Toronto and Region Conservation Authority

Niagara Region Climate Modeling Project:
Climate Change Projections for Niagara Region

1. Project Team

Staff	Affiliation	Project Position
Michelle Sawka	Senior Research Scientist, Ecosystem and Climate Science, TRCA Michelle.sawka@trca.ca	Project Sponsor
Kristina Dokoska	Project Coordinator, Ontario Climate Consortium (OCC) Secretariat, Ecosystem and Climate Science, TRCA Kristina.dokoska@trca.ca	Project Lead
Neil Taylor	Research Analyst, Ecosystem and Climate Science, TRCA Neil.taylor@trca.ca	Technical Support

2. Purpose and Outcomes

2.1 Issue

It is widely acknowledged that "warming of the climate system is unequivocal, and since the 1950's, many of the observed changes are unprecedented over decades to millennia" (IPCC, 2013). Best practices in climate science and atmospheric modeling at the global scale tell us that climate impacts are expected to worsen across the world, with warming temperatures, more extreme weather events, and changes in precipitation patterns, among other climatic changes that are driving increased risks and impacts on communities and the systems they rely upon. This reaffirms the need to operationalize climate change research and information, particularly to ensure that decisions are well-grounded in climate science. As the former Environmental Commissioner of Ontario stated in a 2015 expert roundtable report, "climate change adaptation requires high-quality climate data, especially projections about what the future climate may look like in a specific geographic area" (ECO, 2015).

There is growing demand for municipalities to address climate change at the local scale. In Ontario, Provincial policies also require municipalities to consider climate change impacts as part of policies and plans such as Official Plans and Asset Management Plans. A number of municipalities in Ontario have undertaken climate modeling exercises to understand how local climate conditions have changed in the past and what local climate conditions will look like in the future (e.g., Auld et al., 2016; Fausto et al., 2015; SENES 2012; SENES 2014). However, the approaches used have been wide-ranging and inconsistent.

To enhance the way in which we examine projected future climates and apply a consistent approach across the region, the Toronto and Region Conservation Authority (TRCA) and Ontario Climate Consortium (OCC) partnered with the Region of Durham to update the Region's climate projections and provide an updated methodology for

deriving the climate projections based on the latest climate science and information. Using an ensemble of Regional Climate Models (RCMs), this project provided a new set of climate projections for the Region, its eight local municipalities and five conservation authorities, along with a guidance document referred to as the *Guide to Conducting a Climate Change Analysis at the Local Scale: Lessons Learned from Durham Region* (2020). The guidance document provides a step-by-step methodology for deriving regional climate projections that can be replicated in municipalities across Ontario, including Niagara Region, to establish a consistent and practical approach to accessing, analyzing and deriving climate data for use by municipalities, conservation authorities and other stakeholders.

With this context, Niagara Region has identified the need to develop regional climate projections using the updated methodology provided by TRCA and OCC to support the implementation of climate adaptation initiatives across the Region. The climate projections will help to inform several projects including the Regional Official Plan update, development of future climate adaptation plans and vulnerability assessments, and updates to watershed and subwatershed plans. Niagara Region has also identified the need to transfer knowledge to staff to facilitate better understand how these climate projections can be applied in their day-to-day work to help build capacity and expertise.

2.0 Anticipated Outputs and Outcomes

Outcomes	Outputs
Region-specific climate projections that replicate the best practice approach for climate change analysis outlined in the *Guide to Conducting a Climate Change Analysis: Lessons Learned from Durham Region* (2020). This approach will produce a range of climate projections for the short, mid and long term, including extremes and averages.	• A climate projections report that includes an overview of the methodology, analysis of the climate projections and its impacts on different sectors (e.g., natural environment, socio-economic, etc.), as well as maps and graphs for key climate variables • Climate model output in the format of data summary tables based on agreed climate parameters • Research on climate change impacts on key sectors
Enhanced understanding and mainstreaming of climate data	• Knowledge transfer session(s) for Regional staff to present the climate change data and transfer knowledge to staff on potential application of the climate projections for adaptation and resilience initiatives, as well as integration into day-to-day work • Other deliverables include presentation slides and recordings of session(s) held online

3. Proposed Methodology

The following provides an overview of the proposed methodology to be utilized by TRCA's Climate Program to achieve the outcomes identified in the previous section.

Obtain Historical and Future Climate Data: As a first step, TRCA will download historical and future climate data from the NA-CORDEX climate portal. TRCA will also identify, locate and download all climate stations in and around Niagara Region that contain a complete 30-year record of historical data.

Present Methodology and Confirm Climate Parameters: TRCA will present the climate modeling process and list of climate parameters to Niagara Region staff and stakeholders. TRCA will facilitate a discussion to obtain consensus on the climate parameters (eg., average temperature, precipitation, growing season length, etc.) that will be analyzed.

Undertake a Historical Characterization: TRCA will analyze climate trends for the baseline period (1971-2000). The analysis will include spatial, seasonal, and temporal trends. TRCA will also undertake a bias correction process to reduce the uncertainty in the historical climate projections.

Produce a Future Climate Analysis: TRCA will model the future climate data, conducting a bias correction to the future climate projections to reduce uncertainty. The future climate analysis will also examine spatial, seasonal and temporal trends.

Develop Climate Data Summary Tables: It is proposed that as part of the climate modeling outputs, TRCA will develop climate data summary tables based on agreed climate parameters. Climate data summary tables will be provided for each time period (historical, as well as short, medium, and long-term future) for both the RCP 8.5 (business-as-usual) and RCP 4.5 (stabilized) emission scenarios. TRCA will develop a Region-wide climate data summary table, along with three (3) additional climate summaries to describe and further distinguish climate trends for north, central, and southern Niagara Region, which can be used by the lower-tier municipalities.

Produce a Final Climate Projections Report: TRCA will develop a climate projections report for use by Niagara Region. The report will feature the methodology used to derive the projections, an analysis of the climate projections and its impact on key sectors within Niagara Region (e.g., natural systems, agriculture, wine production, etc.), how the climate projections can be applied for practical use, as well as maps and graphs for key climate parameters. The key sectors will be further scoped with Niagara Region staff upon commencement of the project.

Knowledge Transfer to Regional Staff: TRCA will provide one knowledge transfer session for Niagara Region staff to demonstrate the results of the climate projections, how the climate data can be used, and how it can be applied to various initiatives. The content and number of sessions can be further scoped with Niagara to ensure it reflects the needs of the Region.

4.0 Detailed Workplan and Timelines

Tasks	January 2021	February 2021	March 2021	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
1. Methodology Development										
Draft a methodological approach in the form of a flow chart diagram, clearly indicating data inputs and outputs, analysis components, and engagement processes to be followed		▓								
Develop slides in preparation for the Niagara Region staff and stakeholder meeting, including climate modeling process, climate stations to be used, and ideal climate parameters to confirm among stakeholders		▓								
Send draft methodology and slides for review and comment by Niagara Region staff prior to meeting			▓							
Present methodology, list of proposed climate parameters and next steps at the Niagara Region staff and stakeholder meeting. The objectives of the meeting are to a) seek consensus on deliverables of the project and b) seek consensus on climate parameter selection			▓							
2. Applying the Methodology: Historical and Future Climate Analysis										
Identify, locate and download raw climate station time series			▓							
Obtain gridded climate data (e.g., CANGRD) for re-interpolation			▓							
Quality control climate data time series and fill in data gaps			▓							
Undertake historical trend analysis and include baseline period (seasonal, annual, spatial)			▓	▓						

Tasks	January 2021	February 2021	March 2021	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
Download and/or obtain climate model output for historical and future periods				■						
Determine anomalies in climate conditions and bias correct climate data				■						
Write all scripts to determine climate parameters as confirmed by Niagara Region, run scripts and QA/QC results to ensure accuracy					■					
Analyze future trends (seasonal, average, annual, extremes) and produce statistics in 10-year intervals, to be aggregated up to 30-yr normal periods					■					
Based on historical and future data above, produce a series of graphs and maps to illustrate conditions						■				
Synthesize preliminary results in climate projections report for review						■				
Research climate change impacts on key sectors						■				
Circulate preliminary results for review/reference prior to Niagara Region staff and stakeholder meeting in June							■			
3. Revising Analysis & Developing the Climate Projections Report										
Host a meeting with Niagara Region, present preliminary analysis results and facilitate a discussion of needed refinement/revisions on analysis							■			
Comments received from Niagara Region							■			
Incorporate and address comments on analysis results from Niagara Region and stakeholders							■	■		
Draft Climate Projections Report								■		
Circulate climate projections report to Niagara staff for review, comment and input								■		

Tasks	January 2021	February 2021	March 2021	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021
Incorporate comments and revise climate projections report to produce final version										
4. Knowledge Transfer Session(s) and Climate Data Wrap-Up										
Schedule knowledge transfer session(s) (e.g., doodle polls, invitations, stakeholder communications)										
Logistics (including webinar setup, invitations, reminder emails)										
Draft final presentation slides based on project findings and circulate to Niagara										
Presentation and delivery										
Submit all final materials including climate data summary tables, climate projections report, presentation recordings										
Niagara Region to present project outputs & results to Regional committees and groups and other interested organizations (TBD)										

5.0 Budget and Justification

5.1 Proposed Budget

The following table (see next page) provides a detailed summary of the proposed budget.

5.2 Justification

All costs have been estimated based on standard cost recovery charge-out rates, which include overhead and applicable fees. Travel expenses are not included in hourly budget and these are planned to be provided in-kind by project team members.

Task	Hours Allocated			Estimated Costs (Niagara Region)
	TRCA Climate Program Staff			
	Senior Research Scientist ($108.37/hr)	Project Coordinator ($63.22/hr)	Research Analyst ($72.24/hr)	
1. Methodology Development				
Outcomes for this deliverable include: a) Drafting the methodological approach, including data inputs and outputs, analysis components, and engagement process b) Preparing the presentation for the Niagara Region staff and stakeholder meeting including climate modeling process and climate parameters to be confirmed by stakeholders c) Presenting the draft methodology and list of climate parameters and seek consensus on model content and outcomes	5hrs	35hrs	5hrs	$3,115.75
2. Applying the Methodology: Historical and Future Climate Analysis				
Outcomes for this deliverable include: a) Locate and download raw climate station time series and obtain gridded climate data (i.e., CANGRID) for re-interpolation b) Quality control climate data time series and fill in data gaps c) Undertake a historical trend analysis including the baseline period d) Download and obtain climate model output for historical and future periods e) Determine anomalies in climate conditions and bias correct climate data f) Write all scripts to determine climate parameters as confirmed by, run scripts and QA/QC results to ensure accuracy g) Analyze future trends (seasonal, average, annual, extremes) and produce statistics in 10-year intervals aggregated to 30-year normal periods h) Produce a series of maps ad graphs to illustrate conditions i) Synthesize preliminary results in summary document for review (i.e., summary tables (4 total)) j) Research climate change impacts on key sectors in Niagara Region	5hrs	70hrs	320hrs	$28,084.05
3. Revising Analysis & Developing the Climate Projections Report				
Outcomes for this deliverable include: a) Present preliminary results to Niagara Region b) Develop climate projections report c) Incorporate and address comments from Niagara Region staff and stakeholders d) Develop draft climate projections report and circulate to Niagara Region e) Incorporate comments from Niagara Region and produce final report	5hrs	60hrs	5hrs	$4,696.25

Task	Hours Allocated			Estimated Costs (Niagara Region)
	TRCA Climate Program Staff			
	Senior Research Scientist ($108.37/hr)	Project Coordinator ($63.22/hr)	Research Analyst ($72.24/hr)	
4. Knowledge Transfer Session and Climate Data Wrap-Up				

Outcome for this deliverable include:
  a) Draft final presentation slides
  b) Revise/finalize slide deck
  c) Deliver knowledge transfer session to Niagara Region staff
  d) Submit all climate data, final climate projections report, and knowledge transfer session recording
	5hrs	35hr	5hrs	$3,115.75

Totals:	**20 hours**	**200 hours**	**335 hours**	**$39,011.80**

Supplemental Information

6.0 References

Auld, H., Switzman, H., Comer, N., Eng, S., Hazen, S., and Milner, G. 2016. Climate Trends and Future Projections in the Region of Peel. Ontario Climate Consortium: Toronto, ON: pp.103

Environmental Commissioner of Ontario (ECO). 2015. Connecting the Dots on Climate Data in Ontario. Available online: http://docs.assets.eco.on.ca/reports/other-publications/2015/2015CDRoundtableReport.pdf

Fausto, E., Milner, G., Nikolic, V., Briley, L., Basile, S., Behan, K., and Trainor, E. 2015. Historical and Future Climate Trends in York Region. Ontario Climate Consortium: Toronto, ON: pp.48

Intergovernmental Panel on Climate Change (2013). Summary for Policymakers. In T. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. Midgley (eds.), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

McDermid, J. SK. Dickin, C.L Winsborough, H. Switzman, S. Barr, J.A. Gleeson, G. Grantzberg, and P.A. Gray. (2015). State of Climate Change Science in the Great Lakes Basin: A Focus on Climatological, Hydrological and Ecological Effects. Prepared jointly by the Ontario Climate Consortium and Ontario Ministry of Natural Resources and Forestry to advise Annex 9 – Climate Change Impacts under the Great Lakes Water Quality Agreement.

Ministry of Natural Resources and Forestry. (2014). Climate Change and Natural Resources. Government of Ontario. Retrieved from: https://www.ontario.ca/page/climate-change-and-natural-resources.

SENES Consultants Ltd. 2012. Toronto's Future Weather & Climate Driver Study: Outcomes Report. Toronto, ON: pp. 15. Retried from: https://www.toronto.ca/wp-content/uploads/2018/04/982c-Torontos-Future-Weather-and-Climate-Drivers-Study-2012.pdf

SENES Consultants Ltd. 2014. Durham Region's Future Climate (2040 – 2049): Summary. Toronto, ON: pp. 15.

7.0 Project Team Members CVs

The members of the project team have a wide range of experience and skills. The one page resumes below reflect their experience that is directly related to the project in this proposal.

MICHELLE SAWKA

PROJECT RELEVANT EXPERIENCE:

SENIOR RESEARCH SCIENTIST, ECOSYSTEM AND CLIMATE SCIENCE| TORONTO AND REGION CONSERVATION AUTHORITY: 2013 - Present

- Manages the multi-stakeholder Green Infrastructure Ontario Coalition, including conducting policy analysis, business planning, governance, budgeting, major task oversight, and communications.
- Leads and coordinates scoping, planning, analysis, and communication of green infrastructure policy reviews and strategic research projects.
- Oversees the Ontario Climate Consortium, including guiding research projects.
- Builds relationships with transdisciplinary partners to build trust and influence to drive execution toward common green infrastructure and climate goals.
- Presents regularly to a wide range of audiences.
- Oversees the preparation of technical reports and briefing notes on environmental, economic, social, and health implications of green infrastructure, climate change, and urban forestry.

PROJECT ASSISTANT, INSTITUTE FOR SOCIAL AND ENVIRONMENTAL TRANSITION: 2011

- Researched and programmed an Excel-based tool to assist development of a resilience guidance framework for the Asian Cities Climate Change Resilience Network project.
- Developed graphic material on the Urban Resilience Network for display in reports and presentations to municipal planners and project stakeholders

PROJECT RELEVANT EDUCATION:

Master of Applied Science | 2011 | Ryerson University

· Environmental Science and Management

Bachelor of Science | 2009 | University of British Columbia

· Major: Physical Geography (Hydrology and Biogeography)
· Minor: Biology

KRISTINA DOKOSKA

PROJECT RELEVANT EXPERIENCE:

PROJECT COORDINATOR, ONTARIO CLIMATE CONSORTIUM (OCC), TORONTO AND REGION CONSERVATION AUTHORITY: 2018 – Present

- Provide expertise on a project-specific basis (e.g., Durham Region Climate Modeling project)
- Undertake subject-appropriate research related to climate change adaptation planning and best practice review
- Assist in organizing and facilitating various workshops related to climate change adaptation, as well as delivering presentations and webinars
- Provide expertise around the nexus between planning, climate change, natural systems and reducing climate risks
- Liaise with internal experts and project partners on the completion of partnership research projects or initiatives
- Prepare plans, draft reports for review and circulation to external experts, stakeholders and Steering Committees

RESEARCH ANALYST, ONTARIO CLIMATE CONSORTIUM, NOV 2017 – APRIL 2018

- Document the integration of climate change considerations in environmental policies and plans in Durham Region
- Research best practices for the integration of climate change information within the assessed policies and plans
- Identify a consistent approach to updating the policies and plans based on best available science and best practices
- Deliver a presentation to the Natural Environment and Climate Change Collaborative (NECCC) and Durham Community Climate Adaptation Plan (DCCAP) Steering Committee
- Prepare a final report on the use of a consistent approach for policy/plan integration in Durham Region

PROJECT RELEVANT EDUCATION:

YORK UNIVERSITY (2019)
Master of Environmental Studies (Environmental Planning)

UNIVERSITY OF TORONTO (2015)
Bachelor of Arts in Environmental Geography, Specialist (B.A.)

NEIL TAYLOR

PROJECT RELEVANT EXPERIENCE:

RESEARCH ANALYST, TORONTO AND REGION CONSERVATION AUTHORITY: 2016 – Present

- Leading funding proposals to advance strategic priorities of TRCA and its municipal partners with respect to protection of wetlands and aquatic ecosystems from impacts of stormwater and climate change
- Providing downscaled, bias-corrected climate change projection data to external partners
- Producing geospatial layers to map estimated relative vulnerability of terrestrial ecosystems to climate change across TRCA jurisdiction
- Overseeing data collection, management, and analysis for wetland hydrology monitoring network, including supervising seasonal staff and hiring interns
- Communicating scientific information regarding watershed and climate change science to specialist and generalist audiences via watershed plans, at conferences, and in reports to funding agencies, municipal partners, and Board of Directors
- Building collaborative research partnerships in ecohydrology with Toronto area universities, neighbouring conservation authorities, and municipal staff

FIELD AND LABORATORY RESEARCHER, UNIVERSITY OF WATERLOO: 2012 – 2014

- Published and presented research on water balances and carbon cycling in restored wetlands
- Developed fieldwork plans and budgets for two four-month field seasons, supervised field assistants
- Constructed and programmed meteorological station, installed wells, collected water and soil samples at study sites to inform thesis research questions
- Modeled peatland hydrology to determine plant recolonization thresholds using HYDRUS-1D software

PROJECT RELEVANT EDUCATION:

UNIVERSITY OF WATERLOO (2014)

Master of Science (Physical Geography / Hydrology)

MCGILL UNIVERSITY (2010)

Bachelor of Arts (Double Major, Physical Geography and History)