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Niagara Region Climate Change Projections
PDS 2-2023

Regional Council, at its meeting held on February 23, 2023, passed the following recommendation of its Planning and Economic Development Committee:

That Report PDS 2-2023, dated February 15, 2023, respecting Niagara Region Climate Change Projections, **BE RECEIVED** and **BE CIRCULATED** to Local Area Municipalities, the Niagara Peninsula Conservation Authority (NPCA) and Niagara Adapts.

A copy of PDS 2-2023 is enclosed for your reference.

Yours truly,

Ann-Marie Norio
Regional Clerk
js

CLK-C 2023-022

cc: Susan McPetrie, Planner, Planning & Development Services
Michelle Sergi, Commissioner, Planning & Development Services
Nicole Oakes, Executive Assistant to the Commissioner, Planning and Development Services

Distribution List:

Local Area Municipalities
Niagara Peninsula Conservation Authority (NPCA)
Niagara Adapts

Subject: Niagara Region Climate Change Projections

Report to: Planning and Economic Development Committee

Report date: Wednesday, February 15, 2023

Recommendations

1. That Report PDS 2-2023 **BE RECEIVED** for information; and

2. That a copy of Report PDS 2-2023 **BE CIRCULATED** to the Local Area Municipalities, the Niagara Peninsula Conservation Authority (NPCA) and Niagara Adapts.

Key Facts

- The purpose of this report is to provide an overview and a summary of key findings of the Climate Modeling and Projections project completed by the Ontario Climate Consortium (OCC) on behalf of Niagara Region.

- Niagara Region retained the OCC in February of 2021 to deliver:
  - a climate projections report, including an analysis of regional climate trends and impacts on economic sectors (Appendix 1); and

  - a training session for staff and interested parties to build capacity and facilitate integration of the climate data into future projects, policies and initiatives.

- The OCC modelled region-specific climate data for various climate parameters in the short-term (2021-2050) and the long-term (2051-2080), relative to baseline values (1971-2000), using both a business-as-usual (increasing greenhouse gas emissions) scenario and a stabilized emissions scenario.

- Based on the analysis completed by the OCC, under the business-as-usual scenario, Niagara Region is expected to experience a wetter and warmer climate with more extreme precipitation and temperature events, which may pose threats to the health of communities, natural systems, infrastructure, agriculture, economy, and services within the region.

- The projections provide critical data about Niagara's changing climate that can be used to inform the planning and implementation of strategies to help communities prepare for the impacts of climate change. This data was also used to inform the policies of the newly approved Niagara Official Plan.

Financial Considerations

There are no financial considerations directly related to this report. The costs associated with completing the Climate Modeling and Projections project were accommodated within the Council approved project budget for the Niagara Official Plan (NOP) (2017-2021).

Analysis

Climate models use computer programs to simulate the earth's weather patterns over time and generate predictions about future climate conditions under different scenarios, such as increasing greenhouse gas emissions. These predictions provide data that can inform the planning and implementation of adaptation strategies to help communities prepare for the impacts of climate change.

In January 2021, the Planning and Economic Development Committee endorsed an updated climate change work program for the new NOP (PDS 6-2021). A key pillar of that work program was to develop regional climate models and projections as a means of providing critical data about Niagara's changing climate, which can be used to inform policy decisions at the Regional and local municipal levels.

Project Overview and Milestones

Niagara Region engaged the OCC, a branch of the Toronto and Region Conservation Authority, as the technical lead on the Climate Modeling and Projections project, with the NPCA as a project partner. Work began on the study in February 2021.

The project work plan included two key deliverables:

- The first was a climate projections report that provided an overview of the methodology, an analysis of predicted climate trends and impacts throughout the region, as well as maps and graphs for key climate variables. The report also included discussion of the differences between climate projections for Niagara's northern and southern regions.

- The second deliverable was a training session for staff and other interested parties to help enhance understanding of the climate data and how this information can be applied and integrated into future work. Upon completion of the climate projections report, a training session was held for Regional, local and NPCA staff on February 15, 2022. The presentation slides and a recording of the session were made publicly available on Niagara Region's Official Plan website (www.niagararegion.ca/official-plan/).

In addition to the report and training session, the project team also held working sessions to confirm the methodology and climate parameters used in the project and to provide preliminary findings for comment and feedback. Local area municipalities and agencies were invited to participate in the sessions.

One of these sessions included a meeting with the Brock University staff members leading Niagara Adapts, a partnership between the University and municipalities in the region focused on climate change adaptation planning.

Methodology

Using an ensemble of climate models, the OCC developed region-specific projections for selected climate parameters for short-term (2021-2050) and long-term (2051-2080) periods, and compared them to values for a baseline (1971-2000) period. There were 52 climate parameters analyzed including, mean annual temperature, annual average number of days above 35 degrees Celsius, annual average number of days below -20 degrees Celsius, total average annual precipitation and maximum precipitation in one day.

For each of the future periods, short- and long-term, the climate data were modelled for two different socio-economic scenarios of greenhouse gas emissions: business-as-usual and stabilized emissions. The business-as-usual scenario projects continued increases to greenhouse gas concentrations beyond the end of this century. In the stabilized scenario, emissions would decline by mid-century and then stabilize by 2100. This scenario assumes implementation of climate policies limiting emissions and shifts in the current energy and transportation system. Given the challenges in anticipating global climate action, the climate projections report focuses on the business-as-usual scenario results and includes summary tables for the stabilized scenario in an appendix.

Results

The tables in this section provide a summary of findings for key climate parameters under the business-as-usual emissions scenario. A full description and discussion of the projections for all 52 climate parameters analyzed in the project is contained in the Climate Projections for Niagara Region report in Appendix 1.

Temperature

Based on the analysis completed by the OCC, daily mean, maximum and minimum temperatures are expected to increase throughout Niagara (Table 2). The region will likely experience an average annual temperature increase of 2 degrees Celsius from the baseline to short-term climate period and 3.6 degrees Celsius from the baseline to long-term climate period. The most significant impact will be observed in areas in the northwest portion of the region, where average annual temperatures are expected to be the highest in all three climate periods.

Increasing winter temperatures will result in more variable weather, including the timing and amount of precipitation and an increasing shift from snowfall to rainfall. Rainfall during winter months, when soils may be frozen and less permeable to infiltration, can contribute to more runoff and flooding conditions.

Table 1: Daily Mean, Maximum and Minimum Temperature Projections for the Business-as-Usual Emissions Scenario for the Niagara Region

Climate Parameters	Baseline (1971-2000) (ºC)	Short-Term (2021-2050) (ºC)	Long-Term (2051-2080) (ºC)	Trend
Mean Annual Temperature	8.7	10.7	12.3	Increasing
Summer Mean Maximum Daily Air Temperature	24.9	26.7	28.4	Increasing
Winter Mean Maximum Daily Air Temperature	0.7	3.3	4.7	Increasing
Summer Mean Minimum Daily Air Temperature	15.23	17.1	18.6	Increasing
Winter Mean Minimum Daily Air Temperature	-7.09	-5.0	-2.3	Increasing

During the summer, increased temperatures will result in more extreme heat days where temperatures are above 30 degrees Celsius. The number of days above 30 degrees Celsius is projected to increase from 10.4 days per year in the baseline period to 23.9 days per year in the short-term and 39.4 days per year in long-term (Table 3). Extreme heat events can intensify existing health conditions and trigger a variety of heat-stress conditions, particularly in vulnerable populations.

Extreme cold conditions are expected decline. Annual average minimum daily temperatures will increase from the baseline period by 1 to 3 degrees Celsius during 2021-2050 and by 3 to 4.5 degrees Celsius during the 2051-2080 climate period. The number of days below -10 degrees Celsius is expected to decrease from 32.4 days per year in the baseline period to 20.3 days per year in the short-term and 7.6 days per year in the long-term (Table 3). Increasing temperatures in both the winter and summer, may have ecological impacts, including reduced habitat suitability and an increase in the northward migration of invasive species.

Table 2: Extreme Temperature Projections for the Business-as-Usual Emissions Scenario for the Niagara Region

Climate Parameters	Baseline (1971-2000) (days/year)	Short-Term (2021-2050) (days/year)	Long-Term (2051-2080) (days/year)	Trend
Days Above 35ºC	0.3	2.1	7.1	Increasing
Days Above 30ºC	10.4	23.9	39.4	Increasing
Days Above 25ºC	53.5	77.7	95.8	Increasing
Tropical Nights (days with min. temps. above 20ºC)	9.4	24.5	46.2	Increasing
Days Below -20ºC	4.2	2.2	0.1	Decreasing
Days Below -15ºC	12.3	6.5	1.0	Decreasing
Days Below -10ºC	32.4	20.3	7.6	Decreasing
Days Below 0ºC	125.1	105.7	83.8	Decreasing

Precipitation

Total precipitation is projected to increase over the next two climate periods (2020-2051 and 2051- 2080) relative to the baseline (Table 4). An increase between 0.1 – 0.9 mm and 0.2 – 1 mm is expected for the short and long-term future periods, respectively. The southern part of the region has a higher annual precipitation than northern areas across all climate periods. However, the northern part of the region will see a slightly higher increase (12 per cent) in precipitation than the southern region (11 per cent).

The maximum precipitation falling in one day is expected to increase by about 10 per cent in the long-term period. The maximum amount of precipitation falling over three consecutive days is expected to increase by 6 per cent from the baseline to the long-term period. The frequency of extreme precipitation days (i.e., daily precipitation greater than 25 mm) is projected to increase by 21 per cent and 47 per cent in the short and long-term periods, respectively, relative to the baseline (Table 4).

These extreme precipitation events can lead to flooding, riverbank erosion, negative impacts on water quality and infrastructure damage. In particular, heavy precipitation combined with warmer temperatures in the winter may result in greater runoff and flooding due to the potentially frozen ground.

Table 3: Precipitation Projections for the Business-as-Usual Emissions Scenario for the Niagara Region

Climate Parameters	Baseline (1971-2000)	Short-Term (2021-2050)	Long-Term (2051-2080)	Trend
Total Average Annual Precipitation (mm)	1080.6	1135.0	1192.0	Increasing
Maximum Precipitation in 1 day (mm)	70.7	72.7	78.1	Increasing
Maximum Precipitation in 3 days (mm)	112.4	109.3	119.5	Increasing
Extreme Precipitation Days (# days/year where precipitation exceeds 25 mm)	4.8	5.8	7.1	Increasing

Agricultural Parameters

The results from the growing season analysis indicate that the total increase from 1971-2000 to 2051-2080 in the growing season will be approximately 15 days under the business-as-usual emissions scenario (Table 5). However, the modeling showed occurrence of cold snaps following onset of the growing season and instances of warmer temperatures returning after the growing season end day. Therefore, growing season length will be impacted by the ability of the crops to withstand temperature fluctuations.

With the temperature rise, the region is expected to have more ideal days for growing crops including corn, canola, forage crops and beans. The number of Growing Degree Days above zero degrees Celsius are predicted to increase by 30 per cent by the long-term future climate period (2051-2080) compared to the baseline period (1971 -2000). However, with an increase in temperature comes the risk of more pests. The number of Growing Degree Days for pest occurrence in the region is expected to increase two-fold by the long-term climate period compared to the baseline period (Table 5).

Table 4: Projections for Agricultural Parameters for the Business-as-Usual Emissions Scenario for the Niagara Region

Climate Parameters	Baseline (1971-2000)	Short-Term (2021-2050)	Long-Term (2051-2080)	Trend
Growing Season Length (days/year) (annual # of days after 5 consecutive days above 5^{o}C and before 5 consecutive days below 5^{o}C)	186	194	201	Increasing
Growing Degree Days (days/year) (index of the amount of heat available for the growth and maturation of plants and insects)	3584.1	4104.0	4641.7	Increasing
Growing Degree Days at Risk of Presence of Pests (days/year)	594.2	911.9	1128.2	Increasing
Freeze-Thaw Cycles (events/year)	76.6	67.4	55.8	Decreasing
Ice Potential (days/year)	19.0	16.1	11.7	Decreasing

With increased temperatures, it is expected that there will be fewer freeze-thaw cycles and less occurrence of ice. The freeze-thaw cycle in the region is expected to decline by 27 per cent during the long-term climate period compared to the baseline period. Ice potential is predicted to decrease over 35 per cent from the baseline until the long-term climate period (Table 5). While there may be an overall increase in growing season length, the expected increase in intense heat and precipitation events, as well as the increased presence of pests, may post a risk to crops and have a negative impact on production.

Next Steps

In September of 2021, Regional Council passed a motion declaring a climate change emergency. The Climate Modeling and Projections project provides critical information that will support policies and action to respond and adapt to this emergency. This dataset will be shared with Regional staff and local area municipalities and agencies (i.e. Niagara Adapts, NPCA), to ensure that policy-makers and resource managers have access to a consistent source of information to support decisions.

At the Regional level, the climate data has already been utilized by Niagara Region's Public Health and Emergency Services to complete the 2022 Assessment of Health Impacts and Vulnerabilities Due to Climate Change report. The report draws on the climate predictions to identify expected health impacts for Niagara residents and the adaptive capacity to respond to these impacts. Corporate Strategy and Innovation have also used the climate projections to support development of new corporate greenhouse gas emission reduction targets.

In March 2023, staff are bringing a climate change report to Council on the Region's process on the 2021 climate change emergency declaration items, the Partner's for Climate Protection program, new greenhouse gas emission targets and community partnerships and engagement.

As identified in the NOP, the climate projections will be used to inform an assessment of climate change vulnerabilities throughout the region, such as risks to infrastructure, natural features and resources. The NOP also identifies that the climate data will inform the development and implementation of a climate change adaptation strategy to prepare for and mitigate the impacts of climate change.

With the increasing need to consider the impacts of climate change on Regional services and operations, the climate projections data will play a critical role in planning for anticipated changes and identifying opportunities to increase climate resilience.

Alternatives Reviewed

This report is prepared for information only; therefore, no alternatives are provided.

Relationship to Council Strategic Priorities

The information in this report relates to the following Council strategic priorities:

- Priority 2: Healthy and Vibrant Communities
    - Objective 2.1 Enhance Community Well-Being
- Priority 3: Responsible Growth and Infrastructure Planning
    - Objective 3.2 Environmental Sustainability and Stewardship
    - Objective 3.3 Maintain Existing Infrastructure

Other Pertinent Reports

- PDS 22-2018 Climate Change Framework
- PDS 6-2021 Climate Change Work Program Update
- PDS 17-2021 Niagara Official Plan Consolidated Policy Report
- PDS-C 31-2021 Niagara Climate Modeling Project Update

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Appendices

Appendix 1 Climate Projections for Niagara Region (https://www.niagararegion.ca/official-plan/pdf/climate-projections.pdf)