

Executive Summary

Climate change is one of the greatest challenges of our time. Rising atmospheric concentrations of greenhouse gases are altering the earth's climate, driving increases in global average temperatures and variability and extremes of weather. These changes are causing unprecedented impacts, transforming ecosystem structure and function, damaging infrastructure, disrupting business operations, and imposing harm to human health and well-being. Physical climate impacts and risks to human, natural and built systems in Ontario are driven by average annual warming temperature and extreme heat, drought, changes to intensity and frequency of precipitation and other climate variables. Avoiding or reducing the worst impacts of human-induced climate change requires action on parallel fronts: rapid and deep reductions in greenhouse gas emissions and proactive and planned measures to adapt to current and imminent future changes. While there are adaptation efforts underway to address these impacts, the rapid pace of climate change requires large scale, accelerated action in all facets of our society and economy.

The Ontario Provincial Climate Change Impact Assessment (PCCIA) provides an overview of impacts, including risks and opportunities, that stem from a changing climate. This report presents results of the comprehensive and multi-sectoral assessment of potential climate change-related impacts that underscore the understanding of how and where climate change may affect Ontario's economy, infrastructure, communities, public health and safety, and ecosystems, and provides the impetus for adaptation planning and resilience action across the province. The PCCIA establishes a foundation of impacts against which future assessments can be compared and provides a methodological model for future province-wide studies. Methods used in the PCCIA can also inform derivative assessments of climate change impacts at, for example, regional, watershed, sectoral scales. The PCCIA and its related products can be considered one of many sources of information to inform adaptation decisions and priorities across Ontario sectors and sub-regions.

The assessment was designed to utilize known best current practice for climate change risk assessment with methods grounded in International Standards (ISO 31000 and 14090). The assessment employed a diversity of knowledge, research and skills in areas that include climatology, thematic subject-matter, risk assessment, engagement and communications, socio-economics and geospatial expertise. The process included targeted and broad engagement and sought validation from an Impact Assessment Inter-Ministerial Advisory Committee (IAIC) and external stakeholders. There was also a dedicated initiative to engage with Indigenous organizations across Ontario. In total, more than 250 partners and subject-matter experts were actively engaged over the course of the PCCIA.

The impact assessment was conducted across five Areas of Focus and in six regions that cover the entire province (Far North, Northeast, Northwest, Eastern, Central and Southwest). The five Areas of Focus for the PCCIA include:



Sub-themes for each Area of Focus were developed to enable assessment at finer levels of granularity as noted by Level 1 and 2 categories. Direct impacts were assessed for frequency, consequence and likelihood, and indirect impacts were qualitatively identified and characterized, within Level 1 and 2 categories.

The PCCIA process and results are reported as main sections of this report. Section 1.0 provides a summary of the project context and goals of the impact assessment. An overview of the approaches used to assess climate change impacts and capacity, as well as limitations associated with the PCCIA is included in Section 2.0. A characterization of Ontario’s historical and future climate conditions, including the climate information used to inform the assessment of impacts is summarized in Section 3.0. Socio-economic modeling and projections used to support the impact assessment can be found in Section 4.0.

The findings for each Area of Focus are included under the following sections:

- Section 5.0 – Food and Agriculture
- Section 6.0 – Infrastructure
- Section 7.0 – Natural Environment
- Section 8.0 – People and Communities
- Section 9.0 – Business and Economy

The characterization of current and future climate change impacts that stretch across and between Areas of Focus are labeled as ‘cross-sectoral’ and is provided in Section 10.0. Finally, Section 11.0 summarizes recommended next steps for Ontario to advance adaptation and build capacity to respond to the identified impacts.

What are the key findings of the PCCIA?

More than 3,400 risk scenarios were developed and analyzed as part of the PCCIA. Risk scores were calculated in levels or layers through a step-wise process, then totaled and rolled up into the relevant Level 1 and 2 categories.

Risk scores were assigned for current, mid-century (2050s) and end of century (2080s) time periods. When evaluating the consequences of an impact, ratings of 'very low', 'low', 'medium', 'high', and 'very high' were used. Depending on the Area of Focus, different categories were used to assess consequences in relation to a single risk scenario. Consequences were assessed based on consideration of one or more of the following categories:

- Impacts to Human Health and Safety
- Environmental Damage
- Disruption of Services
- Financial Loss

Based on the consequence of impact, likelihood of occurrence, and frequency of the associated climate variable, risk scores were determined for categories assessed for every Area of Focus and applicable region of Ontario. A summary of risk scores for Level 1 categories is provided below in Table 1.0.

Climate conditions and events driving the highest climate risks differ depending on the timeframe, Area of Focus, and region of the province being assessed. Overall, extreme heat, extreme precipitation and seasonal temperature-related impacts are the drivers of highest risks across Ontario. However, wildfire, drought conditions and seasonal precipitation were also found to be particularly impactful for future time periods in certain regions and Areas of Focus. A summary of key takeaways for each Area of Focus is provided below.

Food and Agriculture

While changes in particular climate conditions (e.g. low temperature) may present stable or even declining risk scores for specific commodities and regions, any potential opportunities are likely to be offset by negative impacts, resulting in declining productivity, crop failure, and livestock fatalities. Several commodities, particularly in the southern regions of the province, are expected to face 'very high' climate risks by the end of the century.

Infrastructure

Existing infrastructure condition pressures combined with a changing climate will drive mid- to long-term challenges in managing Ontario's infrastructure. Not a single asset included in this assessment is considered to have a risk profile less than 'medium' under current climate conditions. Across most regions and asset types, this risk is expected to rise in the future by

mid-century (2050s). Risks may be amplified by existing interdependencies between infrastructure types, triggering cascading impacts across systems.

Natural Environment

Climate change is already causing significant changes to Ontario's natural environment, and risks to species, habitats, and ecosystems, will continue to rise into the future. The impact assessment finds that risk profiles across almost all natural systems and species assessed are rising to 'high' by mid-century. By the end of century, one quarter of these are expected to be 'very high'. Regional differences are important to recognize, with human development enhancing risks in regions further south, and an accelerated rate of climatic changes driving risks in northern regions of Ontario.

People and Communities

The PCCIA finds that climate risks are highest among Ontario's most vulnerable populations and will continue to amplify existing disparities and inequities. Climate risks to Indigenous Communities and associated systems are found to be significant based on additional layers of sensitivity and exposure.

Business and Economy

Climate impacts, and the associated economic shocks will not be uniform across Ontario. The impact assessment finds that most Ontario businesses will face increased risks due to climate change, with the largest increases in risk expected for businesses dependent on natural resource systems and where historical infrastructure deficits exist.

Cross-Sectoral Themes

To represent the inherent connectedness and complex interactions between Areas of Focus, cross-sectoral analyses were conducted and summarized in Section 10.0. The cross-sectoral evaluation centered around human populations and impacts were viewed through an equity lens which highlighted unique factors or populations that may be disproportionately impacted. The cross-sectoral impacts are qualitatively characterized under five broad themes:

- Food security
- Water security
- Energy security
- Human health, safety, and well-being
- Community function

Identifying Adaptation Priorities

Climate change adaptation enabling factors, noted as Adaptive Capacity, were also included in the PCCIA. The categories of Adaptive Capacity included technology, resource availability, sector complexity, equity, and governance. Based on the risk scores derived from this impact assessment and identified levels of capacity, adaptation priorities are identified for each Area of Focus (Sections 5.0 – 9.0), in regions and sectors where risks are highest, and capacity is lowest.

Moving Forward

The PCCIA has produced a number of products aimed at improving knowledge and capacity and stimulating adaptation action across Ontario. This report and each of the accompanying PCCIA products are complimentary to one another and are founded in the findings presented in this report. The external products are identified and referenced in the following section.

The information gained from the PCCIA is not meant to be an endpoint, and it is important to recognize how these findings can be used to spur action to protect residents, ecosystems, businesses and communities across Ontario. As such, key findings should be aligned and used to inform policies, programs, research, and investment decisions moving forward. A next step in this process could be to evaluate specifically how risk results can be used to accelerate adaptation at various scales and in various sectors and systems across Ontario.

Table 1.0: Current and Future Climate Risk Summary for PCCIA Areas of Focus (RCP8.5)

Risk Table Legend		
Risk	Most at Risk Regions Abbreviations ¹	
Low	FN	Far North
Medium	NE	Northeast
High	NW	Northwest
Very High	E	Eastern
	C	Central
	SW	Southwest

¹ 'Most at risk regions' are those that display highest risk scores operating under RCP8.5 (high emissions scenario). For more details on regional risk breakdown by Level 1 category, see Appendix 9.

Food and Agriculture Area of Focus				
Level 1 Categories	Risk			Most at Risk Regions
	Current	2050s	2080s	
Field Crops				C, E, SW
Fruits and Vegetables				C, E, SW
Livestock				C, E, SW
Infrastructure Area of Focus				
Level 1 Categories	Risk			Most at Risk Regions
	Current	2050s	2080s	
Buildings				SW, FN
Pipeline Transportation				All
Stormwater Management				All
Transportation				C, E, SW, NE, NW
Utilities				All
Waste Management				C, E, SW, NE, NW
Natural Environment Area of Focus				
Level 1 Categories	Risk			Most at Risk Regions
	Current	2050s	2080s	
Fauna				C, SW
Flora				SW
Aquatic Ecosystems				C, NE, NW, FN
Terrestrial Ecosystems				All
Regulating Services				C, NE, FN
Provisioning Services				C, SW, E
Ecosystem Cultural Services				NE, NW
People and Communities Area of Focus				
Level 1 Categories	Risk			Most at Risk Regions
	Current	2050s	2080s	
Population				C, E, SW
Health Care				SW
Social Assistance and Public Admin				E
Indigenous Communities				All

Business and Economy Area of Focus				
Level 1 Categories	Risk			Most at Risk Regions
	Current	2050s	2080s	
Accommodation and Food Services	Yellow	Yellow	Yellow	All
Arts, Entertainment and Recreation	Orange	Orange	Orange	C
Construction	Green	Green	Yellow	C, E, SW, NE, NW
Financial and Insurance	Yellow	Orange	Orange	All
Forestry, Fishing and Hunting Economies	Orange	Orange	Orange	All
Information and Cultural Industries	Green	Yellow	Yellow	All
Manufacturing	Green	Green	Yellow	All
Mining, Quarrying and Oil/Gas Extraction	Yellow	Yellow	Yellow	All
Retail Trade	Green	Green	Yellow	C, E, SW, NE, NW
Transportation Economy	Yellow	Yellow	Orange	C, E, SW, NE, NW
Utility Services	Yellow	Orange	Orange	FN

Executive Summary

In the past two decades, climate science established with high confidence that the rise in global temperatures, as highlighted by the Intergovernmental Panel on Climate Change (IPCC), has contributed to a changing climate. As a result, a wide array of rapid-onset extreme weather events such as forest fires, severe storms, and floods, have increased in intensity and frequency. Alongside these events, there is also an increase in slower-onset natural hazards including the spread of disease vectors, droughts, and elevated temperatures.

These accelerated changes in the climate system have intensified impacts on communities and are expected to continue to pose significant risks to human health and well-being. Public health units play a critical role in reducing climate-related health risks, and addressing these risks requires a focus on enhancing the resilience of communities and systems through adaptation strategies. To better understand these risks and vulnerabilities specific to health, public health agencies across Canada and the world are conducting climate change and health vulnerability assessments. The data and evidence in these reports help to inform public health action.

Climate change projections and climate-related health impacts in southern Ontario

Southern Ontario has already witnessed notable climate changes over the past two decades, including an increase in the average annual air temperature in the province of between 1 to 1.5°C over the past century (Ministry of the Environment, Conservation, and Parks, 2023).

Given these changes to the regional and global climate, and the resulting impacts the region is already experiencing, and which will intensify, SWPH in collaboration with the University of Waterloo's Climate Institute, has conducted an assessment of the vulnerability of communities in the region to the health impacts of climate change. This report summarizes this assessment, which drew on a comprehensive review of existing climate change health vulnerability assessments in the province, academic literature, partner engagements, and expert contributions to analyze and present recommendations.

The report outlines various projected climate change impacts in the region, including extreme temperatures, extreme weather events, vector-borne diseases, air quality, and ultraviolet radiation. For example, a recent review by SWPH indicates that by the 2080s, Oxford and Elgin Counties and the City of St. Thomas can expect a significant increase in the number of days surpassing 32°C, which pose serious heat-related risks to the community, underscoring the need for prevention and preparedness in the region. Rising temperatures and shifting precipitation patterns have already led to an increase in the frequency of forest fires during the summer months and to seasonal changes in air quality.

Moreover, the likelihood of winter floods, slippery conditions, and flash freeze events is expected to rise due to increased precipitation during the colder months, particularly in heavy rainfall events. It is projected that Oxford and Elgin Counties and the City of St. Thomas could experience an increase in extremely wet days, from the baseline of 8 days to 11 days by the 2080s, heightening the risk of flooding and its impacts on communities.

Additionally, indirect climate-associated changes, such as the increased presence of vector-borne and zoonotic diseases, are anticipated to pose risks to public health in the region, leading to an increase in diseases like Lyme disease and West Nile Virus (WNV).

A growing body of knowledge and experience is showing that climate change is impacting psychosocial health, including creating anticipatory fear before disasters and through post-disaster trauma, and a growing sense of loss, sorrow, grief and abandonment (Van Susteren, L., and Al-Delaimy, 2020; Miller et al., 2023). New evidence has also shown other harmful outcomes, including direct links between increased high temperatures and the number of suicides (Lawrance et al., 2021). These impacts and the approaches to addressing them are an important focus of this assessment.

Vulnerable populations

These climate change-associated hazards and environmental changes present a series of health risks, particularly affecting vulnerable populations. The impacts of climate-related health risks are not experienced equally by all populations. The report identifies vulnerable populations in the SWPH region such as Amish communities, immigrants, Indigenous communities, older adults, those experiencing homelessness, and others, who may experience heightened susceptibility to climate-related health risks. This is due to a combination of factors, such as elevated levels of exposure from working conditions, limited access to health resources and advice in different languages, age or structural barriers which have historically left populations vulnerable to the different impacts.

Adaptive Actions

SWPH has already initiated actions to address climate-related health impacts and reduce risks through strategic collaboration with a wide array of partners across the public, private, and non-profit sectors. Collaborations with groups such as Health Equity Partners, the Social Determinants of Health Nurses Group, and the Low German Speaking Mennonite Community of Practice aim to reach individuals living in vulnerable conditions in the region. Furthermore, the implementation of initiatives, such as tracking heat and cold-related emergency visits and hospitalizations, as well as the establishment of RAVE Alerts, an early warning system, demonstrates a proactive approach to protect vulnerable residents.

Recognizing the importance of social connectivity in building social capital, SWPH actively participates in local community and neighbourhood groups, councils, and coalitions to enhance social connections. Efforts are underway to develop a Priority Populations Engagement Strategy focusing on specific populations, such as older adults, to address health inequities.

Actionable recommendations

Considering climate change projections for the region and the growing intensity of changes already taking place, there is a pressing need for further action. Through a review of provincial health assessments, a series of stakeholder engagements, and contributions from experts, several recommendations were identified that can strengthen coordination internally as well as externally to improve communication and strategically support climate action.

Seven recommendations were mapped, with a list of over 100 concrete activities, to chart the course for action for SWPH and local partners for the implementation of climate adaptation strategies and approaches aimed at reducing health risks from a changing climate.

- 1. Develop a comprehensive and co-produced risk reduction and prevention strategy for extreme weather conditions.** The strategy would encompass all climate-related natural hazards, including extreme heat and cold temperatures. It would incorporate a specific inventory of everyday actions to reduce health risks for vulnerable populations. It would also outline a partnership roadmap and objectives to support action plans.
- 2. Review and enhance coordination mechanisms with area municipalities on land use planning.** SWPH would undertake a systematic and rigorous assessment to determine where enhanced coordination would be most beneficial to support climate-related objectives. This analysis can build on the risk reduction and prevention strategy for extreme weather and serve as an avenue to pilot solutions that will help strengthen and refine intra-organizational coordination mechanisms.
- 3. Build and strengthen partnerships with agencies, organizations, and individuals beyond jurisdictional boundaries.** SWPH would seek to leverage a broader range of skill sets, capacities, and resources at the municipal, regional, provincial, and federal levels. These partnerships can accelerate progress on actions outlined in this report, particularly in the context of tools, expertise, technology sharing, advocacy for policy change, and harmonizing relevant policies.
- 4. Create a communications plan to share up-to-date data on health risk information with recommendations.** SWPH would develop a comprehensive communication plan for the public to protect against health impacts from climate change. This includes air quality data and warnings, beach pollution data and warnings, and, heat and cold weather warnings. Communication is best when targeted and accessible, taking into account language considerations and different population sub-groups.
- 5. Establish a monitoring and evaluation framework to assess the impact of climate actions and interventions.** This framework would include the establishment of baseline data on health impacts in the region and link to data on climate-related hazards. It would outline ongoing monitoring of a series of indicators that would be used to, understand risk and opportunities, track progress, and make evidence-based decisions. The framework would establish routine monitoring and evaluation with the community, including vulnerable groups, to assess impact and ensure equitable participation in climate action.
- 6. Promote and advocate for social capital building activities.** SWPH would promote and advocate for activities that build the social capital of local organizations and communities to support the implementation of actions that will address many of the health risks associated with climate change, including psychosocial dimensions such as worry, anxiety, and concern for the future.
- 7. Develop a climate-compatible sustainable food system strategy.** SWPH can support integrated community action toward a more resilient food system. The strategy may

include but is not limited to, developing a climate change food supply and disaster risk management plan, reducing food waste (household, schools, and community settings), supporting sustainable diets in community settings, providing knowledge exchange opportunities for community partners on the impact of climate change on food systems, and advocating for local and provincial-level policies to support sustainable food systems.

These recommendations emphasize the need for a strong focus on knowledge sharing and translation to enhance equitable climate adaptation solutions. They also highlight the importance of expanding the scope of partnerships to harness complementary skills, resources, and capacities and emphasizing the value of utilizing available tools to inform evidence-based decisions within SWPH.

This report underscores the urgency of addressing climate change impacts on health, particularly for vulnerable populations, and emphasizes the importance of proactive measures to enhance resilience and promote equity. Overall, the report serves as a vital resource for understanding and mitigating the health risks posed by climate change in the SWPH region, guiding policymakers, public health and partners in implementing effective adaptation and resilience strategies to safeguard community well-being.