2015

Environmental Commissioner of Ontario

CONNECTING THE DOTS
ON CLIMATE DATA IN ONTARIO

THE ENVIRONMENTAL COMMISSIONER'S **CLIMATE DATA** ROUNDTABLE REPORT

Environmental Commissioner of Ontario
Gord Miller, the Environmental Commissioner of Ontario, would like to Invite you to attend his:
ECO CLIMATE DATA ROUNDTABLE
This invitation-only event brings together data end users, providers and intermediaries to discuss the challenges, gaps and opportunities for climate modelling and projections in Ontario.
JANUARY 08 | 2015
MaRS DISCOVERY DISTRICT
101 COLLEGE STREET
TORONTO, ONTARIO, M5G 1L7
SUITE 100, COLLABORATION RM. 3
8:00AM – 4:30PM
ROUNDTABLE AND PLENARY SPEAKERS
4:30PM – 6:00PM
NETWORKING RECEPTION SPONSORED BY Esri
esri Canada
Please note that space is limited and we can only accommodate one attendee from your organization. Seating will be assigned to ensure a mix of perspectives at each table. We request that attendees commit to participating in the entire roundtable.
An information package, including agenda, attendee bios and a briefing note will be provided prior to the event
KEY HIGH-LEVEL THEMES
Usability, accessibility and quality of existing climate data
Future data development (opportunities, needs, barriers)
Governance models
Please RSVP by December 1 with attendee name, bio and photo to Dana Krechowicz dana.krechowicz@eco.on.ca

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ECO CLIMATE DATA ROUNDTABLE

EXECUTIVE SUMMARY

CLIMATE CHANGE ADAPTATION REQUIRES HIGH-QUALITY CLIMATE DATA, especially projections about what the future climate may look like in a specific geographic area.

Climate data consists of pieces of information (data points) about the climate, such as precipitation and temperature, often expressed as trends, averages, and extremes. Climate data can be historic (actual recorded data) or modelled future estimates (projections). The public and private sectors require accessible and reliable climate data to justify the major investment and policy decisions needed to adapt to our changing climate.

The Environmental Commissioner of Ontario (ECO) has determined, through extensive consultation with stakeholders, that climate data, although abundant and largely freely available in Ontario, generally does not meet end user needs. Many end users don't know how to choose or use climate data appropriately.

Government and private sector decision makers ("end users") vary in their level of knowledge, objectives, and capacity with regards to climate data; some require more guidance or customized data. In response to this problem, many "data intermediaries," including private companies, provide fee-for-service consulting or produce applications and more user-friendly technological interfaces. Some non-governmental organizations also help end users determine their data needs and show them how to use available information.

More municipalities, government bodies and private sector organizations are beginning to address their climate change vulnerabilities, which in turn gives rise to a greater demand for climate data. End users with limited expertise in climate change adaptation will need guidance on where to find relevant climate data, how to translate it, and how to apply it in their resiliency planning. While some companies may have the resources to pay for expertise to help understand climate data and projections, this may not be the case for many others, such as small communities with limited resources. Due to the high costs of interpreting climate data, many potential users of climate data have yet to even begin exploring climate risks.

To gain a better understanding of the opportunities and challenges associated with providing access to high-quality and user-friendly climate data, the ECO brought together a range of stakeholders and experts (65 in total) for a one-day roundtable. The roundtable was organized around three main themes:

- **Climate Data User Needs**, which focused on understanding the current state of climate data in Ontario, and the challenges end users face in accessing and using this data.
- **Future Directions for Climate Data**, which focused on the climate data initiatives of various levels of government, academia, and the private sector, and further opportunities to meet the needs of end users.
- **Governance Models**, which focused on the potential role of the private and public sector in delivering more accessible climate data to end users. It also explored climate services organizations in other jurisdictions (e.g., Ouranos in Quebec) and their potential applicability to Ontario.

The Roundtable painted a clear picture of the current state of climate data in Ontario: much climate data exists, but many of its current and potential end users need assistance in accessing and translating reliable climate data to make it relevant for their purposes. (See the Environmental Commissioner's opening remarks at **p. 7** and the presentation by Ryan Ness of the Toronto and Region Conservation Authority (TRCA), and the Ontario Climate Consortium (OCC) at **p.10**.) These end users fall along a broad spectrum, each with their own unique set of climate data needs and issues, from the engineering profession (see the presentation by David Lapp of Engineers Canada at **p.14**) to municipalities of all sizes (see presentations by David MacLeod of the City of Toronto at **p.16** and Ewa Jackson of ICLEI Canada - Local Governments for Sustainability at **p. 20**).

To date, the federal and provincial governments and academia have played important roles in creating and delivering climate data. (See the presentations by Kevin Anderson of Environment Canada at **p. 30** and Ian Smith of the Ministry of Environment and Climate Change (MOECC) at **p. 34**.) For example, the MOECC has funded the production of some localized climate data for Ontario. (See the presentation by Prof. Richard Peltier of the University of Toronto at **p. 38**.) However, the climate projections that are being produced often need additional delivery and translation services for less sophisticated end users, as they may be hidden in dense academic journals, within websites that are not user-friendly, or are based on a wide range of models that vary in their reliability.

There are potential roles for the private sector in the curation and delivery of climate data to end users. (See the presentations by Joe Greenwood and Sasha Sud of MaRS Data Catalyst at **p. 48**, by Alex Miller of Esri Canada at **p. 52**, and by Rob Wesseling of the Co-operators

Insurance Group at **p. 54**.) For example, data communication and delivery challenges are being effectively addressed in the electricity sector with the MaRS' Big Green Button initiative. Geographic information system (GIS) maps can provide an interactive and accessible interface to deliver climate data to end users, and flood plain mapping undertaken within the insurance industry could be a useful source of climate data.

Finally, a look at government-funded climate services organizations from other jurisdictions, namely the United States and Quebec, highlights the potential role for the provincial government in addressing some of the needs of Ontario's climate data end users. (See presentations by Alain Bourque of Ouranos at **p. 56** and by Elizabeth Gibbons of the Great Lakes Integrated Sciences and Assessments (GLISA) Center at **p. 58**.)

For ECO Comment, see Page 64.

WHY DO WE NEED CLIMATE DATA?

WE BUILT OUR COMMUNITIES BASED **ON HISTORIC WEATHER PATTERNS,** BUT OUR ASSUMPTIONS ABOUT WHAT THE CLIMATE WILL BE LIKE **NO LONGER HOLD UP.**

WE NOW LIVE IN AN UNSTABLE CLIMATE.

CHECK OUT OUR VIDEO
"Why Climate Data Matters"
on the ECO YouTube channel:
https://www.youtube.com/EcoComms

INTRODUCTION

ON JANUARY 8, 2015, the Environmental Commissioner of Ontario (ECO) convened a roundtable on climate data in order to initiate a province-wide multi-stakeholder discussion about this policy challenge in Ontario. The ECO invited 13 speakers to present on topics related to three main themes: climate data users' needs, future directions for climate data, and governance models. Each themed session concluded with facilitated small group discussions among the 65 attendees – a mix of public and private sector climate data producers, intermediaries and end users.

This document provides a detailed summary of each presentation and small group discussion, as well as ECO commentary. In addition, video recordings of all speakers' presentations, as well as their slides, are available on the ECO website at **www.eco.on.ca**.

Note: this document has been prepared to provide a general summary of the presentations and discussions shared at the roundtable. The ideas and positions set out in the paper do not necessarily represent the views of the ECO.

COMMISSIONER'S OPENING REMARKS

The Environmental Commissioner of Ontario, Gord Miller, launched the roundtable by observing that ensuring accessible, high-quality climate data and analysis is an important policy challenge in Ontario, and that the status quo is producing poor outcomes for many stakeholders.

The Commissioner reflected on the renewed commitment to climate change policy action in Ontario, noting that this creates an opportunity to explore solutions to challenges such as those faced in the field of climate data. He stated that viable solutions are available, and that some other jurisdictions (Quebec, for example) are ahead of Ontario in this regard.

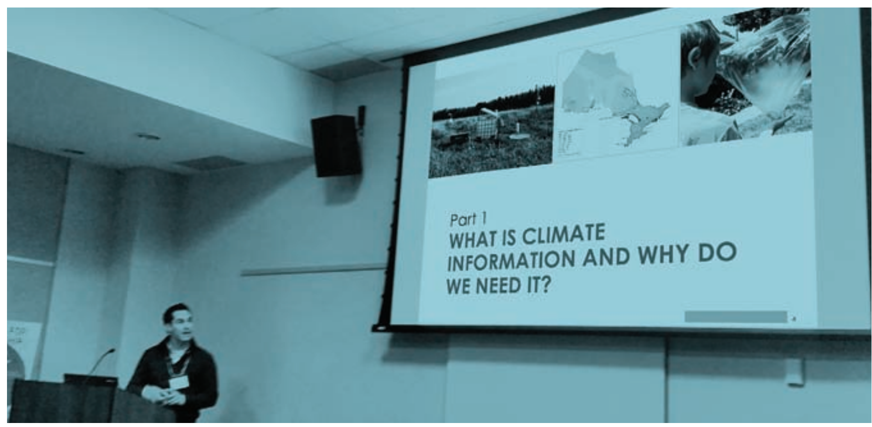
He explained that the goal of this roundtable is to bring together those who generate and use climate data to share their views and to help uncover a potential resolution.

THEME 1

CLIMATE DATA USER NEEDS

The day began with presentations by four experts on the issues faced by climate data end users in Ontario, primarily in terms of accessing and using climate data.

RYAN NESS INTRODUCED THE CLIMATE DATA LANDSCAPE IN ONTARIO



Ryan explained that the availability of reliable climate data is critical because societies plan many of their economic activities and design much of their infrastructure around climate. A changing climate will force public and private sector actors to take adaptive actions. For maximum effectiveness, these actions should be guided by proactive risk assessments using the best available understanding of climate. Ryan clarified that this understanding requires both historical climate data and best estimates of future climate using data from climate model projections and other sources such as trend analysis.

Based on the activities of OCC to understand the state of climate data in Ontario and to compile the best data for use by practitioners and in research, Ryan has concluded that the state of historical climate data availability in Ontario is reasonable. There are at least 14 different publicly available historical climate databases with data relevant to Ontarios, including Environment Canada and other public and private monitoring networks from both Canada and the U.S. However, these sources often provide different types of data and have different geographic coverages and levels of precision and resolution.

Likewise, future climate projections relevant to Ontario are available from a wide variety of sources. According to the OCC, there are at least 21 publicly available databases of future climate projections, many of which are downscaled[1] to various levels. In addition, more sophisticated end users with the necessary means will sometimes commission custom climate data modelling and analysis by intermediary agencies, universities or consultants, the results of which are often not made widely available.

Ryan explained that data availability is not really a problem in Ontario; rather, the issues lie

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[1] *Downscaling data means adjusting the model upon which a larger scale climate projection is based to make it a more accurate depiction of the climate in a smaller geographic area.*

with end users, who do not know where to get climate data, which of the many data sets to use for a given purpose, and how to use them appropriately. Ryan noted several issues of concern relating to the quality of some available data. For instance, some of the climate model projections currently being applied by end users do not incorporate the most recent set of emissions scenarios produced by the Intergovernmental Panel on Climate Change (IPCC). This information has serious implications for climate projection results.

Secondly, the use of a large number of climate projections in model ensembles for the best understanding of the range of possible future climates and the uncertainties associated with these, as is recommended by the Intergovernmental Panel on Climate Change (IPCC) and leading authorities, is often not practiced in Ontario. Generally only one or two sets of climate model projections of the dozens available are used as the basis for climate change risk assessments. Finally, large-scale climate projection models are only rarely downscaled to account for regional or local climate dynamics, such as the Great Lakes in Ontario. Therefore, current use of future climate modelling in climate risk and adaptation studies in Ontario generally does not completely account for uncertainty or local climate conditions.

Ryan also noted that, despite the relative wealth of available data sources, for this data to be useful for decision making, it must be analysed, distilled, and translated into usable forms that meet the needs of a range of end users, and those end users must be supported and guided on its appropriate and defensible use: not a simple feat. Climate information varies greatly in the level of effort needed to process and apply it, and it is important to think about the trade-offs between end user needs and the data's complexity, specificity, and uncertainty. Often, climate data users do not know the type (e.g., temporal and spatial resolutions and scales, statistical methods, etc.) and/or the amount of information they need to understand risks and to make decisions to adapt to climate change.

Because there is no single authoritative source

SPEAKER BIO

RYAN NESS, M.Sc., P.Eng. (environmental and water resources), Manager at the Toronto and Region Conservation Authority (TRCA), is responsible for ensuring that TRCA programs are helping to increase the region's resilience to climate change. Ryan also leads TRCA's role as secretariat and coordinator of the Ontario Climate Consortium (OCC), which brings together Ontario universities, NGOs and governments with the intent of increasing the province's capacity to assess, communicate and respond to climate change risks and uncertainty.

of guidance on climate information in Ontario, users tend to make decisions based on word of mouth within their existing networks. Or if they do hunt for authoritative and expert information, they often end up finding material from other jurisdictions (such as Ouranos and the IPCC), which is generally not sensitive to the Ontario context. In summary, a large part of the inconsistency in climate data information use is because the "landscape" of climate data use in Ontario for risk and adaptation studies consists of ad hoc initiatives without overarching guidance or standards.

The OCC's research indicates that, as a result of Ontario's ad hoc climate data landscape, uncertainty is not properly accounted for in decision making. Even appropriately modeled climate projections (i.e., projections generated by ensembles of models based on the most current authoritative emissions scenarios) result in large uncertainties. These uncertainties cascade into larger uncertainties when downscaled to regional climate change scenarios. This compounded uncertainty, coupled with a lack of expert guidance, can result in decision makers being bewildered and defaulting into seemingly 'low regret' decisions, such as inaction. Alternatively, uncertainty is often completely omitted from consideration, resulting in risk assessments and adaptation decisions that do not account for the massive variability in potential future climate conditions.

Ryan also outlined the issue of uncertainty surrounding effective adaptation solutions. The uncertainty associated with selecting and designing appropriate adaptation solutions is at least as great as the uncertainty associated with climate projections because the often limited understanding of the response of the systems in question (e.g. watersheds, public health) to climate as well as of the uncertainty that the technical or policy measures selected will in fact be implemented successfully. Nonetheless, Ryan insisted that good adaptation and resilience-building work can be done (and will have to be done) without detailed climate information. Society makes many major decisions in areas where equal or greater uncertainty exists (e.g., macroeconomic planning and management). Good climate change adaptation planning involves flexible solutions that are monitored, assessed, and revisited over time.

In summary, Ryan stated that availability of climate data is generally not a problem in Ontario. The problems arise from the ad hoc way in which the data is produced, disseminated and used in the province. Without guidance, support and an established community of practice in Ontario, climate data is analyzed and utilized inconsistently, using divergent range of methods, which leads to results that may not be comparable, do not reflect the full range of uncertainty, or are not appropriately scaled. This climate data utilization landscape can result in the inefficient or ineffective use of resources, or (even worse) inaction in adaptation planning or maladaptation that makes us more rather than less vulnerable to climate. These challenges need to be resolved; however, it must not be forgotten that climate data is only one element of effective risk assessment and adaptation response. The best adaptation planning incorporates principles of flexibility, resilience and adaptive management and can often happen in the absence of climate data, or with very little and uncertain data. Therefore, moving forward, Ontarians need to be assisted in both the appropriate use of climate data and in the design of adaptation responses that are truly adaptive and resilient.

WHAT IS CLIMATE DATA?

CLIMATE DATA consists of pieces of information (data points) about the climate, such as **PRECIPITATION & TEMPERATURE,** often expressed as **TRENDS, AVERAGES, & EXTREMES.**

FUTURE CLIMATE PROJECTIONS EXAMPLES

- AMOUNT OF MONTHLY PRECIPITATION
- AVERAGE MONTHLY TEMPERATURE °C

HISTORIC CLIMATE DATA EXAMPLES

- AMOUNT OF DAILY PRECIPITATION
- MAXIMUM DAILY WIND SPEED
- AVERAGE DAILY TEMPERATURE

CLIMATE DATA CAN BE

HISTORIC
(ACTUAL RECORDED DATA)

OR

MODELLED FUTURE ESTIMATES
(PROJECTIONS)

FOR CLIMATE DATA PROBLEMS SEE PAGE 23

DAVID LAPP ON THE CLIMATE DATA NEEDS OF ENGINEERS IN IMPROVING INFRASTRUCTURE RESILIENCE TO CLIMATE CHANGE

David Lapp's work with Engineers Canada aims to ensure that climate change projections are incorporated into infrastructure risk assessments. Because of this work, Mr. Lapp knows that access to quality climate data and analysis is critical to designing and managing resilient infrastructure.

Mr. Lapp explained that engineers are realizing that identifying infrastructure-related climate change risks enables them to take the necessary proactive and adaptive actions to protect people, property, and the environment and minimize service disruptions, thereby fulfilling their professional code of ethics and minimizing costs. However, he pointed out that identifying risks associated with climate change is only the first step in adapting infrastructure to climate change. Engineering for climate vulnerability must move beyond risk assessments to the planning and design stages, operations and maintenance phases, and applicable codes and standards.

Mr. Lapp observed that building codes traditionally use the past to project the future, a practice that is no longer viable. Increased usage, extreme weather events, and the prolonged use of aging infrastructure can mean that some structures are destined to fail, notwithstanding conservative design standards. As a result of this combination of stresses, even small climatic changes can lead to catastrophic failure. For example, one study found a 25 per cent increase in wind gusts resulted in a 650 per cent increase in building damage.

Engineers Canada has developed the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol – a climate risk screening tool – to address this issue. The protocol is voluntary, but so far has been applied to over 40 new and existing infrastructure projects across Canada. Its application has provided some important insights into which aspects of climate data are most important for the engineering of public infrastructure, such as: the intensity of weather events, interruptions in power supply, and the impacts of combined events. Although the Protocol is primarily focused on design thresholds for damage and failure, it also provides guidance on operations and maintenance decisions.

The PIEVC Protocol considers regional climate expertise and ensembles of models to be important, but also accepts that a single data model can be helpful. The Protocol encourages engineers to work with climate and other experts, especially those with local knowledge, to determine infrastructure risks and vulnerabilities. It also encourages keeping records of weather surrounding the structure, the impact it has had, and the responses undertaken.

Mr. Lapp presented a broader list of items, beyond the Protocol, that Canadian engineers want. This included:

- up-to-date, scientifically-defensible, regional and site-specific climate data;
- updated climate parameters in design codes and standards;
- extreme weather values and probabilities;
- the level of uncertainty associated with climate data;
- updated Intensity Duration Frequency (IDF) curves;
- a publicly available, online, user-friendly, region-specific and provincially endorsed climate projection database; and
- relevant training and education.

Mr. Lapp emphasized that engineers need current climate data because more frequent, more extreme climate events indicative of our changing climate are presenting risks for infrastructure now.

In addition to the PIEVC Protocol, Engineers Canada has also recently published model guidelines on climate change adaption principles for engineers; however, Mr. Lapp clarified that these do not negate the need for Canada's building codes and standards to be updated.

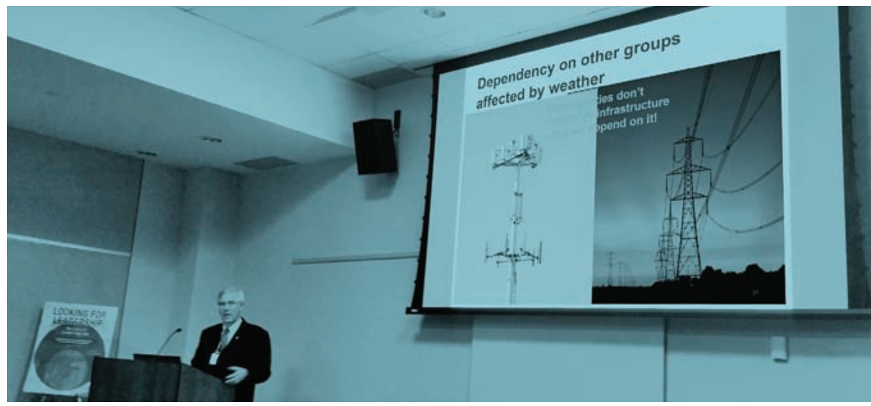
Mr. Lapp concluded by warning that building new infrastructure and rehabilitating existing infrastructure today, without considering current and future climate risks, creates vulnerabilities that will cause service disruptions, damage, and failure in the future. These consequences negatively impact public health and safety, Ontarians' quality of life, as well as increase costs to government, the private sector, and society.

SPEAKER BIO

DAVID LAPP, FEC, P.Eng., is Practice Lead, Engineering and Public Policy, with Engineers Canada. His work focuses on infrastructure, environment, sustainability and climate change and their impact on the practice of engineering. This work includes providing advice, training and technical and administrative support for applications of the infrastructure climate risk assessment tool known as the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol across Canada and internationally. Mr. Lapp is also the Secretary for the World Federation of Engineering Organizations Committee on Engineering and the Environment.

DAVID MACLEOD ON TORONTO'S WEATHER INFORMATION NEEDS

Mr. MacLeod's work at the city focuses on climate change resiliency. As a result, he knows firsthand that climate adaption based on best available climate data is particularly important for Toronto and other municipalities.



His presentation addressed four questions:

1. Which city groups need climate information?
2. What is their context for decision making?
3. What has Toronto done to obtain future climate information?
4. What are Toronto's climate information needs?

Mr. MacLeod explained that municipalities are on the front line of climate impacts. Urban areas bear major economic and social impacts as a result of extreme weather. Around 80 per cent (and growing) of Canada's population lives in cities and rely extensively on increasingly complex, and ageing infrastructure. That infrastructure provides the population's critical lifelines: water, food, shelter, heat, light, mobility, communications, access to services, and waste removal. Infrastructure is a major determinant of the resilience and sustainability of cities. Canadian municipal infrastructure is valued at well over $1.1 trillion. This means municipalities need solid asset management plans and massive investments to make urban infrastructure, both hard (e.g., buildings and roads) and soft (e.g., emergency services and health services), resilient to climate change impacts.

Mr. MacLeod clarified how all types of infrastructure are affected by climate change and how they interact to affect the well-being of city dwellers. For example, overwhelmed stormwater systems can contaminate local lakes, rivers, and streams, and emergency responses are hamstrung when roads are flooded or communications systems are down. What's more, extreme weather can cost cities huge amounts of money. For example, Toronto's July 2013 storm and associated flooding cost the city $80 million; it also cost the insurance industry around $1 billion in pay-outs.

However, a municipality only owns or operates some of the infrastructure upon which it relies. To address this issue the City of Toronto established the WeatherWise Partnership, which is comprised of over 60 organizations drawn from both the public and the private sectors. The group's first priority sector for risk assessment, identified in 2010, was the electrical sector. Through this work Toronto Hydro has completed a climate change risk assessment using the PIEVC protocol, with assistance from Engineers Canada, Natural Resources Canada and the Toronto Environment and Energy Division.

Furthermore, Toronto is particularly vulnerable to climate change due to its large stock of ageing apartment buildings; which tend to be homes for lower income and more elderly people who may be disproportionately more vulnerable to service disruptions. Though some assistance programs exist, there remains a significant concern especially if there were an extended power disruption during a long heat or cold weather event.

David believes guidance from official sources on climate change extreme weather data would enable decision makers to more confidently take certain higher-cost resilience decisions.

David further explained how Toronto's approach to climate change adaptation is hindered by a complex mix of factors. A key factor is uncertainty among decision makers over future weather, weather impacts, and what necessary risk-reduction actions are. This uncertainty is compounded by several other issues such as: an ageing but still growing population; the City's infrastructure deficit; the long lifespan of infrastructure (longer than the careers of decision makers); a lack of provincial or federal mandates (regulations) for anyone to build infrastructure to projected climate changes; and, the lack of a standardized methodology to assess and manage climate risks. Another important factor is

"MUNICIPALITIES NEED SOLID ASSET MANAGEMENT PLANS AND MASSIVE INVESTMENTS TO MAKE URBAN INFRASTRUCTURE... RESILIENT TO CLIMATE CHANGE IMPACTS."

SPEAKER BIO

DAVID MACLEOD

is a Senior Environmental Specialist in the City of Toronto's Environment and Energy Division, where he has been the staff lead on the issue of extreme weather risk management for the last eight years. He has been instrumental in outreach to infrastructure groups through the formation of the WeatherWise Partnership and its electrical sector adaptation project team.

the hesitation of many of the city's infrastructure actors (e.g., designers, builders, maintainers and operators) to alter their existing processes to account for climate change. They know future weather is a problem but need to keep their foreseeable costs low, keep projects on time and budget, and avoid over-spending on risk management.

David then discussed how weather averages and extremes vary significantly across the Greater Toronto Area (GTA) due to the influence of nearby geographical features such as the Great Lakes, the Niagara Escarpment and the Oak Ridges Moraine, as well as from the built urban environment (e.g., heat islands). Available global and regional models are inadequate to reflect these region-specific influences and thus the extreme weather phenomena in the GTA. Municipalities need more specific and realistic climate predictions; consequently in 2008 Toronto initiated a study to specifically assess future local weather impacts, at a cost of $250,000. The study used the Hadley Centre's Global Climate Model (with a scale of 300 km^2), downscaled through a Providing REgional Climates for Impacts Studies (PRECIS) regional climate model to 50 km^2, then further downscaled through the Weather Research Forecasting (WRF) model to a 1 km^2 scale. This study successfully predicted weather extremes subsequently validated by actual events. However, David insisted more modelling could and should be done.

David highlighted some further efforts that Toronto has initiated to obtain climate information. In 2010, Toronto initiated a Climate Change Science Advisory Committee; unfortunately, this group was dissolved when Environment Canada staff sitting on the committee were laid off. In 2012, the TRCA and the Ontario Climate Consortium put together a proposal to support the WeatherWise Electrical Sector Core Project Team with the assistance of CivicAction and the Toronto Environment and Energy Division. The proposal recommended

a stepwise process to assess best available climate information, including pro bono commitments from many top scientists; however, this project did not proceed due to lack of funding which was requested from the Province.

David outlined the City's weather parameters of greatest concern: extremes, not averages, especially in relation to rain, wind, heat, hail, and combined events, for current and future time blocks, at a detailed grid scale of one to five km^2.

David stated the creeping effects of climate change will drive further information requirements for Toronto, in relation to questions such as:

- How will seasonal temperature and precipitation trends affect local ecosystems and invasive species?
- What will be the impacts of new and emerging vector borne diseases?
- What will be the risks to the City's food security?

Climate change risks also require the City to provide communications materials for several audiences, such as technical professionals, elected officials and decision makers, the general public, and the media. The public also requires better location-specific climate data, such as short-term weather warnings, that are communicated through better technology (e.g., broadcast interruptions, social media, and mobile messaging).

To conclude, David highlighted that replacing infrastructure and undertaking major retrofits are opportunities to improve resiliency. These and other adaptive actions need to be taken at all levels, by governments, residents and businesses.

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[1] *The results of this study were published in Toronto's Future Weather and Climate Driver Study (2011), online at: http://www1.toronto.ca/city_of_toronto/environment_and_energy/key_priorities/files/pdf/tfwcds-full-report.pdf*

EWA JACKSON ON CLIMATE DATA USE IN SMALL AND MEDIUM COMMUNITIES

Ewa presented on the climate data needs and challenges of small and medium communities (SMCs) in Ontario. All communities need climate data to: investigate their vulnerability to climate change; provide a foundation for decision making in operations and planning; and, inform their communications with industry and the public. SMCs also share some common challenges in using climate data for any of these potential uses.

The first major challenge Ewa highlighted in relation to climate data use is uncertainty. Climate change is a moving target because of evolving science. Scientific data may speak to one segment of stakeholders, but create uncertainty for others. Ewa observed that despite the fact that decisions based on risk assessments and cost estimations are always contentious, they are nonetheless made all the time. She insisted that although available climate science can provide sufficient information to make informed decisions, supplementing it with anecdotal and historical data would paint an even clearer picture of the climatic changes a community is facing.

The second major hurdle faced by SMCs is acquiring and then analyzing climate data, which is both costly and time-consuming. SMCs are challenged to understand what data is actually needed and at what scale. Knowledge about where to obtain climate projections, and then how to interpret and use them, is lacking, and end users vary greatly in their level of climate data expertise. Ewa suggested that these issues are partly due to a lack of dialogue between climate scientists and end users. In other words, the format of climate data research generally does not reflect the needs and the level of sophistication of the end user.

Ewa explained that the third major challenge faced by SMCs is the phenomenon of climate data being "lost in translation." Municipal staff are often the final translators of climate data, with the aim of prompting action by non-scientists. Ewa suggested that one effective way to undertake this final translation is to make use of local and relevant imagery and personal stories.

Notwithstanding these challenges, Ewa highlighted two municipal success stories in Ontario and one from British Columbia.

Thunder Bay adopted a threefold approach to obtain and apply locally-relevant climate data. First, it enlisted citizen science for a wind analysis of the city; these findings were then presented to city department heads. Second, it enlisted a PhD student to plot residents' views on climate change on a map. Finally, and in association with other Great Lakes municipalities, it procured a climate service provider to obtain regionalized climate data. Using this information, and with the help of a consultant, Thunder Bay produced a formal climate change adaptation response plan, which will be implemented later this year. The mix of citizen-based, academic, and professional input and analysis led to improved buy-in from stakeholders.

"CLIMATE CHANGE IS A MOVING TARGET BECAUSE OF EVOLVING SCIENCE."

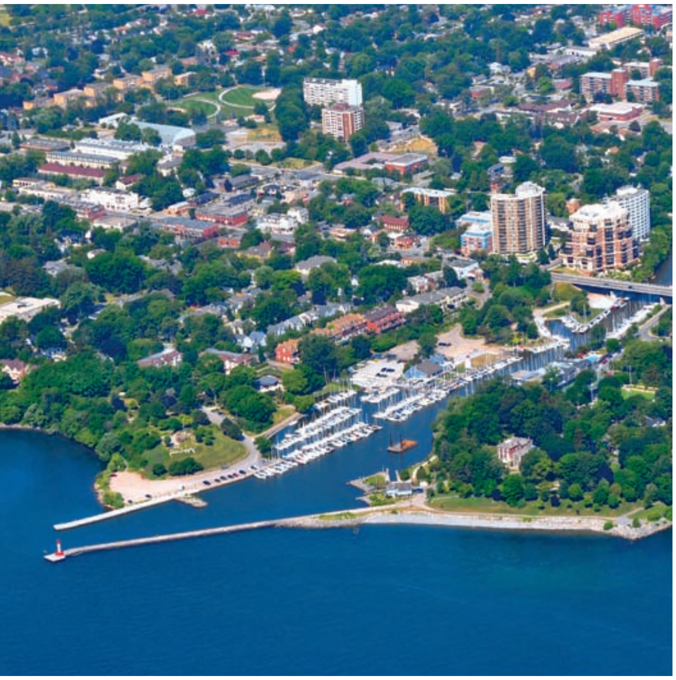
Oakville is also making impressive progress in relation to collecting and using climate data. City staff worked with ICLEI's BARC program, which provided them with a climate science report that synthesized publically available and relevant climate data from Environment Canada, Natural Resources Canada, and the provincial government. The report was then supplemented by the city with anecdotal research on extreme weather and hazards. Oakville was able to use this data to conduct vulnerability and risk assessments across its city corporation.

Finally, Metro Vancouver collaborated with the Pacific Climate Impacts Consortium, ICLEI, and seven BC municipalities to jointly commission a study on localized future projections of hydro-climatology. By acting as a region, rather than as individual local governments, they were able to cost-share the

SPEAKER BIO

EWA JACKSON,

Manager of ICLEI – Local Governments for Sustainability's Canada office, works with municipalities across Canada to help them adapt to climate change, for example, through the delivery of ICLEI's Building Adaptive and Resilient Communities (BARC) programming, and development of capacity building resources and communications around adaptation and resilience. She continuously works with specialists in the field to keep municipal officials at the forefront and responding to the advancements being made.



acquisition of data. ICLEI is acting as the facilitator and convenor of this project and will be conducting an assessment of the use and value of localized data for municipalities as they go through the process of creating and implementing a local adaptation plan.

Ewa concluded by emphasizing that a lot of useful climate data exists, and that with support municipalities can make good use of it. Making this connection happen is an ongoing challenge for both the data providers (e.g., scientists) and the data end users (e.g., municipal decision makers). In addition, climate modelling research priorities need to be reconsidered by researchers, who are often housed within academia and thus either isolated from the needs of end users or driven by other priorities. Analysis paralysis – the practice of over-analyzing a situation to the point that a decision or action is never taken – is also a concern.

In short, Ewa observed, climate data providers must not just deliver information; but must also provide guidance and assistance for its use. The need for this sort of "translation" is often overlooked when assessing the resources required for providing climate services. Related training sessions on appropriate use of data, tailored data products, and data support, are also needed.

IN 2014 THE QUEBEC ORGANIZATION OURANOS introduced a very useful guide that assists practitioners in selecting the climate information most appropriate for them. Though it doesn't recommend specific data sets, the criteria it offers is helpful. It is available here: http://www.ouranos.ca/media/publication/352_GuideCharron_ENG.pdf

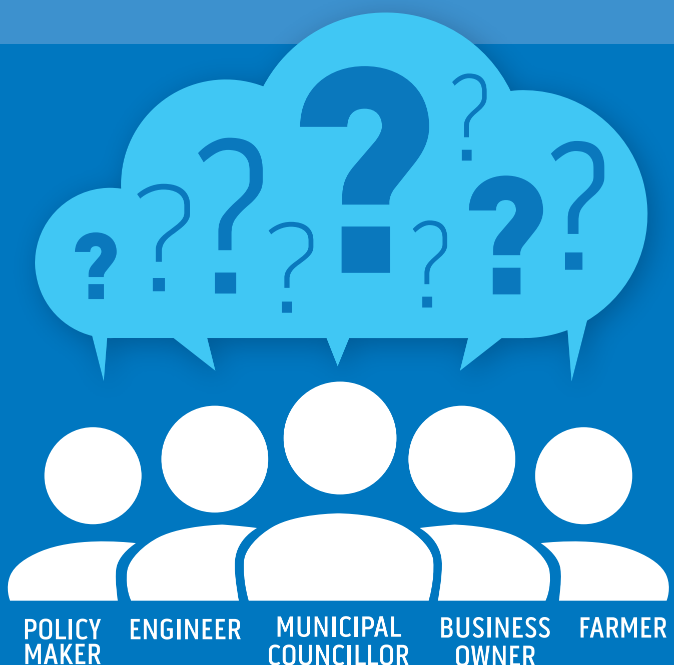
CLIMATE DATA PROBLEMS

THERE ARE 2 MAIN ISSUES WITH CLIMATE DATA FROM THE END USER'S PERSPECTIVE:

ACCESSIBILITY

+

RELIABILITY



END USERS DON'T KNOW WHICH DATA TO USE, OR WHERE TO FIND IT

FOR CLIMATE DATA SOLUTIONS SEE PAGE 33

PARTICIPANTS' COMMENTS AND DISCUSSION ON THEME 1: CLIMATE DATA USER NEEDS

Participants generally agreed that there is a lot of climate data available in Ontario, from many sources, but this wealth of information presents many problems for users. Many participants reported that there was a lot of overlap in the available data, making it difficult to decide which datasets to use. Data is generally not available in user-friendly formats; for example, it may be buried in academic journal articles. Furthermore, the reliability of data is not always clear, as climate data providers are not subject to an accreditation or standardization process. This lack of standardization presents a problem for data users, who vary across a broad spectrum of sophistication and needs: from small municipalities, farmers, engineers, and health service providers, to provincial ministries, private consultants, and climate modellers.

There are also limitations to what the available data can predict; precipitation data is not as precise as would be helpful, as some powerful and damaging storms are very localized and transient. On the other hand, many participants asserted that the cost of downscaling data should be assessed on a case-by-case basis, as it may not always be worth the considerable cost. Alternatively, gaps in the availability of local data could be filled by citizen scientists.

A major challenge highlighted in many participant discussions was a perceived lack of political will at all levels of government to play a more active role in climate data, and climate adaptation in general. Participants explained that municipalities could proceed with greater confidence if they had provincial guidance and support regarding which climate data to use and how to use it. In the meantime, the gap is being filled by "climate services" organizations, such as the Great Lakes Integrated Sciences and Assessments Center (GLISA), based in Michigan.

Facilitators focused the discussions in the first roundtable session around the following themes:

- challenges around sourcing climate data;
- the process for identifying climate data needs;
- sources of climate data;
- the types of decisions being informed by climate data and the data relied on;
- perceptions of the strengths and weaknesses of existing climate data sets; and
- the timeframes and data points of most interest.

Other participants suggested that the lack of political will is in part related to the lack of government funding for climate science. One participant mentioned that in the 1980's, when climate change was a less prominent issue, Environment Canada had many climatologists on staff; it now has far fewer. Similarly, at the provincial level, some participants argued that budget cuts to the MOECC have occurred while at the same time the need to support stakeholders has only grown.

Some participants suggested that the way to reactivate science research is not via governments, but instead via end users, the private sector, and by strengthening the average citizen's relationship with data. For example, the public could be better educated regarding the health and infrastructure implications of climate change. Climate change impacts can also be made more relatable for citizens by referencing the personal impacts and costs, such as those associated with basement flooding.

Participants also expressed the need for support with climate data translation; for example, turning data into a political sound bite or being able to easily convey it in a staff report could help provide justification for adaptive actions. To address these data translation issues, some

participants suggested that there needs to be less focus on data generation, and more focus on sustained dialogue between the data generators (scientists) and end users. In general, data literacy among end users is very low; data is often "lost in translation" or requires extensive resources to be translated into a usable form. For example, climate data is often available in the form of averages, but is more often needed in the form of extremes. Some users need to have access to the uncertainty bounds associated with data, but some types of data presentations hide that important information by using "bias adjustments".

One participant suggested a need to monetize risk to spur adaptive actions; this was an idea supported by many others. Monetizing climate change risks could strengthen the business case for new and upgraded infrastructure. The costs of climate risks are well known by the insurance industry. If the industry were willing to share its data, this could also make a big difference in the rate of climate change adaptation in the province.

More generally, participants insisted that greater support is needed, from both the federal and provincial governments as well as the private sector. That support could take many forms, from funding to offering more guidance to end users. Meanwhile, municipalities are facing tough choices right now, and some participants felt that local actors cannot afford to wait for action at higher levels of governments. Instead, they need to take adaptive actions now that are sufficiently flexible, given their limited resources and data uncertainty.

Some participants also raised the issue of the public's need for instant access to climate data, as in the case of an extreme weather event. They felt that social media and other new technologies were not being effectively utilized to this end and this failure could be addressed through more collaboration between the public and private sector.

ECO OBSERVATIONS ON THEME 1: CLIMATE DATA USER NEEDS

A common thread that ran through the Theme 1 roundtable presentations and discussions was the difficulty faced by end users in Ontario in accessing the right climate data for their needs and in being able to use it for effective adaptation decision making. This difficulty appears to be due to a lack of overarching standards (for climate data production, analysis, and usability) and guidance for end users (e.g., where to access reliable and relevant climate data for their particular needs, and how to use it in decision making).

In summary, roundtable participants highlighted the need for:

- more localized data;
- standards to ensure data reliability and credibility and/or provincially recommended climate models;
- best practices for climate-data analysis; and
- improved translation of climate data for non-scientists.

Despite the number of suggestions raised for important changes in Ontario's climate data landscape, one participant wisely noted that "the only wrong decision is not making a decision. Users can't let the search for perfection be the enemy of good decision making." This sentiment was echoed throughout the room.

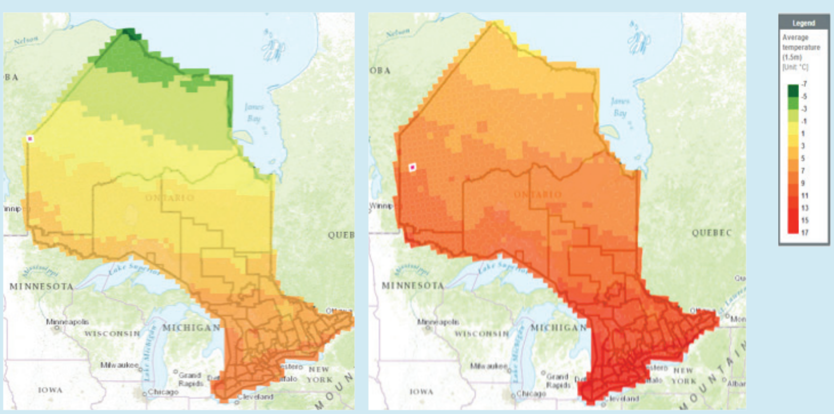


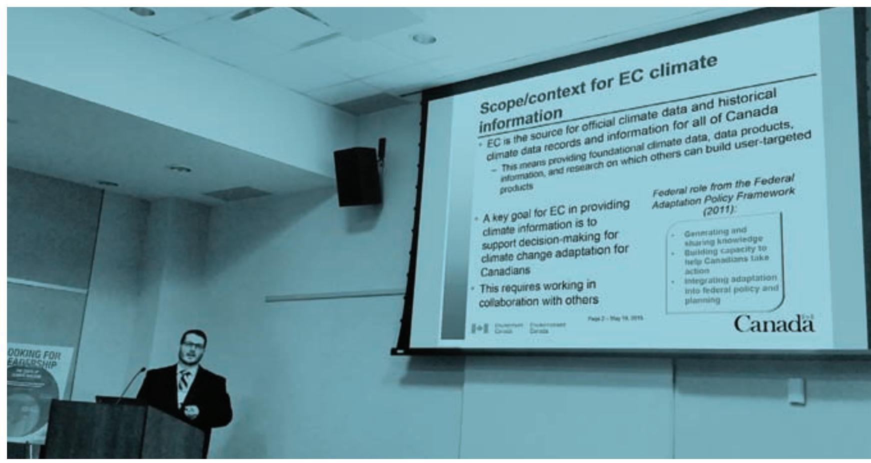
Figure 1: An example of a government-funded publicly available climate projection for Ontario (Source: Climate Change Data Portal, http://www.ontarioccdp.ca/)

THEME 2

FUTURE DIRECTIONS FOR CLIMATE DATA

The second theme, future directions for climate data, featured three presenters who are actively involved in climate data creation and delivery to end users: one each from the federal and provincial governments, and one from academia.

KEVIN ANDERSON ON ENVIRONMENT CANADA'S CLIMATE DATA AND SCENARIOS



Kevin Anderson'spresentation detailed Environment Canada's (EC) role in producing climate data and models, and in making climate data available to end users. His presentation focused on EC's role in providing foundational scientific climate data and research, historical climate data analysis, and future climate projections and scenarios, specifically in relation to EC's goal of supporting climate adaptation in Canada.

Dr. Anderson explained that EC's climate data work involves a lot of collaboration; for example, EC partners with national and international research organizations, including government and academic researchers. When producing tailored climate data products, EC generally collaborates with other federal agencies and departments and regional climate consortia, since these bodies tend to work more closely with end users. He clarified that many other players also undertake a similar range of climate data services, but EC is the primary federal agency with the mandate to do this work with a national scope.

Dr. Anderson noted that EC produces climate data by managing a network of weather and climate monitoring stations across the country. These stations are primarily designed to provide data for the government's operational forecast and are sometimes repositioned or relocated over time. This can introduce challenges for studying long-term climatic variability and changes because non-climatic shifts are introduced into the data. EC develops methods for detecting and adjusting non-climatic shifts in temperature and precipitation for station data using scientifically rigorous methods. With this methodology, EC assesses long-term data trends, variability and changes and produces gridded data sets, both for specific regions and nation-wide. Gridded data sets also enable EC to assess climate models. For example, the data sets allow EC to test a model's ability to replicate historical data.

Dr. Anderson also outlined some of the other climate data work that EC undertakes, such as: climate change detection and attribution studies; input into developing building codes and standards; and developing climate indices and long-term trends (e.g., for determining agro-climate conditions). EC has also developed the Climate Trends and Variations Bulletin (CTVB), which is a communications tool for the broader Canadian public. The CTVB provides recent climate conditions and long-term trends within their historical context, based on climate regions across Canada (not provincial boundaries).

Dr. Anderson then outlined EC's climate projection work, which EC disseminates via two websites. The first is the Canadian Centre for Climate Modelling and Analysis website, which provides raw climate model output from various global and regional climate models; this data is primarily intended for the climate research community.

The second website is the Canadian Climate Data and Scenarios website,[1] which is continually being further enhanced and developed. This site provides a broader range of multi-model ensembles-based climate data (i.e., based on more than just EC's own climate models). It will contain basic prepared graphics and plain language text, as well as highlight data sources, with an emphasis on information that is based on the most current climate model information (multi-model ensembles and different IPCC emissions scenarios). This site is aimed at a wider variety of users, including those who want general information for planning, outreach, and educational purposes, such as teachers, municipal planners, and community groups. EC has undertaken consultations with various users to enhance the site's utility. In addition, this site will also provide more complex and detailed information (climate change scenarios for specific regions and time periods) for users with more complex requirements, such as governments or consultants undertaking impact assessments, design, and adaptation planning. And finally, this site will provide much more detailed information, which could be downloaded for use in other applications, for example, the development of crop or hydrological models.

"ENVIRONMENT CANADA'S CLIMATE DATA WORK INVOLVES A LOT OF COLLABORATION."

SPEAKER BIO

KEVIN ANDERSON, B.Sc. PhD, Manager, Climate Data and Analysis Section at Environment Canada, works closely with the broader Government of Canada community to ensure that their climate research program provides the scientific results, tools, and information to support decision making related to climate change adaptation in Canada.

EC's climate research program, specifically in terms of modelling, is done in close collaboration with the international climate modelling community. The program is directly involved in the Coupled Model Intercomparison Project, which involves the set of models and projections that drives the IPCC assessment reports and is coordinated through the World Climate Research Program's Working Group on Coupled Modelling. EC has developed many of its own climate models including a global Earth System model and a regional climate model, which produces output at 0.22° and 0.44° horizontal grid resolution (approximately 25 and 50 kms, respectively).

Dr. Anderson also highlighted EC's work with the Pacific Climate Impacts Consortium[2], which was undertaken to provide more localized or "downscaled" climate information. Dr. Anderson acknowledged that EC's climate data is currently available through a number of different websites, which is not ideal, but he highlighted how the Government of Canada has adopted the Open Data Portal initiative, which provides a one-stop shop for government data, including EC's climate data.

Dr. Anderson concluded his presentation by summarizing EC's role in producing climate data. He noted that EC aims to be primarily a "wholesaler" of climate information. That is, it wants to provide foundational data, research, and climate information on a "self-serve" basis, via EC websites. It also aims to develop and distribute some targeted products with other Government of Canada departments and agencies, and collaborate with intermediaries to provide some specialized climate products directly to end users, including regional climate consortia, provinces and territories, and sector-based professional associations.

[1] *The EC Canadian Climate Data and Scenarios website is an update of its former Canadian Climate Change Scenarios Network website.*
[2] *Available online at: http://www.pacificclimate.org/data*

CLIMATE DATA SOLUTIONS

THERE ARE **3 KEY WAYS** THAT THE GOVERNMENT + THE PRIVATE SECTOR **CAN COLLABORATE AND RESPOND TO THE** PROBLEMS WITH CLIMATE DATA IN ONTARIO:

TRANSLATION 1

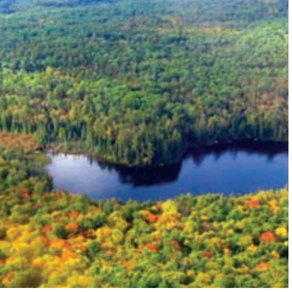
Climate data must be made **understandable** to the average person, which can be done by people and/or technology.

COLLABORATION 2

There is an **opportunity** for the public and private sectors and academia to work together in new and innovative ways to ensure climate data meets the needs of end users.

GUIDANCE 3

Experts need to **guide** climate data end users on choices such as where to find and use reliable data, and also understanding its limitations.



IAN SMITH ON THE ONTARIO PUBLIC SERVICE'S (OPS) HIGH-RESOLUTION REGIONAL CLIMATE MODELLING PROJECT

Ian Smith of the MOECC presented on some of the Government of Ontario's activity to date in generating and promoting the use of climate data in support of adaptation planning, as well as the climate data needs and challenges the province faces going forward. He noted that the province is at a watershed moment concerning climate change adaptation and mitigation.

Mr. Smith described how the provincial government has been focusing on funding scientists who produce downscaled climate models (10-45 km^2 resolution). These downscaled models help to fill in the climate data gaps presented by global climate models, which don't account for the influence of the Great Lakes. The MOECC has been producing these downscaled models through small grants to climate data modellers, largely in the academic community. Since 2008, the MOECC has funded 20 projects with academic partners and research institutions (See **Table 1** for an overview of completed projects).

This refined climate data has been used for provincial risk and vulnerability assessments in support of climate adaptation in various sectors, including the Lake Simcoe ecosystem, municipal wastewater treatment, public health, and the carbon cycle in Ontario's Far North ecosystems. These models are publicly available online.

One challenge faced by the provincial government as a result of this data creation model is that, when it funds academic labs to produce climate projections, grant recipients own the data. The province is working with academic institutions to ensure that once data has been used for academic purposes (e.g., scholarly publications) it is then made publicly available. As it stands, much of this government-funded data is available by way of a plethora of public websites (see **Box 1**); to date, no one-stop shop has been created.

Mr. Smith noted that the MOECC-funded downscaled models project results for over 60 climate variables (e.g., temperature, precipitation, IDF curves, heat waves), which add to the plethora of publicly available climate data in Ontario, at different scales and time frames, and developed by different methods. This abundance of climate data, however, presents a challenge for proper communication to the public and for end users trying to select appropriate data.

Mr. Smith explained that the real climate data challenge faced by the Government of Ontario is its vast array of climate data needs, due to its many roles in the provincial economy as a regulator, "incentiviser," and educator (among other functions). Along with its own data requirements, the province has a responsibility to communicate this data to various end users, from other government agencies to the broader public. For example, the MOECC plans to initiate the application of a "climate lens" across all ministries to ensure that climate change is considered in their work.

"THE REAL CLIMATE DATA CHALLENGE FACED BY THE GOVERNMENT OF ONTARIO IS ITS VAST ARRAY OF CLIMATE DATA NEEDS..."

Mr. Smith then provided examples of how the Ontario government applies the climate data it helps generate to its decision making processes. For example, the province has used climate data in the following projects:

- assisting the agricultural community in understanding the impacts of changing precipitation patterns;
- developing nutrient-loading targets for Lake Erie, taking into consideration extreme precipitation events;
- addressing the human health impacts of extreme heat events, as well as new vectors and diseases the province will face due to a changing climate;
- developing up-to-date standards for the province's transportation infrastructure; and
- protecting Ontario's forests.

SPEAKER BIO

IAN SMITH, M.Sc., Director of the Environmental Monitoring and Reporting Branch (EMRB) of the Ministry of the Environment and Climate Change *(MOECC)*, oversees scientists, technicians, data-analysts, engineers, modellers, and GIS specialists as they: monitor and report on Ontario's environment (including the impacts of climate change), and pursue "open data" for his branch's data sets (including greenhouse gas emissions).

Table 1

MOECC-funded Regional Climate Science Projects[7] (COMPLETED)

YEAR	RECIPIENT	PROJECT
2008-2009	OURANOS	Modelling distribution of trends of major climate indicators across Ontario (45km x 45km grids) using a Canadian model
	UNIVERSITY OF REGINA	Modelling distribution of trends of major climate indicators across Ontario (10km x 10km grids)using a UK model
2009-2010	UNIVERSITY OF TORONTO/SCINET	Modelling Ontario's climate change at high-resolution (10km x 10km) with US model on the SciNet Supercomputer System
	UNIVERSITY OF REGINA	Modelling Ontario's climate change at high-resolution 25km x 25km) with UK PRECIS model and further downscaling to 10km x 10km resolution
	UNIVERSITY OF TORONTO-SCARBOROUGH	Developing future climate change projections over Ontario at annual, seasonal and monthly scales using statistics
	YORK UNIVERSITY	Assessing potential changes in extreme winds over Ontario using high-resolution data from observation and models
2010-2011	YORK UNIVERSITY	Developing high-resolution (45km x 45km grid) probabilistic climate projections over Ontario from multiple regional and global climate models
	UNIVERSITY OF REGINA	Developing high-resolution (25km x 25km) probabilistic climate projections over Ontario from large ensemble runs out of the UK
	UNIVERSITY OF TORONTO/SCINET	Improving regional climate modelling over Ontario at high-resolution (10km x 10km) with US models on the SciNet Supercomputer System
2012-2013	YORK UNIVERSITY	Developing high-resolution (45km x 45 km) probabilistic climate projections of extreme events over Ontario from multiple regional and global climate models
	UNIVERSITY OF REGINA	Developing future projected IDF curves across the entire province and making results and all associated data publicly available on a data portal
	TRENT UNIVERSITY	Assessing climate impacts using Ontario-specific high-resolution climate data for the Lake Simcoe watershed
	ENGINEERS CANADA	A pilot vulnerability assessment of the impacts of climate change on a municipal water treatment plant in southern Ontario
2013-2014	YORK UNIVERSITY	Updating high-resolution (45km x 45km) probabilistic climate projections over Ontario from multiple regional and global climate models published by IPCC AR5
	YORK UNIVERSITY	Developing high-resolution regional climate projections over Ontario using stochastic ensemble
	UNIVERSITY OF TORONTO-ST. GEORGE	Assessing climate change impacts on the carbon cycle of ecosystems in Ontario's Far North
	YORK UNIVERSITY	Assessing climate change impacts on the James Bay Lowland (JBL) in Ontario's Far North
	UNIVERSITY OF TORONTO-SCARBOROUGH	Projecting climate change impacts on human health in Ontario
	YORK UNIVERSITY	Assessing climate change impacts on the hydrological cycle over the Lake Simcoe Basin
	UNIVERSITY OF GUELPH	Projecting climate change impacts on water quantity and quality, and soil quality over agricultural land in Southern Ontario
2014-2015	RISKS SCIENCES INTERNATIONAL	Design and delivery of training course ("Accessing and Interpreting Climate Change Information for Decision Making") for OPS and other decision makers with climate sensitive portfolios in Ontario

[7]Final reports for all projects online at: https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home?uuid=c69c541b-60f1-4983-9c5e-79d855f8d6af

Again, much of this work also presents communications challenges, with the public, with local agencies, and with other governments.

Mr. Smith concluded his presentation by observing that the province's dialogue on science and adaptation is just beginning, and that this roundtable is a welcome addition to the discussions. The MOECC will be initiating a broader public conversation on climate change adaptation and mitigation and climate data science will be an important part of that conversation.

PROVINCIALLY-SUPPORTED CLIMATE MODELLING PRODUCTS ACCESSIBILITY

Simple Provincial Climate Mapping (Ministry of Natural Resources and Forestry)

- Statistically downscaled climate projections for Ontario
- http://www.ontario.ca/environment-and-energy/climate-change-regions-and-districts

Former MNRF Climate Change Adaptation Tool Box

- https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home?uuid=c69c541b-60f1-4983-9c5e-79d855f8d6af

Source Water Protection (Ministry of Natural Resources and Forestry /MOECC external project)

- web platform with local climate data
- http://www.conservation-ontario.on.ca/

Ontario Climate Change Data Portal (OCCDP) by University of Regina (MOECC)*

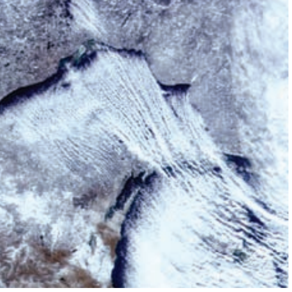
- Dynamically downscaled climate data
- http://ontarioccdp.ca
- Since its launch in Jan 2014:
  - 15,000 data downloads & 60+ registered users (incl. academia, municipal & provincial agencies, conservation authorities, NGOs, & the private sector)

Ontario Climate Change Projections by York University (MOECC)*

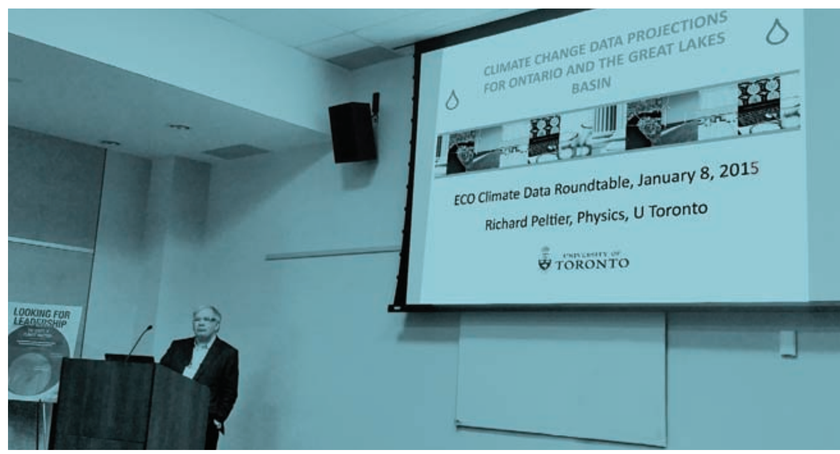
- Combined downscaled climate data
- http://lamps.math.yorku.ca/

**BOTH SITES PROVIDE:*

- *Assessment of Climate Change Vulnerabilities, Risks and Impacts using the Ontario-focused high-resolution data,*
- *Updates of Ontario focused climate data using the latest IPCC AR5 projections to ensure that data remains up-to-date and relevant.*



PROF. RICHARD PELTIER ON HIS CLIMATE CHANGE DATA PROJECTIONS FOR ONTARIO AND THE GREAT LAKES REGION



Prof. Peltier of the University of Toronto began by describing the climate modelling research he conducts with his team at the Centre for Global Change Science, using the supercomputer systems at SciNet. His dynamically downscaled model is unique because it accounts for the influence of the Great Lakes, as well as other local factors, on Ontario's climate.

Prof. Peltier explained that his work at the University of Toronto is supported by significant funding from the province of Ontario. His work uses a dynamic downscaling methodology, which requires the massive (and massively expensive) computing capability, provided by SciNet.

Using a regional climate model to make climate data policy-relevant could mean providing climate data at the scale of 1 km^2. Currently, Prof. Peltier's team has achieved 10 km^2 precision, and in some cases 3 km^2 precision. This precision allows these models to account for the impacts of lakes (e.g., on snow storms and precipitation processes in general) and to provide projections of water availability. The Centre for Global Change Science is currently producing water-availability projections for the Grand River Basin.

SciNet's downscaling starts with a global climate data model, which typically provides data at up to a 100 km^2 scale. Prof. Peltier's team embed a continental scale model (50 km^2 to 30 km^2 resolution) into the global model, and then embed data at a 10 km^2 resolution within that model, which for Ontario requires accounting for the feedback effect of the lakes. The rate at which each source of data is refreshed within their dynamically downscaled model is one of the many complex issues they face.

This downscaled model allows the Centre for Global Change Science to examine – for the first time ever – the effect of climate change on Ontario's snowbelts, which are relevant for the tourism industry, especially ski resorts (See Figure 2). Interestingly, Prof. Peltier explained that the lake effect is projected to actually increase snowfall in the snowbelts by mid-century, notwithstanding increasing temperature.

Prof. Peltier outlined some of the other modeling work that he has helped produce on precipitation and temperature changes for mid-century Ontario. (See **Figures 3** & **4**).

The globally-averaged temperature-increase projections for 2100 are about 3.5ºC. **Figure 4** highlights how that temperature average will be experienced in Ontario by mid-century, given that the heat retaining capacity of land is less than on water, and notwithstanding the mitigating effects of lakes.

"PROJECTING CLIMATE EXTREMES... PRESENTS SOME SIGNIFICANT UNCERTAINTIES."

In terms of projecting climate extremes, which are very important for a variety of practical decisions, such as designing infrastructure, Prof. Peltier explained that climate change projections present some significant uncertainties. These uncertainties are associated with natural variability, the model(s) used to make the projections, and the emissions scenario chosen.

Producing projections of climate extremes requires an ensemble of models, which differ from each other in the representation of physical processes (e.g., the level of sea-ice change). As a result, predicting climate extremes at a regional scale can result in predictions of severe climate events. However, Prof. Peltier explained that there is a great deal more scientific work needed to come to a clearer understanding of whether such severe extremes are actually plausible. For example, the Centre for Global Change Science has modeled precipitation amplitudes of 50 year events to increase in Ontario by 14 to 29 per cent by mid-century, and for current 50 year storm events to increase their frequency to every 15 to 25 years. Another of the Centre's model ensemble members projected that Ontario could face a severe drought by 2100 although is an outlier. These predictions highlight the importance of the analysis of projected severe climate extremes.

SPEAKER BIO

RICHARD PELTIER, PhD (physics), D.Sc., FRSC, is a professor at the University of Toronto, Director of the Centre for Global Change Science, and Scientific Director of the SciNet facility for High Performance Computation. He researches processes that affect the atmosphere, the oceans and the solid earth, and long timescale climate variability.

Figure 2: Modeling regional climate change.

Simulated snowfall changes (%) over the North American Great Lakes region by 2050 to 2060 are shown for two cases. (A) Results from a global climate model (GCM). (B) Results when the GCM output is downscaled with a dynamical mode. Because the lake effect snow can only occur when the lake is unfrozen, a warming climate enhances the likelihood of lake effect snow, largely canceling out the general snow decrease due to a warmer atmosphere. (Source: J. Gula, W. R. Peltier, J. Clim. 25, 7723 (2012).)

GCM RESULTS

DOWNSCALING RESULTS

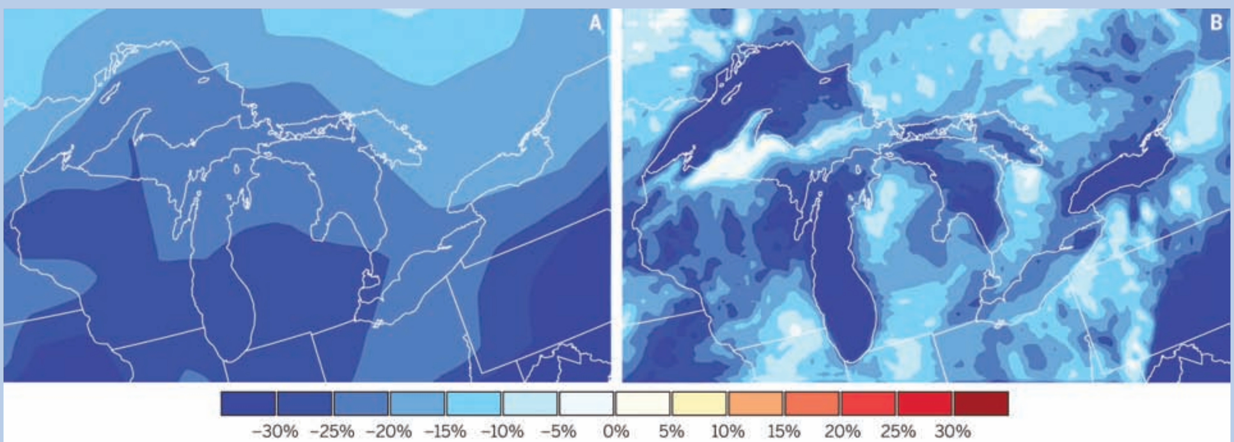


Figure 3: Monthly precipitation change projections for Ontario in 2050-2060 relative to 1979-2001.

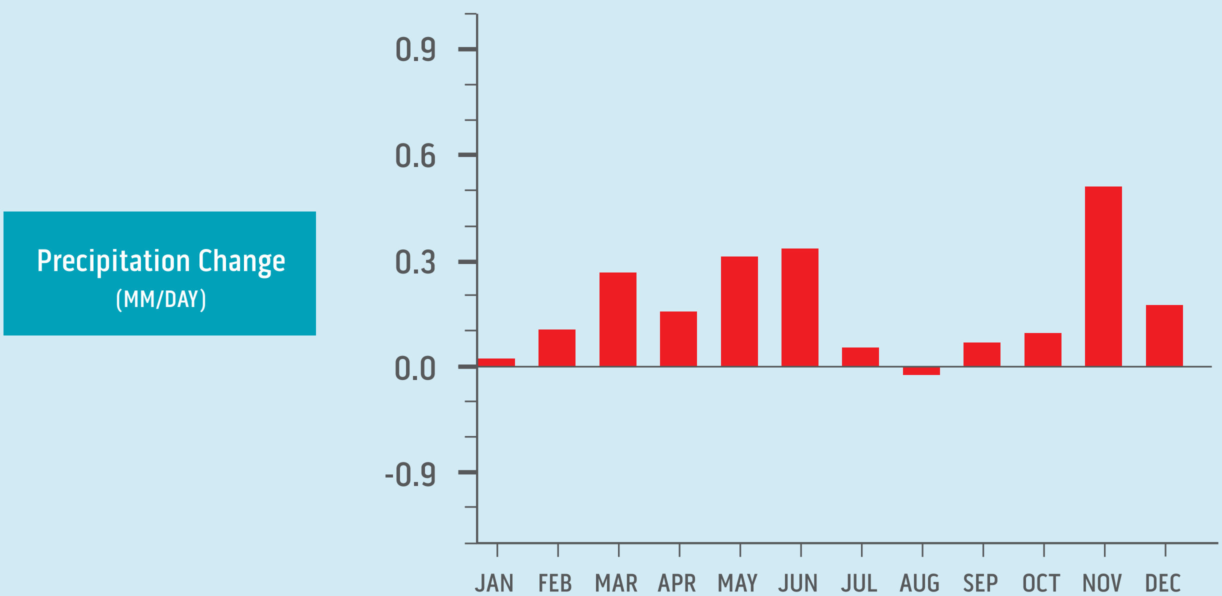
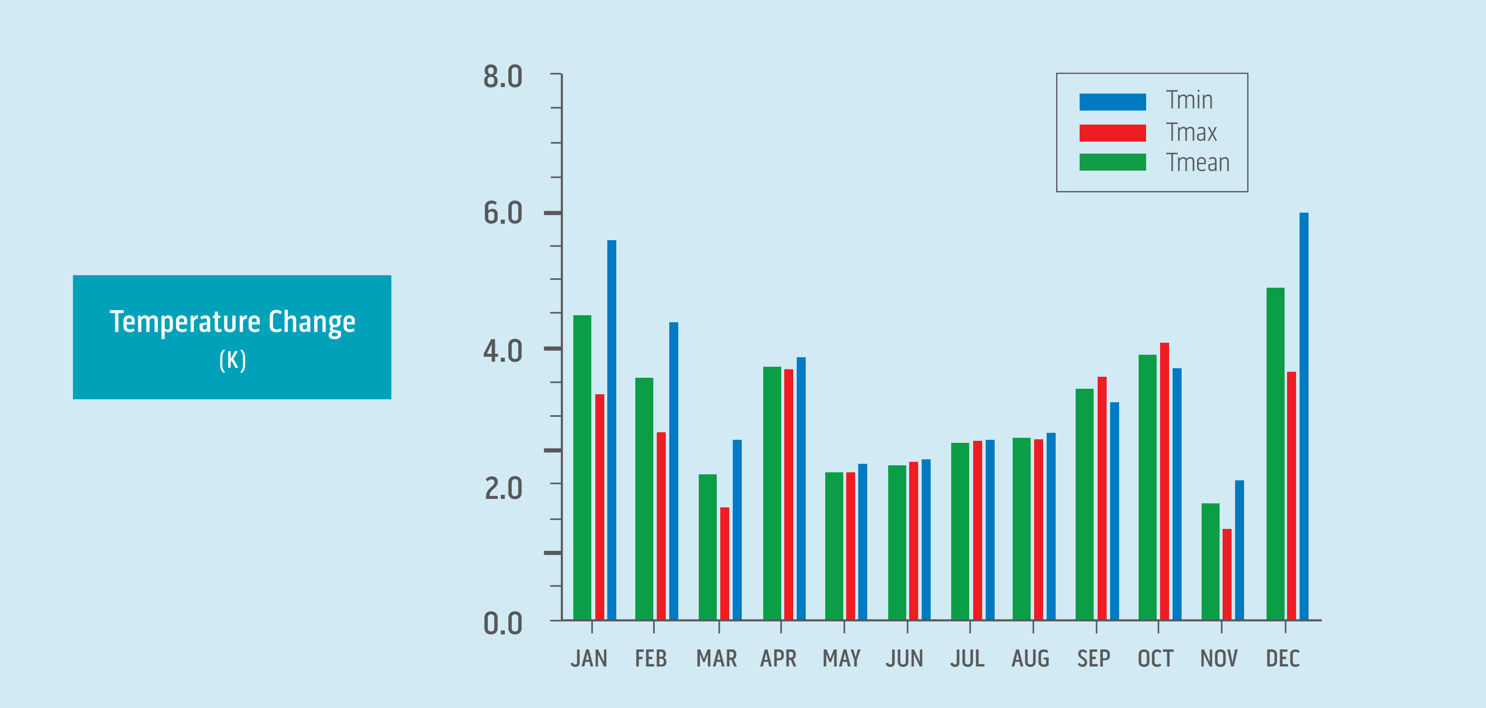


Figure 4: Monthly temperature change projections for Ontario in 2050-2060 relative to 1979-2001.



As a final recommendation, Prof. Peltier observed that the huge amount of climate data out there is due to the lack of quality control, and that he would like to see the provincial government take responsibility for establishing an organization that would make the highest-quality climate change projections publicly available.

PARTICIPANTS' COMMENTS AND DISCUSSION ON THEME 2: FUTURE DIRECTIONS FOR CLIMATE DATA NEEDS

Participants highlighted some further gaps in, and potential improvements to, Ontario's climate data landscape. In particular, participants focused on opportunities for improved climate data education, communication, collaboration, and innovation.

Participants discussed the need to educate the public and climate data users on the relevance of climate data and how to apply it. Many users don't know that they need to use longer time scales for planning, or that historical climate records are no longer reliable predictors of the future. In addition, participants again raised the issue of guidance for end users on how to incorporate climate data into their decision-making processes. One climate data education initiative mentioned was the University of Waterloo's new degree in climate change, which focuses on how to apply climate data to different areas.

The need for more climate data education overlapped with another major issue raised by participants: the need for improved climate data communication. Participants noted that education does not resolve the need for climate data to be meaningful (translated) to the non-scientist, who is often the decision maker. Participants reiterated that climate change presents serious economic risks that aren't yet fully understood by politicians or the public. Although making the costs of climate change impacts known will be a challenging process, these costs are critical to driving adaptive actions. Improved communication will also help developers make the business case to invest in infrastructure in the face of climate data uncertainties. Efforts

Building on the first session's discussion of climate data needs, in session two, participants identified what "ideal" climate data would look like in terms of:

- delivery mechanisms,
- data points, and
- other attributes.

Participants also discussed related topics such as communications and education (climate data literacy).

to communicate climate change data to lay people are particularly important. To illustrate this issue, one participant provided the example of Environment Canada's climate scenario website, which does not provide the public with any customer service; as a result, the majority of people downloading climate information are climate scientists.

In terms of collaboration, participants recommended that the province take a key role in data provision, and that, in order to do so, governments and agencies at the federal, provincial and regional levels harmonize what they are offering in terms of climate data and analysis. Any solution will also require collaboration with other industries and sectors (e.g., sharing data), adopting best practices and processes (e.g., in relation to data collection and to avoid duplication) and evolving technology (e.g., inexpensive technologies to compute and access data are increasingly available).

The need for collaboration also raises the question of how we move from protected data to open data. This issue arises especially in the context of data that represents a source of income for the private sector. How do producers of open data make money?

Building on the collaboration recommendations highlighted above, participants identified several opportunities for climate data innovation in Ontario. For example, participants suggested a one-window data-sharing solution, though they also flagged that whoever hosted this portal could face liability issues (a similar issue was flagged in the U.S.). Accordingly, portal hosts should incorporate consultations with the legal profession and the financial sector into their processes. Other participants observed that there is a need in Ontario to focus efforts on the transfer of available climate data to tools used in areas like fisheries management and agriculture. The provincial government could also address climate data issues by adopting some of the lessons it learned 10-15 years ago while developing its geographic information system (GIS) data.

Participants also discussed the need for climate data standards, so that users know which models, or ensembles of models, can be trusted, and within what thresholds of application. Finally, one participant commented that the future climate will create opportunities (e.g., growing new crops in agriculture) that we are not considering now, which will bring with them new data needs.

ECO OBSERVATIONS ON THEME 2: FUTURE DIRECTIONS FOR CLIMATE DATA

The presentations and participant discussions of Theme 2 further emphasized the need for improved communication and for education of both the public and decision makers regarding climate data and how it should be applied in decision making. Again, participants felt that a big part of communication and education is the need to translate climate data so that it is meaningful to non-scientists.

The Theme 2 discussions also focused on the need for innovation and collaboration necessary between the public and private sectors to improve climate data use in Ontario. In terms of this collaboration, participants focused on opportunities for improved climate data sharing. In terms of innovation, participants focused on opportunities for improved and streamlined user access to climate data, for example, via a one-window data portal.

THEME 3

GOVERNANCE MODELS

This final session explored two related themes: the potential roles for the private sector and of the provincial government in the provision of climate data.

ROLE OF THE PRIVATE SECTOR

This session focused on the role the private sector can play in the creation and delivery of climate data to end users. The private sector has unique capabilities, such as creating interactive user-friendly technology platforms, which could be better leveraged to ensure climate data reaches a broader audience and is effectively applied to decision making.

JOE GREENWOOD ON THE PRIVATE SECTOR'S ROLE IN CLIMATE DATA

Joe Greenwood outlined the private sector's expertise and roles with respect to climate change:

- **Managing risk**: reinsurance companies have high-quality climate and flood data for calculating insurance rates;
- **Allocating capital**: investors are altering their investment strategies due to increased knowledge of climate change risks;
- **Innovating new products and services**: climate change presents many new business opportunities;
- **Managing supply chains**: getting cold products, such as ice cream, to market will be more difficult and costly in some warming regions; and,
- **Shaping and responding to customer demand**: airlines are offering customers innovative carbon offset options.

He described how in the UK, large portions of the country were not insurable for floods due to increasing intensity, duration and frequency of flooding. The insurance industry had a better flood model than the government, and worked collaboratively on a program ("Flood Re") to share risk across the entire industry to avoid the total collapse of the UK's flood insurance market.[1]

Mr. Greenwood stated that climate data is needed to avoid other market failures. The financial sector in particular is a potential key player in identifying climate change risks due to its intermediary role in the economy and impact on capital allocation. If the financial sector could understand how climate forecasts translate into likely scenarios, then it could influence the rest of the economy by properly pricing risk. He noted that the private sector is especially adept at managing its own risk.

More broadly, climate data can help tell a company where and when there is likely to be a market for its products. Climate data can also help companies manage supply chains (e.g., where ingredients should be sourced).

Some sectors (e.g., insurance and water) will be more negatively affected by climate change than others; meanwhile, other sectors (e.g., alternative energy, buildings and building systems, and transport) may discover investment opportunities. Studies have shown that the most profitable large companies are those that address climate change.

Mr. Greenwood then turned to the failures in the "climate data value chain". Currently a gap exists between available climate data and the ability of end users to apply it. He identified some of the barriers faced by climate data end users: poor awareness of climate data; inability to understand and incorporate climate data into decision making; and, lack of incentives to incorporate climate data into decision making (i.e., until climate change directly impacts people, demand for climate data may be low). In addition, a massive data translation effort (and the capacity to undertake it) is needed, as well as government policies that stimulate and support climate data innovation.

Mr. Greenwood described the various ways in which climate data relates to products and services emerging in the private sector (though products and services that are purely climate data-driven are in their infancy):

- **Data Informed**: companies that provide advice on climate change strategy, informed partly by climate data.
- **Data Driven**: companies that provide data-based solutions to help end users better understand climate change risks, like the Climate Corporation, which provides climate data to farmers and was sold to Monsanto for approximately $1 billion in late 2013.
- **Climate Counting**: companies that offer technology products that help companies track and manage their environmental impact.

Mr. Greenwood concluded that making climate data more accessible may unleash innovation. He suggested Ontario should take the lead from the U.S., which is a leader in making government-owned-and-produced climate data widely available, as well as creating enabling conditions for innovation (e.g., sponsoring an app contest and shaping private-public sector partnerships).

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[1] *Association of British Insurers, Flood Re explained, https://www.abi.org.uk/Insurance-and-savings/Topics-and-issues/Flooding/Government-and-insurance-industry-flood-agreement/Flood-Re-explained*

SPEAKER BIO

JOE GREENWOOD, IM(GIS), MBA, is Program Director for MaRS Data Catalyst, which brings together data and analysis from a variety of partners to track, quantify and grow Ontario's innovation economy. Joe collaborates with governments at all levels to enable the greatest commercial and social impact from the use of data.

SASHA SUD ON A MODEL DATA INNOVATION PROJECT: THE GREEN BUTTON

Mr. Sud explained how the Green Button, an electricity data access standard, bridged the gap between complex data and end users, and encouraged private sector innovation.

Electricity data, like climate data, can be confusing for the consumer. In Ontario, the investment in smart meters generated lots of data in many different formats. However, because the data are not standardized, it was difficult for the private sector to use them to develop products. MaRS Data Catalyst took on this issue.

Many barriers needed to be addressed. Data are available in many formats and are typically hard to understand. Even where understandable, there are privacy concerns. The Green Button project attempts to deal with these issues by standardizing and digitizing electricity data for consumers. Now consumers can download their electricity data in one format – no matter the source. And

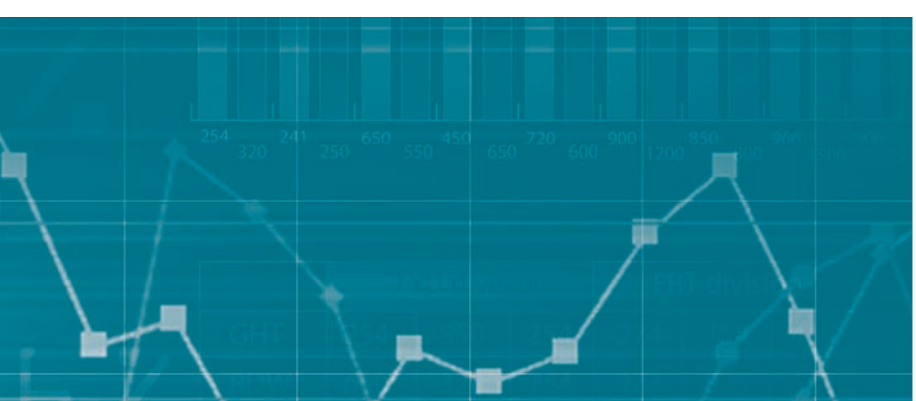
they don't need to spend time understanding what the information means (because innovative solutions and applications translate the data for them.) The Green Button standard is now available to over 3 million homes and small businesses in Ontario.

MaRS Data Catalyst's experience working with electricity data has some lessons for those working on the climate data issue. For example, the potential economic value of enabling access to data, which if communicated to key industry stakeholders, could help get policymakers' attention. MaRS found that the utility data analytics industry, which includes some climate data, potentially represents a $20 billion market in North America.

"ELECTRICITY DATA, LIKE CLIMATE DATA, CAN BE CONFUSING FOR THE CONSUMER."

In the case of the electricity sector data, MaRS brought stakeholders together to help them realize the value of the data and create new solutions to leverage this market. For example, MaRS organized an event for developers, so they could use the data to create mobile apps. Now MaRS is working on enabling access to natural gas and water data.

Green Button Download My Data ®



SPEAKER BIO

SASHA SUD leads Ontario's Energy Data Access Project at MaRS Data Catalyst, which is the first international implementation of the Green Button Standard outside the U.S.

ALEX MILLER ON THE ROLE OF GIS SOFTWARE WITH CLIMATE DATA

Alex opened with an anecdote describing his personal experience with climate change; in the early 1970s, near the start of his career, he visited Lake Chad while mapping northeast Nigeria. That lake has since shrunk by 90 per cent.

His company, Esri Canada, promotes the use of its GIS software, ArcGIS. In his view, computerized geography provides a context for people to better understand the world, and will become more and more important as we face complex challenges like climate change. It is one example of how the private sector can help make sense of climate data and make it more accessible to support decision making.

GIS software was invented over 50 years ago and has become a key technology worldwide for integrating geography into everyday work and problem solving in many fields. GIS creates a common platform for people to post and access data, which can then be used by developers to create apps, for example. GIS by its very nature integrates organizations because maps are easy to understand, and geography connects people. GIS is evolving very quickly; the first generation of software was about collecting data; the second generation was about making data available for various applications (e.g., analysis); and now, the third generation is about making this data and its various applications available online.

Alex gave many examples of how GIS can help change the way people think and act, in particular the way we conduct activities such as environmental monitoring, assessment, and management. There are many examples of GIS being leveraged across sectors as diverse as urban planning, real estate, transportation, utilities, buildings, sales, human health and more. GIS software also helps professionals such as engineers collaborate on projects in an iterative way (called geodesign) to incorporate feedback, evaluate, and ultimately reach better decisions. GIS can also utilize climate data to help understand the spread of diseases, such as malaria, which are becoming more prevalent as the climate warms. Likewise, it can help governments prepare for and respond to disasters.

GIS provides people with a tool to publish and maintain their data. Alex is working on various initiatives to promote it. One open data initiative that Esri Canada has undertaken is working with all levels of government to create a community map of Canada , to be completed by July 1, 2017 (57 per cent of the population is already covered). Esri has already created a living atlas portal of the world, which integrates data from partners such as Environics Canada.

"THE PRIVATE SECTOR CAN HELP MAKE SENSE OF CLIMATE DATA AND MAKE IT MORE ACCESSIBLE TO SUPPORT DECISION MAKING."

The biggest challenge with GIS mapping is always data access and reliability: how do I get at the data and know if it's any good? Esri is already involved in the GeoFoundation Exchange, where governments make their official base-map data available. Alex believes that a similar type of official and reliable data exchange is needed for climate data, and that processes to easily curate that data are also needed.

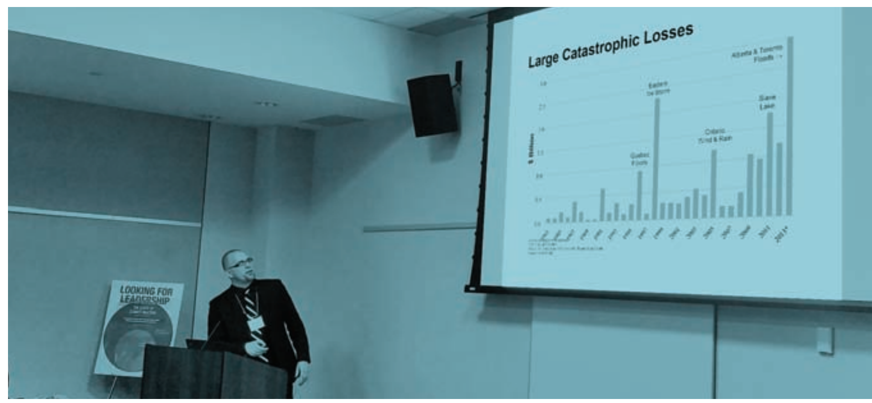
He noted that the private sector can move more quickly than governments, although the latter have an important enabling role. For the ECO roundtable event, Esri Canada created a sample web portal that integrates a few maps and data sources for climate change, including the Government of Ontario's climate change modelling portal. It also used story maps – maps that tell a story in a way that would be hard to describe otherwise.

SPEAKER BIO

ALEX MILLER, B.Sc. (Surveying Engineering), is President and founder of Esri Canada, which provides enterprise geographic information system (GIS) solutions. Alex has broad experience in surveying, mapping, engineering, information systems designing, in management consulting and in applying information technology to land, natural resource and environmental management. Alex is a member of the Government of Canada's Open Government Advisory Panel.

ROB WESSELING ON THE INSURANCE INDUSTRY'S RELATIONSHIP WITH CLIMATE DATA

Mr. Wesseling highlighted how, from the insurance industry's perspective, climate change is happening now.



He presented charts demonstrating how extreme weather events linked to climate change (specifically storm activity) have increased catastrophic financial losses for the industry. Not only are the insurable losses of these storms huge, but the broader economic impacts are even greater.

Mr. Wesseling then detailed a case study about an initiative, called "Partners for Action," to address flood risk in Canada.[9] At the end of 2012, the Co-operators started thinking about the flood problem in Canada, and what the role of the industry and the company should be. The Co-operators then commissioned two studies from the University of Waterloo.

The first study looked at what it would take for overland flood insurance (which covers damage caused by river and urban flooding events that cause water to enter a dwelling through doors windows and other openings, as well as the sanitary sewer system) to be offered in Canada.[10] Following the study, the Co-operators and the University of Waterloo engaged a broad group of stakeholders to examine this issue. The second study focused on identifying the necessary conditions for society to successfully manage its increasing flood risk. These included:

1. Canadians need to understand the risks that overland floods present to their homes, businesses, and communities. This requires effectively communicated climate science and modelling.
2. Canadian decision makers need to use their understanding about flood risk to make decisions to protect their property. This again requires user-friendly climate data.
3. Canadians need to have access to a means to transfer the risk that remains after adaptation; this could be insurance.

The insurance industry has a role to play in understanding climate risks, because the science of insurance is about monetizing risk. The monetization of risk provides an important social benefit: economic signals that provide a basis for good decision making.

In order to be able to offer overland flood insurance in Canada, climate data is needed. The Co-operators are themselves doing the type of downscaled modelling (30m^2 grids) that is needed. They can currently predict the average damage per year due to flooding at a house-by-house level. However, they are currently using historical climate data to project into the future (not forecasting models).

Canadian decision makers need this local-level understanding of climate risk. This requires a business case for the necessary funding. In Mr. Wesseling's view, the business case can be made real by monetizing risk, i.e., telling people the average flood damage per year in a given community. The insurance industry can partner with municipalities to share data and influence the decisions of individual homeowners.

"THE INSURANCE INDUSTRY SHOULD HAVE A ROLE IN SHARING CLIMATE DATA AND MONETIZING CLIMATE CHANGE RISKS MORE BROADLY."

Mr. Wesseling concluded by restating that a dire need exists for flood insurance in Canada and by clarifying that, although his presentation focused on flooding, the insurance industry should have a role in sharing climate data and monetizing climate change risks more broadly.

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[9] *Partners for Action: Priorities for Increasing Flood Resiliency in Canada, http://www.cooperators.ca/~/media/Cooperators%20Media/Section%20Media/AboutUs/Sustainability/Partners%20for%20Action%20Flood%20Report_EN_19September2014.pdf*

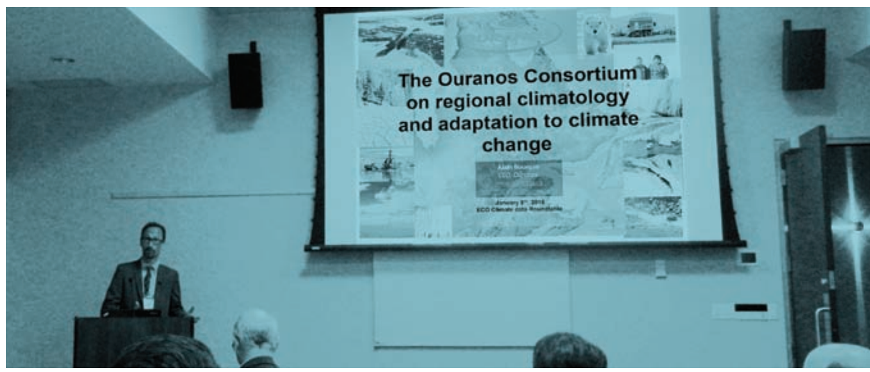
[10] *Although coverage for some damage related to flooding, such as sewer back-up, is available, property insurance in Canada does not cover losses from overland flooding, which is by far the most common type of natural disaster in Canada.*

SPEAKER BIO

ROB WESSELING, M.Sc. (Applied Statistics) is the Executive Vice-President, National Property and Casualty Product and Chief Operating Officer (COO) of the Sovereign General Insurance Company, which is a member of the Co-operators Group. Rob has years of insurance industry experience in product design, pricing and segmentation, technology development, business information, client relationship management and government relations.

ALAIN BOURQUE ON OURANOS, QUEBEC'S RESEARCH CONSORTIUM ON REGIONAL CLIMATOLOGY AND ADAPTATION TO CLIMATE CHANGE

Mr. Bourque began by outlining Ouranos' governance structure and explaining the unique circumstances in Quebec that led to the genesis of Ouranos.



The group was formed in 2001 in response to a number of catastrophic weather events in Quebec: the significant 1998 ice storms and Saguenay flood, as well as many smaller regional events that contributed major financial losses to the province and kindled stakeholders' interest in climate change. Many decision makers began to realize that they needed to do something about climate change. As a result of this history, Ouranos always tries to document climate events, because the information helps to deliver a clear message to decision makers that something is happening.

Created by eight provincial ministries, Hydro-Québec and Environment Canada, the Ouranos office is located in Montreal close to some of its key collaborators. Its funding structure is mixed; it has members whose annual fees provide base funding, but it also relies on project-based funding. Members also provide personnel (i.e., staff located in the Ouranos office) to help advance the science for well-identified research needs and provide a critical mass of expertise on climate change risks.

Ouranos produces user-driven research – even its board is biased towards user needs. In 2007 Ouranos made a major strategic decision to split into two programs: one focused on climate science, and the other focused on vulnerability impacts and adaptation. In the climate science program, Ouranos' role is to develop climate science for Quebec. It is now working with university partners on the next generation of regional climate models for Quebec: Canadian Regional Climate Model (CRCM) 5. CRCM 5 has a physics package based on Environment Canada's weather forecasting model, and has a finer spatial resolution than previous models. In Ouranos' vulnerability impacts and adaptation program, the general trend is towards collaborative, participatory projects with end users. Ouranos aims to consolidate climate science, while building capacity to undertake integrated climate data analysis.

Ouranos is in a constant state of evolution. After a number of years, Ouranos realized that it needed end users to play an active role in structuring projects. As a result, each program is strongly influenced by program committees, which have representatives from the end user community. Meetings with these committees determine priorities for the scientific and technical program. They also help structuring projects and monitoring its progress.

Ouranos has cultivated a network of hundreds of practitioners and academics across Quebec, and, over time, has integrated more and more disciplines into its work. In 2012 Ouranos undertook over 100 projects with over 450 collaborators.

Ouranos' role is to ensure a common understanding of adaptation, provide a collaborative forum, connect policymakers and experts, and drive its network to do the work. It also provides office space for collaborators. Ouranos has many projects ongoing at the moment, including one with Hydro-Québec that is using climate data to help determine turbine design for a dam. Currently it is also working to provide web access to climate data.

"THE GENERAL TREND IS TOWARDS COLLABORATIVE, PARTICIPATORY PROJECTS WITH END USERS."

In summary, Mr. Bourque explained that a decade of experience has led Ouranos to understand the importance of involving end users as much as possible in order to create win-win-win situations for researchers, users, and funders. This strategic approach is essential to ensuring that projects generate tangible outputs and outcomes. Ouranos' success is also due to its broad base of support and the fact its funding comes from multiple sources. For example, although the Ministry of Public Security was key in creating Ouranos, others have taken over and it is no longer the driving member of the consortium.

SPEAKER BIO

ALAIN BOURQUE,
BSc (Meteorology), M.Sc. (Atmospheric), is the CEO of Ouranos, a research consortium on regional climatology and adaptation to climate change.
Ouranos produces climate information and vulnerability assessments that enables climate risk management and collaborative research opportunities involving experts and end users.
Alain is also involved in international (IPCC), Canadian and Quebec scientific work and is regularly featured in the media regarding climate change, its impacts and ways to prepare.

ELIZABETH GIBBONS ON THE GREAT LAKES INTEGRATED SCIENCES AND ASSESSMENTS PROGRAM'S WORK ON CLIMATE DATA

Ms. Gibbons expressed her appreciation for being invited to this event, as her organization strives to work across the U.S.-Canada boundary throughout the Great Lakes region.

The Great Lakes Integrated Sciences and Assessments Program (GLISA) is a Regional Integrated Sciences and Assessments (RISA) Center – one of 11 in the United States. GLISA is a joint initiative between the University of Michigan and Michigan State University, and is funded by the National Oceanic and Atmospheric Administration (NOAA). It strives to straddle the boundary between research and service, and as such refers to itself as a "boundary organization."

RISAs have been around since 1995, collectively making them one of the oldest federal climate research programs. In the past several years, it has become more challenging to understand how RISAs fit into the proliferation of climate-adaptation programs in the U.S. federal government. For example, there are now climate change adaptation programs in the U.S. Department of Agriculture, Environmental Protection Agency, Department of the Interior, and directed through the White House.

According to Ms. Gibbons, GLISA needs to recognize how it fits at the federal and regional levels. The Great Lakes region (eight states and two provinces) where it works is not a recognized jurisdiction; in fact each federal agency has a different way of dividing and describing regions of the country, including the Great Lakes. The region is most often divided between the 'Northeast' and 'Midwest'. GLISA needs to have an expansive view, since its partners' service areas reach from Maine out to Colorado. For the Great Lakes region, GLISA has become a convener of local organizations and national agencies with the goal to make climate data clear and consistent to the end users – so they can get the same answer no matter who they ask.

GLISA has found that there is no single way of providing information that resonates with everyone. It is important to understand end users' needs and think about the role of climate data in decision making. Local and historical information needs to be balanced with future regional information. GLISA also has a large social science component to its work, especially around climate literacy and understanding whether there has been an uptake in policy-making (i.e., determining whether GLISA's work is effective). Secure funding from NOAA enables GLISA to study its efficacy and make adjustments as needed. It has to reapply for funding from NOAA every five years, and its priorities are revisited annually.

GLISA has found that the climatic changes that resonate most with end users are extremes and seasonality. Changes in water availability, for instance, can only be understood by looking at seasonality. However, even if they don't make headlines, small changes can also be significant. It doesn't take much to push a system out of its coping range. GLISA can help end users drill down into the data to understand what is important to them, and to determine which changes can push their system of concern out of its coping range.

GLISA relies on regionally scaled historical data (1951-1981, 1981-2010) as an entry point, as they provide users with context. This context is particularly useful when GLISA deals with skeptical communities. Historical trends can tell a story that matches people's personal experiences (e.g., "we used to skate here"), making it easier to walk through the next step, which is: what to do?

GLISA has also developed an online tool that projects climate trends 40 years into the future. However, it has also found that few of its end users want digital climate data. Accordingly, it has another tool (only available for the U.S.) that integrates climate data with economic information, allowing decision makers to see, county by county, who is the most vulnerable and why.

GLISA has found the biggest challenge with producing downscaled data for the Great Lakes region is the impact on the climate of the Great Lakes. Ms. Gibbons stated that she hasn't seen a good downscaled model that accommodates for the lakes (though she is intrigued by Dr. Richard Peltier's modelling work).

SPEAKER BIO

ELIZABETH GIBBONS, MPI, is the Program Manager for the Great Lakes Integrated Sciences and Assessments Program (GLISA), based out of the University of Michigan and Michigan State University. GLISA is one of 11 regional integrated sciences and assessments centers funded by the National Oceanic and Atmospheric Administration (NOAA). GLISA is housed at the University of Michigan Climate Center. Elizabeth also directs the activities of the U-M Climate Center. In both roles her core responsibilities include transferring information on climate change and resilience from the research side to stakeholders throughout the region.

PARTICIPANTS' COMMENTS AND DISCUSSION ON THEME 3: GOVERNANCE MODELS

Participants generally agreed that the Ontario government's current role in providing climate data is not adequate, and that alternative delivery models should be explored. Though the provincial government is providing some climate data, a more user-friendly service interface is needed. Increased access to existing data, as well as ongoing investment in climate data, would facilitate considerably more analysis. For example, an evaluation of the preparedness of specific geographic areas to climate change would be immensely helpful in prioritizing adaptation spending.

Participants converged around the idea that Ontario needs a one-stop shop for climate data and modelling science and support ("climate services"). The cost of funding such an organization may be high, but the cost of not adapting to climate change is likely to be much higher. Many participants felt that either the Ouranos or GLISA model might work for Ontario, though perhaps with some modifications. Others identified a potential opportunity for Ontario to work with Ouranos in some capacity, since Ontario and Quebec are integrating other aspects of their climate change policies. Either way, the organization providing climate services in Ontario should: have a secure source of funding; maintain good relationships with the academic community; be at arms-length from the government; and be end-user

The third roundtable session focused on the roles of different types of organizations, discussing who should take the lead addressing Ontario's climate data challenges, and how the lead organization should be governed and funded. The participants explored the particular role of the provincial government in the provision of climate data.

driven. Participants generally agreed the province should help establish this organization and provide some degree of oversight and support (financial and otherwise). The province could also establish the standards and protocols required to facilitate the integration of the data into other uses, bearing in mind the diverse needs of Ontarians, from northern Ontario to the densely populated south.

To save end users time and assure them that the data are sound, attendees agreed that an independent body is needed to consolidate and validate climate data. The Ouranos-type organization described above could provide an assessment and/or validation process for existing climate models, giving users confidence to choose a model (or an ensemble of models) knowing that it would be credible and appropriate for their purposes. The challenge will be building capacity over time and appropriately supporting it.

The funding model could be similar to that used by Ouranos, with contributing members from both the public and private sectors, as well as project-based funding. Participants suggested that revenues from a future carbon price are another potential funding source.

Many felt that Ontario needs a climate data web portal, one that is not solely operated and maintained by either the provincial government or the private sector. Some noted that data sharing between various levels of government is already happening in the province to some degree (e.g., Land Information Ontario's data warehouse); however, more is needed, as well as more open data made available by the province. Data could also be shared through formal agreements, though these need to be well thought out.

The private sector also has a role to play, perhaps in: data management (cloud computing and storage); through the use of technology platforms; or as end users and funders.

ECO OBSERVATIONS ON THEME 3: GOVERNANCE MODELS

All of the discussion groups came to a broad consensus that the status quo in Ontario is not serving the needs of most end users, and that Ouranos in Quebec and GLISA in the U.S. provide interesting governance models that Ontario could adopt. Both organizations have been working in this field for a long time and Ontario can learn a lot from their strategic approaches to serving the needs of climate data end users, as well as from their governance and funding models. GLISA's work is similar to that of Ouranos, but it has stable funding from the U.S. federal government. Participants felt that Ouranos' membership-based funding and operating model makes a lot of sense for Ontario. Although Hydro-Quebec is Ouranos' largest funder and Ontario does not have an equivalent, our province is home to many private sector companies who would likely be interested in funding such an organization to some extent.

Almost all participants felt that an Ontario-based climate services organization should not be housed within the provincial government, although the province has important enabling, funding, and oversight roles to play. At the same time, an Ontario version of Ouranos should explore partnerships with the private sector, which can offer its expertise in delivering data on user-friendly technology platforms.

Overall, a consensus developed among participants regarding the need for an Ontario climate data champion, whether within the provincial government or external to it, to push for the establishment of an Ontario climate services organization.

ECO COMMENT

The Commissioner's climate data roundtable was an opportunity for the ECO and participants to hear the viewpoints of a wide range of stakeholders on this important Ontario policy issue. The day presented many opportunities for participants to learn from the speakers during the plenary presentations, as well as to express their opinions and hear from their peers during the small facilitated roundtable discussions. The ECO hopes that the conversation on climate data in Ontario continues in other fora and broadens to include an increasing number and range of stakeholders.

Participants expressed conflicting viewpoints on a few topics, but overall found consensus on the need in Ontario for the translation of raw data and science into information formatted to support decision making. Other provinces and jurisdictions (Quebec and BC, as well as the U.S.) have encountered the same challenges and have implemented solutions that Ontario can draw

upon. A partnership with Ouranos to provide climate services to Ontario-based end users could even be explored. But the key question remains: which organization should be responsible for ensuring end users get the data required to make sound climate change adaptation decisions?

From the ECO's perspective, since climate data is critical to adaptation planning, the province must ensure these data are accessible in a user-friendly format to stakeholders. However, the province does not have the resources (financial or staff) to house a climate services organization within the provincial government, nor would such a governance structure be ideal. Many participants felt that it makes sense for Ontario to have an independent climate services organization with provincial oversight, along with some provincial funding and technical support.

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