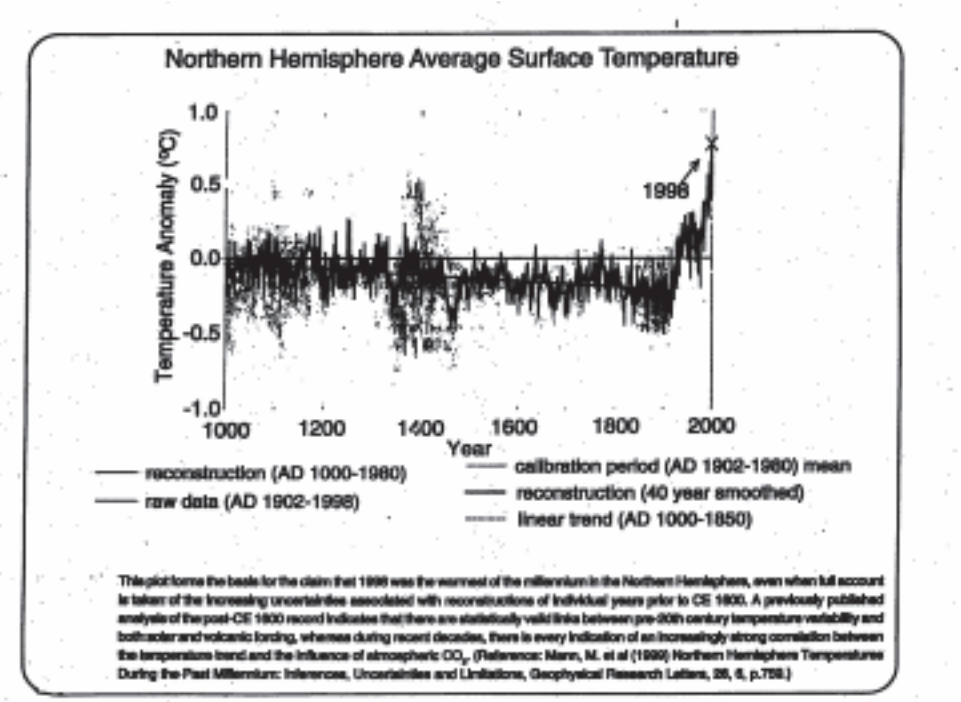
- developing drought contingency plans in municipalities that do not use Great Lakes waters.

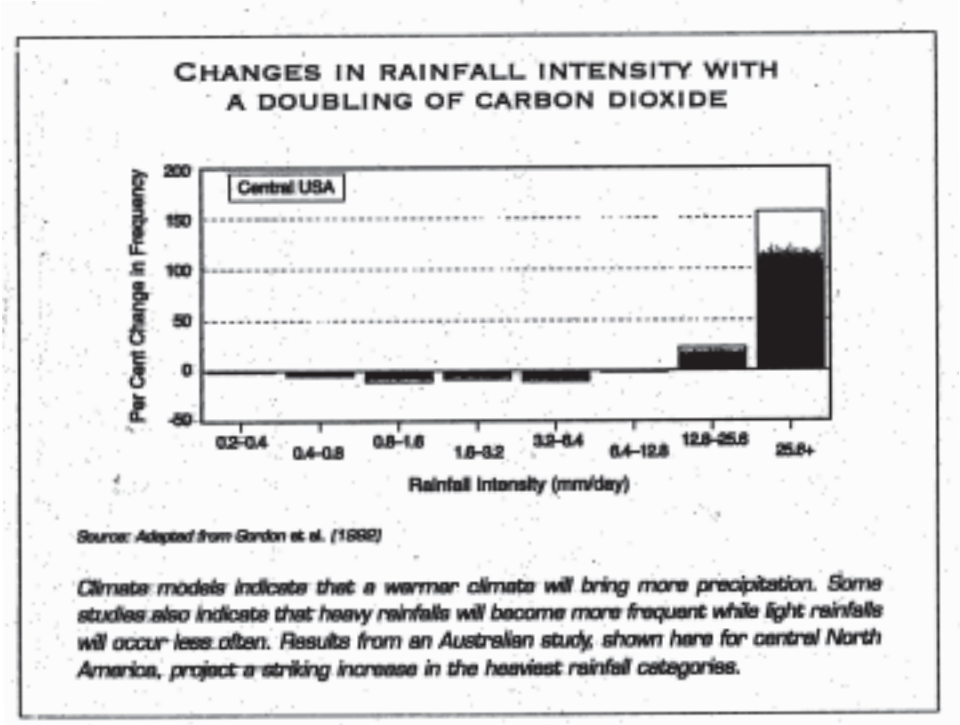
The paper suggests putting climate change adaptation measures into a risk management framework, as is already used by many municipal managers for other kinds of risks.

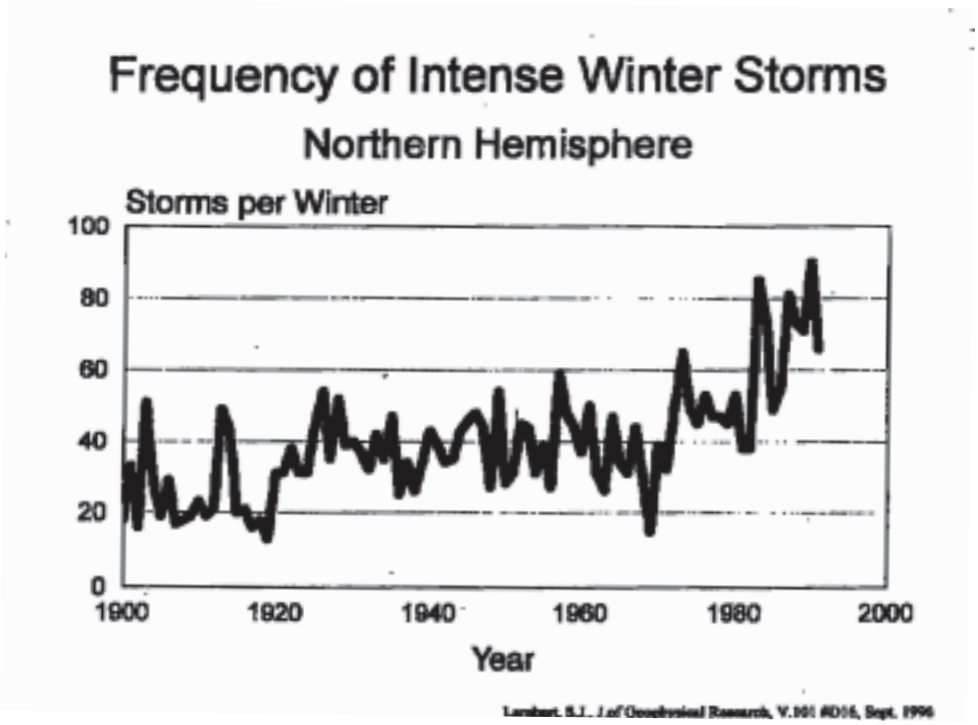
Editor's Note: Dr. Bruce's presentation included extensive slides, most of which were in colour. Only a few of his slides are reproduced here in black on white.



Source: M.Grubb, Energy Policies and the Greenhouse Effect, Vol.I: Policy Appraisal, 1990; updated for IPCC by the author using energy data from BP Statistical Review of World Energy, 1994.


Northern Hemisphere Average Surface Temperature
Temperature Anomaly (°C)
1.0
0.5
0.0
-0.5
-1.0
1998
1000
1200
1400
1600
1800
2000
Year
reconstruction (AD 1000-1980)
raw data (AD 1902-1998)
calibration period (AD 1902-1980) mean
reconstruction (40 year smoothed)
linear trend (AD 1000-1850)
This plot forms the basis for the claim that 1998 was the warmest of the millennium in the Northern Hemisphere, even when full account is taken of the increasing uncertainties associated with reconstructions of individual years prior to CE 1800. A previously published analysis of the post-CE 1800 record indicates that there are statistically valid links between pre-20th century temperature variability and both solar and volcanic forcing, whereas during recent decades, there is every indication of an increasingly strong correlation between the temperature trend and the influence of atmospheric CO_2. (Reference: Mann, M. et al (1999) Northern Hemisphere Temperatures During the Past Millennium: Inferences, Uncertainties and Limitations, Geophysical Research Letters, 26, 6, p.759.)


CHANGES IN RAINFALL INTENSITY WITH
A DOUBLING OF CARBON DIOXIDE
Central USA
Per Cent Change in Frequency
200
150
100
50
0
-50
0.2-0.4
0.4-0.8
0.8-1.6
1.6-3.2
3.2-6.4
6.4-12.8
12.8-25.6
25.6+
Rainfall Intensity (mm/day)
Source: Adapted from Gordon et. al. (1992)
Climate models indicate that a warmer climate will bring more precipitation. Some studies also indicate that heavy rainfalls will become more frequent while light rainfalls will occur less often. Results from an Australian study, shown here for central North America, project a striking increase in the heaviest rainfall categories.


Frequency of Intense Winter Storms
Northern Hemisphere
Storms per Winter
100
80
60
40
20
0
1900
1920
1940
1960
1980
2000
Year

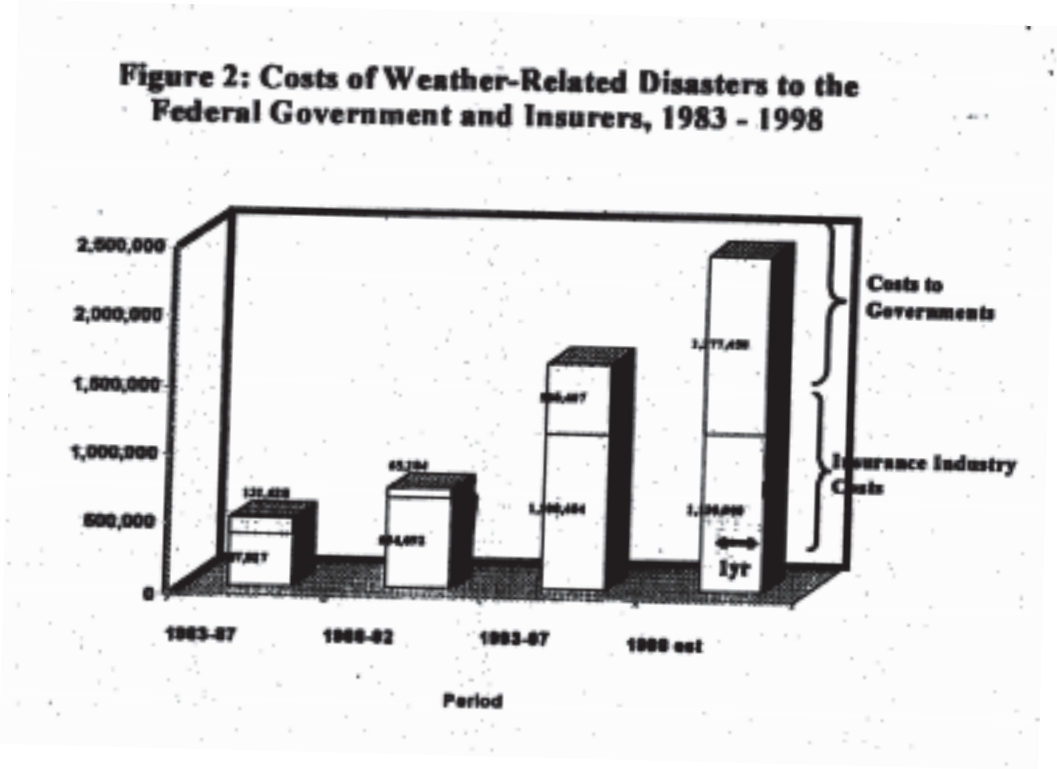


Figure 2: Costs of Weather-Related Disasters to the Federal Government and Insurers, 1983 - 1998
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Costs to Governments
Insurance Industry Costs
1yr
1983-87
1988-92
1993-97
1998 est
Period

Regional Trends and Impacts

HEATHER AULD **Atmospheric Environment Branch,**
Ontario Region, Environment Canada
B.Sc (Physics), M.Sc (Meteorology)
Phone / Fax 416-739-4258 / 416-739-4721
E-mail: heather.auld@ec.gc.ca

BIOGRAPHY

Ms. Auld joined Environment Canada in 1979. She has worked across Canada as both a meteorologist and a climatologist. She served as a weather forecaster in Edmonton, CFB Trenton, Vancouver, and Toronto, and as a trainer of weather forecasters. For eight years Ms. Auld worked as an engineering climatologist, where she researched and developed weather design values for the National Building Code of Canada, national energy codes, and for other national standards dealing with electrical, telecommunications, and hydrological infrastructure. Her current position within Ontario Region of Environment Canada gives her responsibility for climate variability and climate change science affecting the province.

PRESENTATION

Ms. Auld's presentation was based on both the anticipated general impacts of climate change in Ontario and results from the Integrated Mapping and Assessment Project (IMAP), the goal of which is to bring national issues such as climate change to a level at which municipal decision-makers can take action. The presentation outlined the potential implications of climate change on bio-diversity, land use planning, built infrastructure, watersheds, water quality, and water availability in southern Ontario. Key elements were:

◆ By using a GIS-based approach to data assimilation, Environment Canada's Integrated Mapping and Assessment Project (IMAP) is discovering many probable correlations between information held by various agencies and climate change. The benefits of this information can only be expanded by further co-operation with more provincial, municipal, and conservation agencies.

◆ The warming trend of 2 to 5^0 C expected for southern Ontario by the end of the century is expected to drive possible decreases in soil moisture and surface water runoff, and lead to declines in water levels on the lower- and mid- Great Lakes. Changes in atmospheric circulation patterns and storm tracks may also affect wind patterns, the frequency of storm surges, erosion, and the intensity of storm rainfalls.

◆ Shipping activity, hydroelectricity production, and the stability of aquatic and near-shore ecosystems may be affected by lower lake levels and warmer water temperatures. In addition, the projected decline in water supply, coupled with ongoing population expansion and resulting increases in water consumption, may lead to greater competition for water.

◆ Groundwater infiltration, stream base flows, and aquatic environments may all be challenged, and have serious implications for water availability, water quality, shipping, recreational boating, wetlands, and fisheries. Any increase in mean annual temperature will be reflected in the temperature of groundwater inputs to the watercourses. Even a small increase in stream flow temperature will result in cold water habitats being lost or seriously degraded. Temperature changes have the potential for a major shift in the type of fishery that a watershed may be able to support, regardless of any habitat issues.

◆ Although human systems in a watershed may adapt to climate change, albeit at some cost, natural ecosystems and wildlife cannot adapt very quickly to a sudden, large change and hence are at risk. For example, some open shoreline wetlands will migrate lakeward while more enclosed wetlands will dry up, and the resulting habitat changes will have substantial implications for migrating birds and wildlife. Climate change thus adds another layer of stress to species and ecosystems that may already be seriously threatened by impacts from other human activities.

◆ Urban infrastructures may sustain increasing damage from more intense storm rainfalls and other weather extremes, while human health may be affected directly by increased heat stress and indirectly by more amenable climatic conditions for air pollution episodes and for vector-borne diseases such as Lyme disease and malaria. The outbreak of equine encephalitis experienced in Winnipeg in the early 80s, for example, was brought to Canada from Florida by an atmospheric anomaly that could foreshadow similar air-borne insect infestations in the future.

◆ Currently, southern Ontario has representatives from 42 - 49% of the total number of families of plant life found in the tropics. Toronto, for example, has representatives from 42% of the families and Windsor 49%. Isobar projections of future warming trends indicate this may move to 65% for Toronto and 75% for Windsor. This has obvious implications for local bio-diversity, as well as for invasions of currently non-native organisms including insects such as pear thripes and malaria-bearing mosquitoes.

◆ One of the more challenging aspects of climate change noted by IMAP are the opportunities and threats posed as a result of longer and warmer growing seasons. Correlating increases in Corn Heat Units and Degree Growing Days, IMAP suggests:

- a warmer climate may bring increased opportunities for agriculture if soil moisture deficiencies can be managed;

- farmers may be tempted to shift from pasture and silage crops to higher value commercial crops as the growing season lengthens and available heat increases; and

- higher value crops place economic pressures on farmers to convert woodlots and wetlands to agricultural purposes, as well as expand irrigation.

The net change is less forest cover, less wetlands, and more demand for water from a landscape that has a reduced capacity for water retention.

- IMAP results to date show strong support for several scientific hypotheses:

  (1) available heat is a powerful trigger in the natural world;

  (2) atmospheric heat has a significant influence on land use change and biodiversity, particularly in rural areas;

  (3) subtle warming of a degree or two Celsius could significantly change land use, landscapes and the biodiversity of southern Ontario; and,

  (4) natural resource managers should not underestimate the importance of monitoring, detecting, and predicting the results of subtle warming on the aquatic and terrestrial environments on southern Ontario.

Clearly, climate change may result in several serious difficulties in southern Ontario with respect to groundwater supplies, lake levels, urban environments, public health, and bio-diversity. Ms. Auld finished her presentation with a challenge to municipal and natural resource managers to think in new ways about both conserving water and protecting the forests, wetlands, and other aspects of the natural eco-system in Ontario.

Watershed Level Implications

Robert Walker **EBNFLO Environmental**
M. Eng., P. Eng.
Phone / Fax 519-886-8611 for both
E-mail: ebnflo@netcom.ca

BIOGRAPHY

Mr. Walker is a water resources engineer consulting in the areas of watershed management, water quality assessment, and climate change assessment. During his twenty-three year career he has developed and applied environmental models for widely varying ecosystems to address numerous environmental issues and concerns, is particularly interested in the inter-relationships between climate factors and watershed processes, and has worked in recent years to develop GIS-based computer modelling techniques for watershed management.

PRESENTATION

Mr. Walker provided highlights of a hydrological and water quality modelling study he conducted for the the Trent/Moira watershed, which drains into the Bay of Quinte on Lake Ontario. Mr Walker used projections of climate change for Ontario made by Environment Canada's General Circulation Model (GCM) as well as data from two areas, Washington, DC, and Dodge City, Kansas, where the current climatic conditions are within the range of the expected future conditions for the Bay of Quinte area. Mr. Walker's presentation concentrated on the impact of climate change on water quantity and the natural eco-system, with additional observations on water quality and socio-economic impacts. Key elements include:

◆ An overall serious impact will accrue from climate change that will result in minimal snowpack development, less runoff in general, and frequent summertime drought.

◆ Annual water volume in the Moira / Trent will drop significantly. The GCM shows that the watershed will receive approximately the same amount of precipitation for the year 2050, but experience a drop in the annual flow by 18%. The Washington scenario shows a net reduction of 16% of annual flow with 33% more precipitation, while the Dodge City scenario shows an 83% reduction in annual flow with 27% less precipitation.

◆ Increased water temperature might present problems for fish and other aquatic species, and transform the existing cold water fishery into either a cool or warm water fishery.

◆ The aquatic habitat would be further stressed by a lack of ice cover that is required at specific times in the fish breeding cycle, the loss of wetlands, and a drop in the level of nutrients that are currently carried into the watercourse during the spring freshettes.

◆ The reduction in flows associated with traditional spring freshettes would also have an impact on water quality, though the prospect of more intense storms at other times of the year could provide the cleansing volumes normally associated with the freshettes.

◆ These more intense storms, of course, would create a greater distinction between peak and base flows, with concomitant implications for erosion, flooding, water quality, and the health of fish and other aquatic species.

◆ Overall water quality would be degraded due to a smaller annual volume of water, accompanied by:

- the higher BOD (biological oxygen demand) of warm water than cool water;

- increases of from 25% (GCM) to 80% (Washington scenario) and 360% (Dodge City scenario) of phosphorus concentrations due to increasing non-point source loadings upon the reduced streamflow.

◆ Climate change in this area of Ontario clearly has the capability of taking water quality far below the goals of the Bay of Quinte RAP.

◆ The socio-economic impacts of climate change in the Moira / Trent include:

- stranding docks and disrupting personal boating, thereby disrupting the cottage segment of the local economy;

- reducing water levels in the Trent-Severn canal system, further disrupting personal boating and severely impacting the non-cottager segment of the local tourist economy;

- limiting water-taking permits, including those for golf courses (further disrupting the tourist economy), agriculture, and municipalities.

In conclusion, this approach toward watershed modelling shows that a hydrological imbalance induced by climate change is expected to occur in the Bay of Quinte watershed. Climate change will alter most aspects of watershed management as we know them, from snowpacks to altered stream flows, from existing water quality and habitat types to reduced eco-system health, and from a traditional comfort in water availability to reduced water-taking permits and a severely disrupted local economy.

All of these impacts require new approaches to watershed management and a significant effort at developing adaptive responses to climate change.

Practical Issues Facing Municipal and Natural Resource Managers

This session of the Symposium featured three speakers who were asked to provide some insight into the nature of the discussions that would take place in the breakout groups after lunch. The speakers and their messages were:

HYDROLOGICAL INFRASTRUCTURE: **Don Haley, Co-ordinator, Floodplain Mgmt**
The Toronto and Region
Conservation Authority
Phone/Fax 416-661-6600 ext 5226 / 416-661-6898
E-mail: dhaley@trca.on.ca

Mr. Haley stated that while flooding and urban storm water management had traditionally focused on impacts to the hydrological cycle created by changes in land use, the advent of climate change suggests a need to re-evaluate the importance of meteorological impacts on local hydrological infrastructure. Changes in the patterns and amounts of rain and snow inputs and their concomitant impacts could be as follows:

Possible Meteorological Change	Possible Hydrological Impacts
An increase in mid-winter melts.	More flooding, more freeze / thaw erosion of stream banks.
More / longer dry periods.	Water supply problems, lower base flows, impacts on intake pipes and effluent discharge as well as aquatic life.
Increased intensity of storms.	Flash flooding, sewer surcharging, design issues for most aspects of stormwater management.
Increased evaporation rates.	Lower lake and pond levels, impacts on intake pipes and effluent discharge.

Infrastructure that might be impacted by climate change includes flood control structures, bridges & culverts, storm & combined sewers, stormwater management ponds, roadway drainage, sewage treatment plants, filtration plants, utilities placed in valley corridors, docks & marinas, and wells.

Mr. Haley suggested that municipal and natural resource managers need a clear definition of how to design and manage for future meteorological realities, and an understanding of the types of policies and strategies, both mitigative and adaptive, that will help us deal with the anticipated climatic changes.

RURAL & URBAN LAND USE PLANNING:

Joe Perrotta, Senior Planner
Ministry of Municipal Affairs and Housing
Phone / Fax 416-585-6064 / 416-585-4245
E-mail: joe.perrotta@mah.gov.on.ca

Mr. Perrotta provided a humorously-delivered and comprehensive message that with MMAH involved, the province's climate change prayers have been answered. His presentation touched on three main points:

◆ Municipalities have responsibilities and mandates that provide the greatest opportunity to affect climate change and influence the actions of the average citizen, with a particular benefit that the reduction of Green House Gas (GHG) emissions from municipal operations could provide significant cost savings for transportation, building operating costs, resource protection, and water conservation.

◆ Climate change is not just an urban issue. While urban municipalities are typically seen as the source of the problem because of the intensity of development and population, rural areas are also significant contributors to GHG emissions due to low density and reliance on the automobile. Actions in both areas, therefore, are equally important; and,

◆ The three critical components needed to address climate change are Balance, Balance, and Balance. Because municipalities bring together many emitters and many opportunities, it is important to understand that any action taken will create an impact elsewhere - be it economic or environmental. Examples could be job losses from new emission standards for certain types of industries if we don't allow sufficient lead time for transition strategies. Mr. Perrotta stated that measures must be carefully developed and designed to strike a balance, otherwise they might result in diminished public support.

In conclusion, Mr. Perrotta felt that one positive aspect of climate change would be a greater public awareness of and an appreciation for planning and its far-reaching influence to affect change in a number of different ways. As good planning has always preached the efficient use of land and resources, greater public awareness of environmental issues would help raise public interest in and appreciation for the importance of sound land use planning.

MANAGING TERRESTRIAL & AQUATIC HABITATS:

Donna Wales, Climate Change Program Cordinator
Ministry of Natural Resources
Phone Fax 705-755-1564 / 705-755-1957
E-mail: donna.wales@mnr.gov.on.ca

Ms. Wales provided some insight into the work being pursued by the Ministry of Natural Resources to address the consensus among scientific authorities that greenhouse gases are accumulating in the atmosphere due to human activity, and that this accumulation will result in changes to our climate and have significant impacts on natural resources.

Recent work by MNR suggests that there is evidence that the year-to-year variations in weather experienced in the province in the 1990's may have strongly affected Ontario's natural resources. As scientists are predicting that changes in climate will have more significant effects on Ontario's natural resources in the future, the Ministry is developing programs to help us identify how to manage our natural resources sustainably in the context of a changing climate, and prepared four sectoral papers as a result of a major MNR retreat held in Peterborough in 1998. The four sectoral reports, on fish, water, forestry, and wildlife, were made available to attendees.

Ms. Wales suggested that, in order to effectively solve the climate change problem and minimize the possible impacts on our natural resources, we need the help of the public and all stakeholders. Increased public awareness of the causes and likely impacts of climate change on natural resources would increase public appreciation of the consequences of climate change, and should help build acceptance for the need for emission reductions.

Copies of one or more of the four sectoral papers are available by contacting Ms. Wales, preferably via the e-mail address above.

Breakout Groups:

- Hydrological Infrastructure

- Rural & Urban Land Use Planning

- Terrestrial & Aquatic Habitats

The breakout groups were designed to solicit input from professionals involved in common issues. Groups were asked to brainstorm to create a list of the types of impacts climate change might present to them, and then identify key mitigative and adaptive strategies in their areas of expertise. The following definitions were provided to the breakout groups:
Mitigation: actions designed to reduce green house gas loadings to the atmosphere;
Adaptation: actions focused on living with changes that are and will continue to occur.

A strategic assessment of the Adaptation Suggestions developed in the breakout groups and compiled after the Symposium by the Planning Committee consists of the following:

- there are over-arching social needs for improved climate change science, public education and awareness, political leadership, new legislative and regulatory mechanisms, and professional guidelines for climate change mitigation and adaptation;

- all government agencies need to address emission reduction targets for their own operations and for any greenhouse gas emissions which fall under their jurisdiction, as well as to establish goals for local carbon sequestration; and,

- municipal and natural resource professionals need to develop or incorporate local climate change scenarios into their long range management strategies, identify potential impacts, establish climate change benchmarks, and develop appropriate adaptation strategies for everything from natural heritage, water and energy conservation, agriculture, and greenspace management to building codes, land use planning, transportation and transit planning, stormwater management, and more, as detailed below.

Please see the Appendix for a complete summary of the flip charts from all of the break out groups.

Over-arching Scientific and Social Needs

We need practitioners to be involved in identifying what science is needed on the ground so that scientific research can be readily applied.

We need political leadership and extensive public education and awareness campaigns on climate change, changed behaviours, and new expectations.

We need new provincial research, strategies, and guidelines on energy conservation, land use planning, groundwater management, and water conservation.

We need new guidelines for municipal and natural resource professionals to develop and incorporate local climate change scenarios into their long range management strategies, including their approach to risk management.

Suggested Mitigation Strategies

All government agencies need to set emission reduction targets for their own operations, as well as to identify goals for local carbon sequestration.

Suggested Adaptation Strategies

HYDROLOGICAL INFRASTRUCTURE

Develop and adopt dynamic design practices based on better science (constant flow monitoring, high and low flow management, climate change modelling).

For new developments, upgrade design standards to new IDF curves (Intensity / Duration / Frequency) , and address requirement for new types of design for lot sizes, grading, ditches, and water conservation.

For re-development, expand use of real time management, easements, demand management, and flexible design standards.

For flood control, address new techniques for dam operation and storm water management for a broader range of significant events.

With respect to valley corridor infrastructure and erosion management, respect meander belt design standards for utilities and stormwater management ponds.

Support increased infiltration, better management of water takings, water conservation, real time management, and pricing for ground and surface water management.

For integrated data gathering and dissemination: apply risk management techniques while increasing naturalization; expand professional and public education, and; champion the improved integration of infrastructure management into land use planning.

PROTECTING TERRESTRIAL HABITAT

Develop a natural heritage inventory, strategy, implementation framework, and monitoring protocols.

Natural resource managers should overlay climate change scenarios on forests in a manner similar to how Mr. Walker has done for water quantity and quality in the Trent/Moira Watershed.

Identify how to monitor, detect, assess, and deal with invasive species, their impacts on a changing bio-diversity regime, and habitat distribution.

PROTECTING AQUATIC HABITAT

We need better science, including more watershed modelling and monitoring for both ground water and surface water.

We need improved provincial strategies on groundwater management, water-takings, and water pricing, as well as better enforcement.

We need water conservation strategies addressing increased water storage capacity, more wetlands, a change in agricultural practices, and potential changes in water-taking approaches.

We need a better understanding of the impact of climate change on water quality, especially for temperature, BOD, pollutants and bio-accumulation, and how changing water quality might impact aquatic species, particularly their eggs and young.

Adopt more bio-engineering, increased buffer zones, improve stormwater management techniques.

RURAL AND URBAN PLANNING

Address climate change in provincial policy and through the OMB to re-enforce the weight of local decisions.

Support political leadership on climate change.

Expand public education and seek changes in public expectations.

Re-appraise the ecological impact of climate change on key resources such as forests, wetlands, and water.

Re-enforce the linkages between land use planning, energy, and water.

Address legislative and regulatory changes required.

Develop new urban design guidelines for floodline mapping, groundwater, and stormwater management ponds.

Adopt a vision of forests as carbon sinks as a key element in protecting water resources and establish a Greater Toronto Area carbon sink.

Seek better integrated greenspace strategies, more mixed density developments, and proportional land use planning.

Have more regard for “implementation” statements in official plans.

Conclusion and Recommendations

The Symposium concluded with comments from representatives of the federal, provincial, and a local government. Each stated that early actions are required by all sectors of society, and that they are seeking to improve our scientific understanding of how climate change may impact Canada and its regions to form the basis of suggested actions. Collectively, the speakers urged all agencies to support emission reductions, and applauded the interest and efforts of the Symposium and its attendees to identify and develop the adaptation tools and practices we will need as greenhouse gas concentrations rise.

In conclusion, at a time when key national programs are being developed to help Canadians reduce the emission of greenhouse gases, **the Planning Committee notes the corresponding need for national, provincial, and regional programs to help Canadians address the early implementation of adaptive management to deal with the unavoidable impacts of local climate change,** and recommends the following to help Canadians develop the appropriate adaptation strategies:

1) an increased focus on the development of local climate change scenarios. These scenarios should be developed using a variety of approaches, be funded by a partnership of governmental and other organizations, and involve municipal and natural resource practitioners in their development in order to identify possible local impacts;

2) substantial changes to federal and provincial strategies and guidelines for groundwater, surface water, water conservation, land use planning, energy conservation, and transportation to help society reduce emissions and adapt to the expected impacts of climate change;

3) improved communication and co-ordination within municipalities between those departments dealing with policy and planning issues and those dealing with water, stormwater, sewage, energy, transportation, and the natural landscape; and,

4) extensive social marketing from all levels of government, as well as from professional organizations, about the need for new expectations, changed behaviours, and improved technologies for both mitigation and adaptation strategies to deal with climate change.

Web Based Resources on Climate Change

United Nations Environment Program	www.unep.ch
UN Framework Convention on Climate Change	www.unfccc.org
Environment Canada. including international agreements and national programs, and links to the National Secretariat on Climate Change and the Climate Change Action Fund	www.ec.gc.ca
Government of Ontario Sites:	
MOE	www.ene.gov.on.ca
MMAH	www.mah.gov.on.ca
MNR	www.mnr.gov.on.ca
Office of the Environmental Commissioner	www.eco.on.ca
Federation of Canadian Municipalities, including the Partners for Climate Protection Program, fomerly the 20% Club	www.fcm.ca
The Toronto and Region Conservation Authority	www.trca.on.ca

Notes from the Breakout Groups

This appendix contains the full notes from the breakout groups on Hydrological Infrastructure, Rural & Urban Land Use Planning, and Terrestrial & Aquatic Habitats, from which the Planning Committee made the strategic assessment contained in the text of the Proceedings.

Hydrological Infrastructure

The brainstorming session identified the following areas of potential impacts, and then distinguished issues from actions:

ISSUES

Reduced summer flows (low flows)
Less general availability of water
Reduced infiltration, where we can expect less surface water, lowered groundwater levels, and impacts on wells
Impacts on distribution systems
Lower lake levels
Changes in temperature and resulting change in bod (biological oxygen demand)
Changed land use would lead to changes in hydrology
Extreme precipitation events: More in number, more in severity, and a need for new idf curves (intensity/duration/frequency)
More freeze / thaw events
More deposition to watercourses and receiving waters
More sediment loading to swm ponds
Threats to operations by severe weather such as ice storms

ACTIONS

Need for water conservation
Changes in real time operations for dams, cso's, and swm ponds
Need better control of water takings and rules on inter-basin transfers
Impacts on water pricing
Need for better resource mapping, especially for groundwater
Street sewer impacts, with a need for greater inlet capacity, more one way valves, the possible requirement to acquire new lands, and a need for new data sets
Need for dynamic design practices and better risk assessment
Requirement for new design and development standards and types of approaches, including a need to address lot size, lot management, grading, and ditches
Need more risk education
Need lifestyle changes
need for more naturalized table and valley lands

Hydrological Infrastructure: Key Mitigative and Adaptive* Strategies

Issues	Strategies
Infrastructure	**Dynamic Design Practices based on better science**
New Development	**Upgrade design standards to new IDF curves**
	New types of design for lot sizes, grading, ditches, and water conservation
Re-development	Real time management, easements, demand management, design standards
Flood Control	Dam operation, storm water management, allow for broader range of significant events
Erosion and Valley Corridor Infrastructure	**Respect meander belt design standards for utilities and SWM ponds**
Groundwater and surface water	**Support increased infiltration, better management of water takings, water conservation, real time management, pricing**
Integrated data gathering and dissemination	**Need to apply risk management, better professional and public education, more naturalization, better integration of land use planning into infrastructure management**

Note: Adaptive Strategies highlighted in bold.

Rural and Urban Land Use Planning (session 1 of 2)

BRAINSTORMING

Increased insurance claims (flooding, erosion, ice, sewer backups)
World-wide displacement of people and some environmental refugees to canada
Movement of vegetation zones
Changes in recreation (low water) and leisure activities (too hot to go outside)
Low flows could lead to fish kills and other health problems
Possibility of more urban sprawl requiring more energy and more infrastructure
Inherent difficulty of managing urban areas sustainably
Lifestyle / pricing / employment issues
Form of urban development very important for and to lifestyles
Possibility of more severe impacts, a reduced capability to plan for them, and the greater cost of preparing for and responding to them
Possible higher costs for structures and energy efficiency, even with energy savings
Energy use could move to brownouts, higher costs, worse summer air quality, more respiratory problems, and higher health costs
Reduced water flows could impact hydro-electric generation
More forest firs could lead to more air pollution, more carbon release, and less sequestration
More local competition for water and energy could mirror global shortages, with concomitant needs for more conservation, better research, and better conflict resolution
Need better scientific data sets for aquifers and stream flows
Need better public education for water resources and the inter-connectedness of all environmental issues
Difficulties for farmers and potential increased costs for agriculture and for food
Possible less outdoor and more indoor activities
Possible more moulds, easier spreading of diseases, and other health problems and costs
Need better control of water resources
Costs of park management may go up
Increased costs for pest management, vector born disease, exotics
More difficulty in creating government consensus in a changing situation
More competition amongst “experts” with differing views on emerging sciences
Great opportunities for: The need to live in harmony with nature
More inter-agency co-operation, and
More inter-disciplinary and sectoral co-operation.

Rural & Urban Planning: Mitigative and Adaptive* Strategies, (session 1 of 2)

Multi-billion dollar government fund for green energy and green transportation
Improved policy linkages between transportation and human health
Better integration of rail / transit / transportation links
Reduced (government) spending on 400 type highways and better use of existing roadways
More incentives for off-peak energy and transportation use
Better cost estimates for transit and sewer infrastructure
Establish a GTA carbon sink
More education and government public relations on climate change
Better integrated greenspace strategies
More mixed density developments and proportional land use planning
More regard for "implementation" statements in official plans
Stricter pollution laws, monitoring, and enforcement
More scientific research and co-operation - eg with insurance industry
Better public agency co-ordination, co-operation, and shared priority setting
Better multi-stakeholder scoping of water issues
Vision of forests as carbon sinks and as key element in protecting water resources
More focus on a co-benefits approach

Note: Adaptive Strategies highlighted in bold.

Rural and Urban Land Use Planning (session 2 of 2)

BRAINSTORMING

Really need to think globally and act locally for climate change and recognize it is a generational issue requiring a long term solution
Need for federal/provincial/municipal co-operation
A provincial policy statement would be helpful
Need to change planning mechanisms through the act, the OMB, and give local decisions more weight
Legislation and regulations should address climate change vis-a-vis building codes, groundwater, etc.
Need to improve the linkage between land use planning and energy and water use
Work with experts from all sectors to bring issues forward
Must get climate change on our own agency agendas and develop official policies
Agencies should perform energy audits and establish energy conservation campaigns
Incorporate climate change into urban design guidelines:
Eg: Re-assess flood line mapping based on a different future, re-consider swm pond designs, think about shoreline work and dropping lake levels, reduce street lighting to save energy vs the role of lighting in public safety & crime prevention, infiltration and ground water protection, downspout disconnection, park management, urban canopy.
Municipalities should join the partners for climate protection program, use full cost accounting for climate issues, identify costs of action/no action, put regeneration in municipal standardssustainable management practices, demonstrate cost savings in waste management, adopt higher densities, etc.
Need to understand realities of current political leadership and deal with some pro posed changes that may not appear economically attractive
Need to work with media, climate experts and the medical community, to increase public education and awareness campaigns, use spokespersons, etc
Need to change social expectations for transit, grass clippings, pesticides, etc.
Need to use risk assessment and make public health an issue
Transportation must become more accessible, better linked, better funded, and shift toward environmentally friendly fuels
Municipalities should adopt aggressive energy and water conservation programs.

Rural and Urban Planning: Mitigative and Adaptive* Strategies (sess. 2/2)

Adopt energy and water conservation programs
Address transportation strategies, linkages, and funding
Develop alternate energy sources
Demonstrate cost savings available in waste management
Address climate change in provincial policy and through the OMB to re-enforce the weight of local decisions
Support political leadership on climate change
Expand public education and seek changes in public expectations
Re-appraise the ecological impact of climate change on key resources such as
forests, wetlands, and water
Re-enforce the linkages between land use planning, energy, and water
Address legislative and regulatory changes required
Develop new urban design guidelines for floodline mapping, groundwater, and SWM ponds

Note: Adaptive Strategies highlighted in bold.

Managing Terrestrial and Aquatic Habitats

This session involved more people than any other breakout group and defined their focus as everything but built structures. The group generated long lists of possible issues, identified priorities by having the participants place a mark on the flip charts beside which impact or issues they thought were the most important, and then created lists of key issues and adaptive actions needed.

Terrestrial Habitats

HIGH RANKING

Ecosystem health will be stressed by species extinction, the arrival of non-native invasive species, and a changed landscape
Ontario forests will be stressed by temperature change, precipitation change, disease, fire, insects, changes in transpiration rates and soil moisture retention, and the length of time it takes for some plant species to migrate
Climate change may have a particular impact of reducing Ontario wetland areas
A changed temperature may also have impacts on wildlife ranges, as well as reproduction habits and other behaviours

MEDIUM RANKING

Need to understand implications of both erosion and less recharge in areas with impervious soils
Need for increased efforts at soil conservation and changed agricultural practices
Need changes in rural and urban land use planning practices
Simplification of habitat diversity ((what is this???))
Need for natural resource managers to change management practices

LOW RANKING

We need more public education on climate change and for natural resource managers to be involved
Need to address impact of climate change on inter-species actions
Address how system changes could impact terrestrial habitats
Address possible impact of reduced pollination
Need to prepare for possible new legislative or regulatory responsibilities
Address possible migration of protected species out of protected areas
Potential impact and issue of uncertainty of lake water levels on terrestrial wildlife
Impact of poor water quality on terrestrial as well as aquatic species

Key Issues for Terrestrial Ecosystem Health

Increased stress due to temperature, transpiration, water retention, disease, and new insect and plant species
Increased costs for new monitoring and control programs (fire)
Need for more reforestation both for wildlife corridors and as carbon sinks
Need to protect what we have today - especially wetlands
Need for lots of public education

Adaptive Actions Required

Need to think globally
Must develop a natural heritage inventory, strategy, implementation frame work, and monitoring protocols
Need to understand how to deal with invasive species, their impacts on a changing bio-diversity regime, and habitat distribution
Natural resource managers should overlay climate change scenarios on forests in a manner similar to how Mr. Walker has done for water quantity and quality in the Trent / Moira

Aquatic Habitats

HIGH RANKING

Overall reduction in the quantity of water for lake levels, stream flows, wetlands, groundwater
Potential for disruptions in seasonal norms of precipitation and their effect on spring freshettes, nutrient levels, the reproductive behaviours of aquatic species, aquatic bio-diversity, and the potential impact of floods and droughts in reducing aquatic habitats
Overall reduction in the quality of water from phosphorus, pollutants, and toxics
Natural resource managers need to consider changes in benchmarking, interpretation, and increased monitoring

MEDIUM RANKING

Impact of changes in water temperature to aquatic species and aquatic bio-diversity
Need to preserve wetlands and explore their use as carbon sinks
The loss of aquatic habitat available to terrestrial species
Change in species mix and species behaviours
More energy in the system and more erosion
Cumulative impact on aquatic environment and groundwater - eg, impacts from agriculture and urban areas
Changes in water use - ie withdrawals, recreation
Potential for greater bio-accumulation of toxics in warmer water
Impact on groundwater infiltration, temperature, and quality

LOW RANKING

Change in types of aquatic vegetation
Introduction of invasive exotics
Changes in our management frameworks required
Dealing with current public expectations - ie pesticides, golf courses
More competition for competing uses: both for land use planning and resource extraction
Socio-economic impacts for tourism and fishing

Key Issues for Water Quantity and Water Quality

Prospects of more flooding and less base flow will reduce overall quantity and quality

ADAPTIVE ACTIONS REQUIRED

We need better science, including more watershed modelling and monitoring for both ground water and surface water

Need a provincial strategy on groundwater, better groundwater management, the price of water, water-takings, and better enforcement

We need water conservation strategies addressing increased water storage capacity, more wetlands, a change in agricultural practices, and potential changes in water- taking approaches

Need a better understanding of the impact of climate change on water quality, especially for temperature, BOD, pollutants, & toxic bio-accumulation and how changing water quality might impact aquatic species, particularly their eggs and young

Need to adopt more bio-engineering, increased buffer zones, and better SWM techniques