



Report: PDL-CPL-15-58

Region of Waterloo

Planning, Development, and Legislative Services

Community Planning

To: Chair Tom Galloway and Members of the Planning and Works Committee

Date: December 8, 2015 **File Code:** D06-80

Subject: **Climate Adaptation Planning - Observations and Projections for Waterloo Region**

Recommendation

For Information.

Summary:

The University of Waterloo's Interdisciplinary Centre on Climate Change has recently completed research on climate projections for Waterloo Region compared to historical conditions over the past 30 years. An Executive Summary of the research is attached to this report. This research was jointly supported by the Region of Waterloo along with the Cities of Cambridge, Kitchener and Waterloo. Community concerns about the impact from changing climate conditions and extreme weather expressed during stakeholder consultations earlier in the year have resulted in the inclusion of climate adaptation planning within the Region's new strategic plan.

The research compiled by the University informs climate adaptation planning at corporate and regional community scales. It will be shared with staff involved in asset management and infrastructure master planning as well as other stakeholders (e.g. Grand River Conservation Authority). During November 2015, the three City Councils received the University of Waterloo report and presentation. City staff is encouraging support for a coordinated approach to conduct climate adaptation planning in collaboration with the Region as a way to address common service areas and interests. If supported by City and Regional 2016 budget approvals, such collaboration would help identify and address specific local vulnerabilities and risks. Pending this approval of resources, City and Regional staff would report back in 2006552

the spring of 2016 with draft terms of reference for consideration by the City and Regional Councils for the collaborative adaptation planning endeavour using a framework which is generally being followed by Canadian municipalities.

Report:

Background - Clarity of Terminology and Existing Plans

Actions to address climate change are generally divided into two realms – mitigation and adaptation. Mitigation refers to initiatives that lead to a reduction in greenhouse gas (GHG) emissions which contribute to climate change. Adaptation refers to measures taken to cope with the level of change observed and expected from changing climate conditions and extreme weather events.

From the perspective of municipalities, mitigation and adaptation are often further divided into a corporate scope, where there is direct control over municipal operations and facilities, and a community scope, which includes factors beyond the direct control of municipalities. The Region of Waterloo has already made commitments and progress on mitigation for both the corporate scope, through its Corporate GHG Reduction Plan approved in 2011, and the community scope, through the Community Climate Action Plan approved in 2013.

It is widely accepted that mitigating climate change will require substantial and sustained reductions in GHG emissions on a global scale. However, no matter how successful these efforts may be, we are still faced with climate change impacts linked to past and ongoing GHG emissions that will be present in the atmosphere for many years to come. This means that both types of climate action are necessary, mitigation to avoid even more serious impacts, and adaptation to deal with the level of change expected over the next century or longer.

An increasing number of municipalities across Canada are engaging in adaptation planning in order to improve resilience to extreme weather events and projected changes in climate conditions. According to a survey conducted in 2012 involving University of Waterloo researchers, 238 communities across Canada are engaged in some form of climate adaptation planning activity but very few have an adaptation plan in place at this time. Several municipalities however are in the process of developing adaptation plans at the community scale and/or for specific infrastructure.

To make progress on adaptation, the first question to be addressed is “what conditions do we need to adapt to?” The process used to address this question is described below.

Dialogue within Waterloo Region

On October 10th, 2014, the University of Waterloo’s Faculty of Environmental Studies hosted a preliminary meeting to discuss the need to adapt to changing climate conditions including extreme weather events. In part this meeting was in response to several recent extreme weather events (e.g. severe ice, rain and wind storms) along with abnormally warm or cold

winter and spring seasons that occurred within Waterloo Region between 2012 and 2014 impacting agricultural crops, local homes, businesses, infrastructure and other community assets. Moreover, there is a growing awareness and concern of the impacts from climate change still to come.

The local meeting held in 2014 included representatives from:

City of Cambridge	Grand River Conservation Authority
City of Kitchener	Region of Waterloo
City of Waterloo	University of Waterloo
Engineers Canada	

Representatives from the four Townships were also invited but were unable to attend.

One of the outcomes of the meeting was that participants identified the need for localized and detailed climate projections in order to guide further work, help frame the issue for consideration by Area Municipal and Regional Councils as well as to engage other stakeholders. Participants agreed that it would be more efficient and cost effective to work collaboratively rather than for each jurisdiction to prepare its own research.

Stakeholder consultation conducted earlier in 2015, as part of the Region's Strategic Planning process, identified community concerns arising from changing climate conditions and extreme weather. These concerns resulted in the inclusion of climate adaptation planning within the Region's new Strategic Plan as well as similar recognition in the three Cities' strategic plans.

The Region and the Cities of Cambridge, Kitchener and Waterloo collaborated with the University of Waterloo's Interdisciplinary Centre on Climate Change to conduct research on modelled climate projections for Waterloo Region in order to help support local climate adaptation planning efforts. An overview of the research study is enclosed below.

Research on Local Climate Projections in Waterloo Region

The University of Waterloo's Interdisciplinary Centre on Climate Change has recently completed research on climate projections for Waterloo Region compared to parameters observed over the past 30 years. The purpose of the report is to summarize information on various climate parameters for our area which will inform climate adaptation planning.

The report contains localized projections based on both historical weather data for the area and an ensemble of climate models. Projections for a number of different climate parameters are provided for three time periods: 2011-2040, 2041-2070 and 2071-2100 in comparison to historical records for the 1981-2010 period. It should be noted that the comparison period may be conservative as it does not include earlier climate norms from the 1951-1980 period.

The climate parameters studied within the research included:

- mean temperature (annual mean temperature, monthly mean temperature)
- extreme temperature thresholds (extreme heat, extreme cold, days below freezing and freeze-thaw cycles)
- degree days (heating demand, cooling demand, growing degree days)
- total precipitation (total annual and seasonal precipitation, days with precipitation, snowfall, freezing rain, wet and dry spells, precipitation return periods)
- wind gusts

The projections for each time period also cover three different future GHG emission scenarios:

1. A net-zero carbon emission scenario that would be necessary to limit global warming to two degrees Celsius;
2. An aggressive emission reduction scenario consistent with current emission reduction pledges of countries; and,
3. A business-as-usual (BAU) emission scenario

It is noted within the study that the BAU scenario is the current trajectory based on the most recent historical records of global GHG emissions.

The climate in Waterloo Region and beyond is changing. Localized climate projections indicate that there will be further changes over the next several decades. A sampling of modeled outcomes include:

- An expectation of 40% more freezing rain events by the period 2041-2070;
- Rainfall intensities to increase with large-magnitude rainfall events expected to occur more frequently across all scenarios and time periods;
- An increase in extreme heat days (temperatures over 30 degrees) from the current 10 days to 32 under the BAU scenario by 2041-2070, and then nearly double again to 60 days by the 2071-2100 period; and
- More wind gust events are expected as both large-scale frontal storms and local convective windstorms (i.e. damaging downdrafts) are projected to occur more frequently.

The full research study outlines some of the implications as a result of these changes such as potential for high damage costs to property and buildings, substantial power outages and service disruptions to transportation networks and water infrastructure along with health impacts from prolonged heat waves. The Executive Summary of the study entitled Localized Climate Projections for Waterloo Region is attached as Appendix A.

Proposed Next Steps

The University of Waterloo study provides a picture of what climate change may mean locally, and a basis upon which to examine risk and vulnerabilities. The research compiled by the University informs climate adaptation planning at corporate and regional community scales. It will be shared with staff involved in asset management and infrastructure master planning within the Region and Area Municipalities. The Cities and Region are currently exploring options to complete a coordinated approach to climate adaptation planning that would involve other region-wide agencies (emergency management, GRCA, etc.)

During November 2015, the three City Councils received the University of Waterloo report and presentation. City staff is encouraging support through appropriate channels for a coordinated approach to conduct climate adaptation planning in collaboration with the Region as a way to address overlapping service areas and interests. If this initiative is funded through the approval of the 2016 City and Regional Budgets, staff would prepare terms of reference using a framework suitable for Canadian municipalities. The terms of reference would be submitted for consideration by the respective Councils in the spring of 2016.

Area Municipal Consultation/Coordination

Staff at the Cities of Cambridge, Kitchener and Waterloo are working closely with Regional staff on this initiative and were consulted in the preparation of this report. Township staff will continually be invited to participate at their discretion and ability.

Corporate Strategic Plan:

Investigating localized climate projections supports Strategic Objective 3.4 of the Environment and Sustainable Growth Focus Area to “Improve the Region of Waterloo’s resilience to climate change and /or severe weather.”

Financial Implications:

The Region’s portion of the University of Waterloo Climate Projection Study cost is included in the approved 2015 Planning Capital Program under Community Sustainability (project 22036) to be funded from Revenue (Taxation) (100%, \$7,100). A Budget Issue Paper for Climate Adaptation Planning has been endorsed by the Region’s Corporate Leadership Team for consideration by Regional Council as part of the 2016 budget process.

Other Department Consultations/Concurrence:

Regional staff working on Asset Management within Transportation and Environmental Services as well as the Manager of Risk Management have been consulted in the preparation of this report.

Attachments:

Attachment A – Localized Climate Projections for Waterloo Region, Executive Summary –
October 2015

Prepared By: David Roewade, Sustainability Planner

Approved By: Rob Horne, Commissioner, Planning, Development and Legislative Services

Attachment A

Localized Climate Projections for Waterloo Region



Executive Summary – October 2015

Prepared by:



Prepared for:



Cover photos:

- Top: The rooftop of the Seagram Lofts provides a bird's eye view of a deadly thunderstorm rolling in over Uptown Waterloo on September 5, 2014. Credit: Jason Thistlethwaite
- Bottom left: Hail in Waterloo Region on August 2, 2015. Credit: Jason Thistlethwaite
- Bottom right: Flash flooding at Fairview Park Mall in Kitchener on June 28, 2013. Credit: Driveseat Kitchener via CTV News Kitchener

Contributors:

- Alex Cadel, Candidate for Master of Climate Change, University of Waterloo
- Sarah Brown, Interdisciplinary Centre on Climate Change, University of Waterloo
- Dr. Chris Fletcher, Department of Geography, University of Waterloo
- Dr. Daniel Scott, Department of Geography, University of Waterloo
- Dr. Jason Thistlethwaite, School of Environment, Enterprise & Development, University of Waterloo

Executive Summary

Addressing climate change is one of the global challenges of this century. Regions across Canada are experiencing changing climatic conditions such as higher average temperatures, new precipitation patterns, and increased frequency and severity of extreme weather events (e.g. heat waves, intense rainfall, and strong winds)¹. These changes are having a variety of impacts on ecosystems and everyday life in Canadian communities, including property damage and infrastructure failure during extreme events, shifting growing seasons, a range of economic losses (e.g., construction delays, crop damage, tourism patterns), increased health risks posed by extreme weather, and shifts in the ranges of pests and infectious disease.

Climate adaptation refers to measures taken to reduce the vulnerability of natural and human systems to actual or expected effects of climate change. In addition to efforts to mitigate climate change by reducing greenhouse gas (GHG) emissions, the importance of climate adaptation is rising across Canada. Municipalities are being called upon to respond to vulnerabilities exposed by current changing conditions and recent extreme weather events, as well as to prepare for both risks and opportunities that may arise given longer-term local climate impacts. The City of Windsor and the City of Toronto, for example, have developed climate adaptation plans that were driven largely in response to extreme heat and urban flooding pressures affecting their respective communities. To enable effective adaptation planning and action that builds community resilience, it is imperative for municipal decision-makers to have access to locally relevant and robust climate projections that examine how temperature and precipitation are expected to change in the future.

The effort to develop localized climate projections for Waterloo Region was initiated in response to the need expressed by municipal staff to gain a greater understanding of climate-related risks that are relevant to our region as a means to inform municipal strategic and collaborative planning. The University of Waterloo's Interdisciplinary Centre on Climate Change (IC3) prepared this report to contribute to ongoing climate collaborations on climate action between the Cities of Cambridge, Kitchener, and Waterloo, and the Region of Waterloo. The purpose of the report is to summarize information on projected climate change for our local region that could aid in advancing a local dialogue on climate adaptation planning and extreme weather resilience.

How are localized climate projections developed?

The process of developing climate projections uses both historical weather data for this region as well as an ensemble of climate models, which provide the best available scientific assessment of how future social and economic conditions will influence the global climate system and climate in this region.

¹ Warren, F.J. and Lemmen, D.S., editors (2014): Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation; Government of Canada, Ottawa, ON, 286p.

For Waterloo Region, projections for a number of climate parameters of interest to municipal stakeholders (e.g. monthly mean temperature, seasonal precipitation) have been provided for three different time periods: the 2020s, 2050s, and 2080s (respectively covering the years of: 2011---2040, 2041---2070, and 2071---2100). The projected changes in climate are relative to historical data from the 1990s (1981---2010) as the baseline (or “observed”) period. Across each of these time periods, three different future GHG emissions scenarios are examined:

- A net---zero carbon emission scenario that would be necessary to limit global warming to 2°C;
- An aggressive emission reduction scenario consistent with the emission reduction pledges of countries; and,
- A business---as---usual (BAU) emission trajectory.

Our current trajectory as a global society is in line with the BAU scenario, and recent global efforts to curb GHG emissions have not yet been substantial enough to deviate from this path. The other two scenarios considered here are still plausible; however, substantial international commitment will be required to reduce emissions to the levels on which those scenarios are based.

Which climate conditions are projected to change in Waterloo Region, by how much, and by when?

Temperature:

- Annual mean temperature is projected to increase by about 2-3°C by the 2050s across all emission scenarios.
- Increases in monthly temperatures are projected to be the most marked throughout the winter and into early summer (see Table ES1). For example, under all scenarios the monthly mean temperature in February in 2050s is expected to be 3---5°C warmer than it is today, pushing the average temperature for the month closer to, or slightly above, 0°C.
- Currently, the region experiences around 10 days per year with extreme heat (daily maximum temperature exceeding 30°C). Under a BAU scenario, the number of days with extreme heat is projected to more than triple to 32 days by the 2050s, and then nearly double again to 60 days by the 2080s (see Figure ES1).
- Currently, around 22 days per year are observed with extremely cold temperatures (daily minimum temperature lower than ---15°C). A reduction in the number of extremely cold days is projected under all scenarios, with less than half as many extreme cold days occurring in the 2020s as were recorded during the 1990s, and further reductions occurring over the rest of the century (as few as 6 days by the 2080s under a BAU scenario).

Table ES1: Range of projected changes for Waterloo Region by the 2050s compared to the 1990s

Scenario	Temperature Change (°C)		Precipitation Change (%)	
	Summer	Winter	Summer	Winter
Net-zero carbon	+ 1.1 to 2.1	+ 1.1 to 2.9	6.3 to 21.5%	--5.0 to 17.1%
Aggressive mitigation	+ 1.6 to 2.6	+ 1.8 to 3.7	--3.8 to 22.2%	6.1 to 20.4%
Business-as-usual	+ 2.8 to 3.5	+ 2.8 to 4.4	5.5 to 25%	4.7 to 26.9%

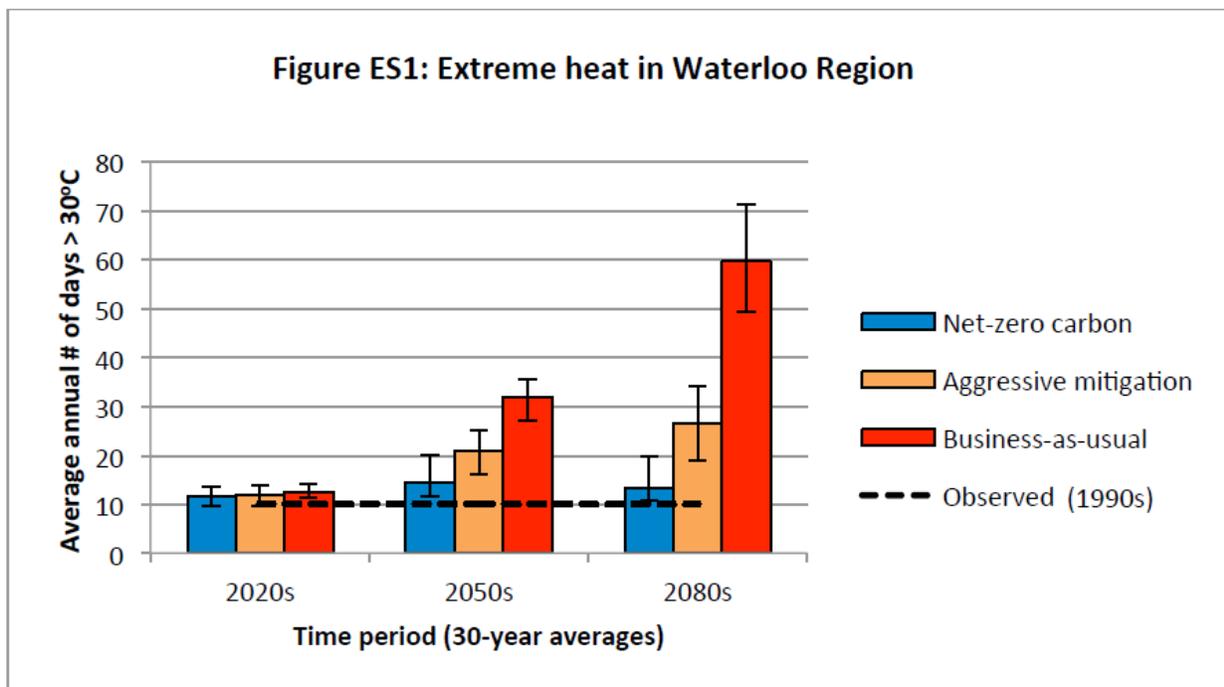


Figure ES1 demonstrates the average annual number of days projected to reach extreme heat conditions, which is defined as days where maximum air temperatures reach or exceed 30°C. These values are shown in comparison to the observed average value (10 days) for the 1990s period. Error bars represent the range of uncertainty for the multi-model ensemble.

Precipitation:

- Total annual precipitation is projected to increase by approximately 4---6% by the 2020s, and by approximately 8---12% in the 2050s and 2080s (see Table ES1).
- Seasonally, the largest precipitation increases are expected in winter, spring, and summer, although the magnitude of change in summer is associated with the largest range of uncertainty due to a lack of consensus between climate models.

- Increased amounts of precipitation are likely to initially result in increases in total annual snow in the 2020s, yet into the 2050s and 2080s, warmer winter temperatures are likely to cause less precipitation to fall in the form of snow, compared to today's climate.
- In Southern Ontario, the months of December, January, and February are expected to experience 40% more freezing rain events by the 2050s, and 45% more freezing rain events by the 2080s.
- Rainfall intensities are projected to increase across all scenarios and time periods, with large-magnitude rainfall events expected to occur more frequently than in the historical record. If the variability of precipitation events does not change, then climate change is projected to slightly decrease the frequency of 6-day dry spells from an average of 14 to 13 events occurring per year by the 2050s.

Wind:

- More wind gust events are expected in Southern Ontario by the end of the century, as both large-scale frontal storms and local convective windstorms are projected to occur more frequently.

What action can be taken at the municipal level to respond to these projected changes?

Successful adaptation to climate change requires a robust range of projections on how the local climate is expected to evolve as well as an understanding of the remaining scientific uncertainties. Projections can be considered the starting point towards developing a shared base of information upon which to develop a plan and specific responses or projects. Having access to future scenarios of what climate is expected to look like in Waterloo Region is one of the foundational steps of an adaptation planning process, along with identifying stakeholders and assessing current climate impacts (both risks and opportunities). Using localized climate projections and other community knowledge as inputs, a full assessment of potential impacts and vulnerability across community assets and services can begin.