



Growing Resilience

**Durham Region Agriculture Sector Climate Adaptation Strategy - 2019
An Addendum to the Durham Community Climate Adaptation Plan (2016)**

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Mitigation versus Adaptation

- Mitigation is reducing greenhouse gas emissions to “avoid the unmanageable”.
- Adaptation is taking action to reduce vulnerability to “manage the unavoidable”.

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Executive Summary



Durham Region is a leading agricultural producer, with the largest Gross Domestic Product from agriculture of the Greater Toronto Area municipalities. In 2017, Durham Region contributed \$321.7 million to Ontario's total farm production. Durham is home to more than 1,300 farms, with a total farmland area of more than 118,497 hectares (292,815 acres).

Farming has always required continuous adaptation to seasonal variability and changing growing conditions. In 2013 Durham Region published Durham Region's Future Climate (the SENES Study), which used leading available climate modeling techniques to describe Durham Region's future climate up until 2049. The SENES Study projects that, over the coming decades, the climate in Durham will experience greater extremes in relation to both precipitation and temperatures. Some of these impacts are already being felt.

The development of the Durham Region Agricultural Sector Climate Adaptation Strategy was led by an Agricultural Sector Expert Task Force and took place between March 2018 and March 2019. Over 150 stakeholders, including Durham's area municipalities, the Provincial Government, academia, the Durham Agricultural Advisory Committee (DAAC), and the agricultural community were engaged through two broad stakeholder consultation processes.

This strategy is an addendum to the award winning 2016 Durham Community Climate Adaptation Plan and supports other strategies and plans, including the Durham Agricultural Strategy (2013-2018), the Durham Region Food Charter, and climate adaptation positions of the Ontario Federation of Agriculture and Canadian Federation of Agriculture.

The Strategy identifies anticipated risks to the local agricultural sector, resulting from a warmer, wetter and wilder climate with increased frequency of extreme weather events. These include risks to certain varieties of crops and yields; heat-related and other health risks for livestock and farm workers; flooding and storm water management; invasive species/pests; damage to public infrastructure, farm buildings and structures; concerns around electrical outages/capacity and emergency alerting and response systems. Many of these risks overlap with risks and impacts that will be faced by other sectors. Significant opportunity exists for collaboration around adaptation efforts. Cross-sectoral opportunities for collaboration have been identified as an Appendix to this Strategy.

It is important that Durham's agricultural sector is well informed and positioned to take advantage of potential opportunities and benefits related to a changing climate. At the same time, being prepared to proactively address the challenges.

Farmers are stewards of the land and play a critical role in climate resiliency through the implementation of best management practices. The Durham Region Agricultural Sector Climate Adaptation Strategy and Action Plan is intended to provide the members of the agricultural community with programs and tools to will help them to engage in and take advantage of climate change opportunities and successfully navigate extreme weather conditions. If Durham Region successfully adapts to climate change it will continue to have a thriving agricultural sector and a local food system that is strong and resilient.

The Region aims to support the local agricultural sector to adapt to climate change by: recognizing the agricultural diversity within the Region; understanding that impacts of climate change will be felt differently across agricultural sectors; and ensuring that program options are flexible and reflective of that diversity.

The ability of the local agricultural sector to adapt to climate change will rely on:

- A protected and healthy agricultural land base (i.e. amount of land, good quality soil).
- Resilient public and on-farm infrastructure.
- Education and knowledge (best management practices, community-based research).
- Communication (information sharing, partnerships, consideration of agriculture and overlap with the work of other sectors, advocacy on matters beyond local control).
- Economic capacity.

Durham's **Agricultural Sector Climate Adaptation Strategy** is centered on the following themes:

- Increase local education and awareness on agriculture and climate change adaptation.
- Build community and research capacity.
- Enhance policy support for agriculture and climate change adaptation.
- Address agricultural sector climate adaptation through DCCAP cross-sectoral programs and other Regional programs and initiatives.

Priority should be given to program options or initiatives that enhance adaptation for Durham's key agricultural sectors to achieve the greatest degree of protection. Partnerships and community-led initiatives will be the cornerstone of adaptation in the agricultural sector. It is extremely important that programs be packaged so they can be easily implemented by the agricultural sector.

This strategy includes an action plan—based on a preliminary assessment of resource requirements—that outlines short-term, priority activities. These recommended actions were developed collaboratively by the Region, lead agencies, and potential partners.

The actions address key theme areas and will assist the Region's agricultural sector in working toward climate adaptation and enhanced resiliency:

- Broad promotion of the Strategy (including a social media component).
- Ensuring consideration and integration of the Strategy in the review and ongoing implementation of various Regional and community plans and initiatives.
- Addressing sectoral overlaps and integration of agricultural considerations in the ongoing work of other Durham Community Climate Adaptation Plan (DCCAP) Working Groups.
- Ensuring updates to regional climate projections capture agricultural sector considerations; working with academic and research institutions to achieve more research presence in Durham around agriculture and climate change.
- Hosting events on the topic of climate adaptation and the agricultural sector.
- Developing or encouraging the development of guidelines for climate resilient agricultural structures.
- Initiating agricultural sector climate adaptation pilot projects and demonstrations with community partners and the agricultural industry.

Through consultation, several potential research topics, pilot projects, and informational sessions and workshops were identified. Not all of these items are possible or fall under the scope of the DCCAP. These ideas have been captured and included as an Appendix to the Strategy for reference purposes and to provide guidance for other stakeholders on possible contributions to agricultural sector adaptation efforts.

Implementation and continued monitoring of progress is expected to take place from Spring 2019 onward, in close collaboration with the other Sector Working Groups and under the guidance of the DCCAP Steering Committee and DAAC.



Introduction

The climate is changing both globally and locally in Durham. Climate projections indicate that Durham will experience significant climate changes before the middle of the century which can be summarized as “warmer, wetter and wilder.” This future climate poses risks to the infrastructure and economy of Durham Region and to the health and well-being of our residents. In response to this climate future, in 2016 Durham Region published the Durham Community Climate Adaptation Plan (DCCAP).

The DCCAP was created using rigorous research and consultation processes that incorporated the knowledge and perspectives of expert stakeholders from across Durham Region and beyond. Program decisions for the DCCAP were based on knowledge about our future climate, generated from the most accurate climate projections available at the time, provided by SENES Consultants. These projections cover the future period of 2040 to 2049. A summary is provided in Appendix 1.

The DCCAP contains 18 programs intended to help the Region adapt to future climate. These programs are separated into seven sectoral areas including: cross-sectoral, the building sector, the electrical sector, flooding, human health, roads and the natural environment. The plan also recommends developing climate adaptation strategies to ensure food security and a viable agriculture sector in Durham Region.

The DCCAP has been approved in principle by the Region, all eight local area municipalities, all five conservation authorities and three electrical utilities. In 2018, the Plan received the Federation of Canadian Municipalities (FCM) award for the best municipal climate plan in Canada.

The DCCAP and the work proposed in this draft strategy prioritizes enabling Durham Region to adapt to climate change. The Region of Durham is also working to mitigate climate change. In 2012, the Region published From Vision to Action: Region of Durham Community Climate Change Local Action Plan (LAP). The LAP proposes seven program areas intended to contribute to slowing climate change, protect the natural environment, enhance the economy and improve the quality of life of people living in Durham Region. Inherent aspects of the Agricultural Sector contribute to climate mitigation efforts including managing forests on land that is unsuited to cultivation and using updated farm technologies that limit the consumption of fossil fuels and petroleum-based industrial chemicals. Many of the adaptation initiatives proposed in this Strategy will contribute to mitigation efforts. However, the focus of this Strategy is limited to adaptation.

Durham Climate Adaptation Plan – Agricultural Sector Strategy Development

The agricultural sector is incredibly important to Durham Region’s social and economic fabric and will be significantly impacted by climate change. Therefore, the DCCAP recommended forming an agriculture sector taskforce to propose strategies to adapt to future climate in Durham Region. To that end, this project was initiated at the Climate Change and Extreme Weather Symposium on February 9, 2018, hosted by the Durham Agricultural Advisory Committee (DAAC), the Durham Environmental Advisory Committee (DEAC), and the Durham Region Roundtable on Climate Change (DRRCC).

Following the Symposium, an Expert Task Force was formed to provide input and guidance into the development of a regional climate adaptation strategy for the agricultural sector. The Region conducted an extensive literature scan, including academic research and review of other municipal climate adaptation strategies. Additionally, the Region partnered with Professor Kirby Calvert at the University of Guelph and his third-year Geography Course 3020, Global Environmental Change, to gain deeper insights into some of the risks associated with future climate in the agriculture sector in Durham Region. This Strategy represents an addendum to the DCCAP to include the agriculture sector in Durham Region’s plan to adapt to climate change.

Strategy Development Timeline and Major Milestones

Date	Milestone
February 9, 2018	Project kick-off at the Climate Change and Extreme Weather Symposium
Spring 2018	<ul style="list-style-type: none"> Established Expert Task Force Developed and finalized work plan Conducted preliminary risk analysis and background research
Summer 2018	Research and data collection (University of Guelph partnership)
September to November 2018	Program option development
October 2018	Circulation of preliminary risks and potential program options to stakeholders
December 2018 to January 2019	Circulation of draft strategy to all stakeholders for feedback
Spring 2019	Presentation of Draft Strategy to Agricultural Advisory Committees, DRRCC, and Regional Committee and Council
Summer 2019 and onward	Strategy implementation

Agriculture in Durham

An aerial photograph of a rural landscape in Durham, North Carolina. The scene is dominated by large, green agricultural fields, some of which are planted in rows of crops. A multi-lane highway runs horizontally across the middle of the image, with several white semi-trucks visible. A road cuts diagonally from the bottom left towards the top right, passing through the fields. In the foreground, there are several farm buildings, including a large white structure and a red barn. The background shows rolling green hills under a clear blue sky. A dark blue banner with white text is overlaid on the upper portion of the image.

Durham Region borders the County of Simcoe to the north, the City of Kawartha Lakes and Northumberland County to the east, the Region of York and City of Toronto to the west, and Lake Ontario to the south. Durham Region is the eastern gateway to the Greater Toronto Area (GTA). Durham Region is the upper-tier level of government, which includes eight area municipalities, including the towns of Ajax and Whitby, Municipality of Clarington, cities of Oshawa and Pickering, and townships of Brock, Scugog and Uxbridge. Over 80 per cent of Durham Region is covered by the provincial Greenbelt.



Durham Region has demonstrated a commitment to the agriculture and agri-food sector through A New Strategic Plan for Durham Region: 2015-2019; and the 2017-2021 Economic Development Strategy and Action Plan, ensuring that agriculture remains a strong and viable sector.

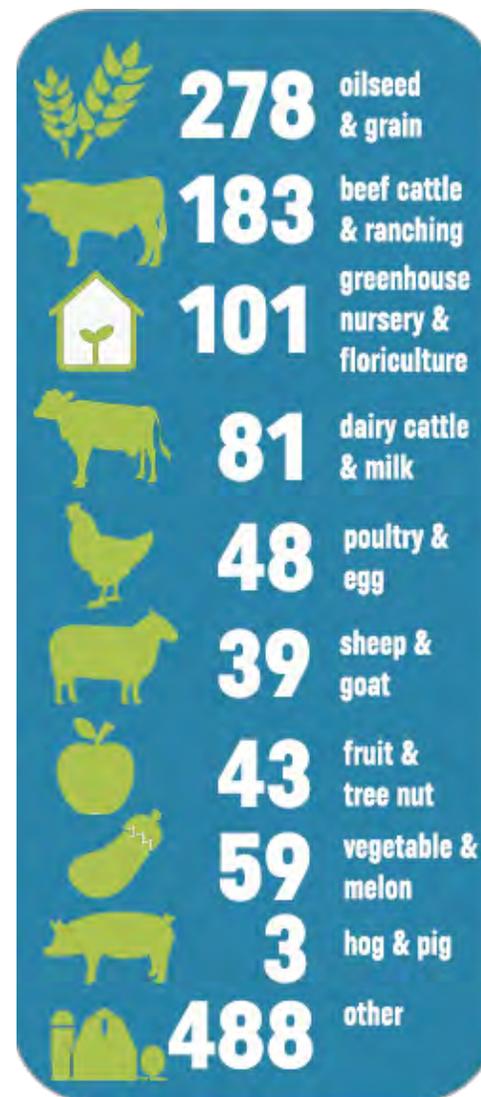
Durham is a leading producer with the largest GDP from agriculture of the GTA municipalities. In 2016, Durham Region contributed \$321.7 million to Ontario's total farm production. Durham is home to over 1,300 farms with a total farmland area of more than 118,497 hectares (292,815 acres).

Key agricultural sectors in Durham are:

- Oilseed and grain farming (corn, soybeans, and hay are the dominant crops in the Region).
- Cattle ranching and farming (beef and dairy).
- Greenhouse, nursery and floriculture production.
- Fruit and vegetable.
- Equine industry.

Across the Region, farmers and agricultural operators are already using and adopting best management practices and the latest technology to reduce environmental impacts and ensure continued viability of their land and agricultural operations.

Number of Farms in Durham Region by Industry Group, 2016





Anticipated Impacts of Climate Change on Agriculture in Durham Region

Farming has always required continuous adaptation to seasonal variability and changing growing conditions. The Region's SENES Study predicts that over the coming decades, the climate in Durham will become warmer, wetter, and wilder (an increased frequency of extreme weather events). Some of these impacts are already being felt.

Recent examples of extreme weather-related impacts to agriculture include the ice storm of December 2013 and the July 2018 tornado that came without warning and had severe effects, including the destruction of livestock facilities.

Increased temperatures could impact livestock health and crop yields. Power outages, due to extreme weather, would have significant impacts to farmers. Agricultural production, equipment and facilities are all vulnerable to climate-related impacts. There is also the risk of increase in pests and invasive species. For example, the western bean cut worm has affected corn producers and there has been an increase in the black-legged tick populations that can carry Lyme disease. Dealing with pests and invasive species raises the cost of production at a time where prices that farmers receive for their crops have been declining.

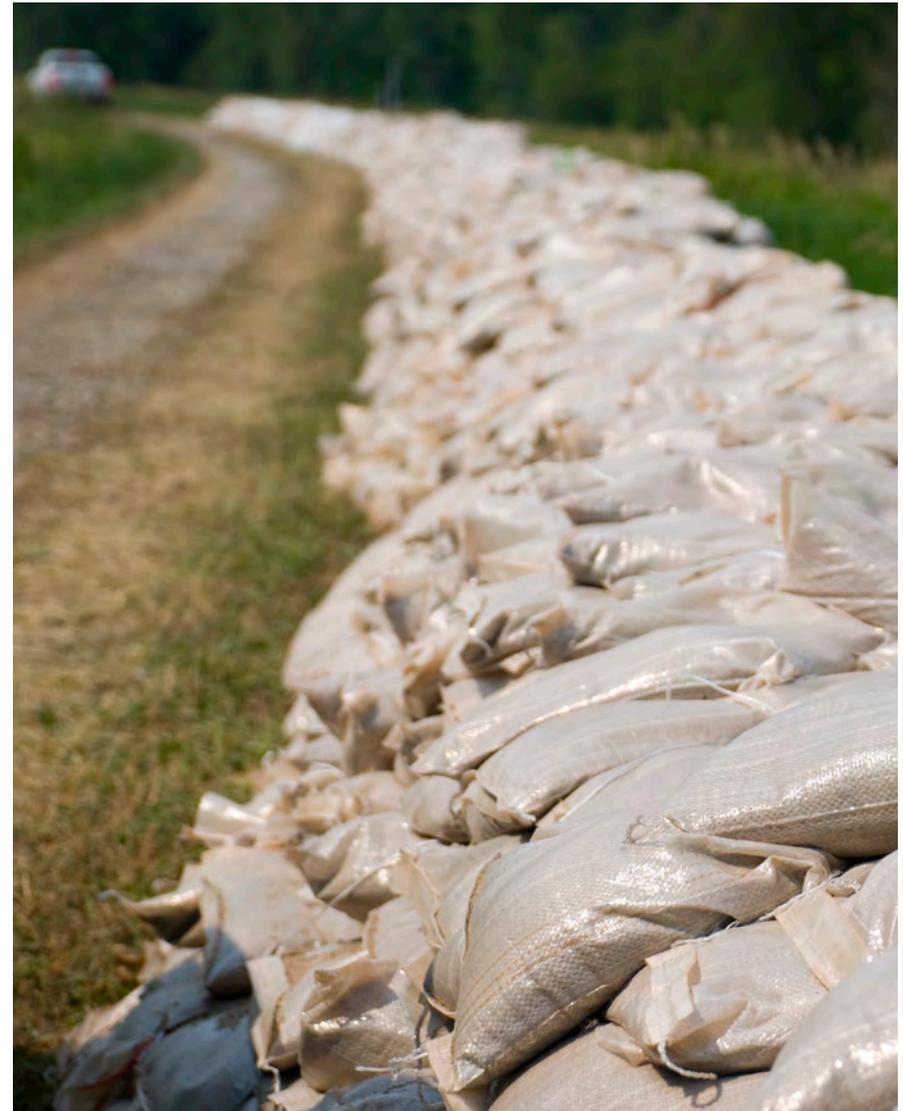
While climate change may increase risks for Durham's agricultural sector, there may also be opportunities. This could include increased crop yields, a longer growing season, and more options for growing different types of crops. It is important that the Region's agricultural sector is well-informed and well-positioned to take advantage of the potential opportunities and benefits of a changing climate. Farmers are stewards of the land and play a critical role in climate resiliency by using best farming practices.

Agriculture in Durham is diverse. Impacts will vary across different agricultural sectors and each sector will have different capacities from which to adapt. Climate change likely means that environmental best practices—adopted by the farm community—must continue to evolve to adapt to changing conditions.

For example, warming streams may mean that forested riparian buffers (areas along streams which include trees, shrubs, or grass) become even more important to protect critical aquatic habitats in the future. Similarly, the changing seasonal nature of runoff may mean that tile drain management may become critically important in managing water quality and quantity.

In 2018, the Region conducted a Local Food Business Retention and Expansion Survey. A significant majority of agricultural respondents anticipate changing their production practices to respond to changes in climate or the environment. Many local farmers indicated they have already been taking steps such as: diversification of crops and crop varieties, erosion management, using frost fans, and adjusting planting and harvesting schedules. There exists opportunity to learn from, build on, and share these local adaptation practices that are already taking place.

An initial step in developing this strategy was to identify anticipated impacts to Durham Region's agricultural sector, based on climate change. Impacts were initially identified by the Agriculture Task Force and enhanced through extensive consultation with local community stakeholders and summarized in the table on pages 16 and 17. It should be noted that the impacts listed below are not exhaustive and that the field of research around agriculture and climate change is only just emerging.



Durham Region Agricultural Sector Anticipated Climate Change Risks and Opportunities

Possible/Likely Associated Impacts of Warmer Weather

- Greater threat to livestock operations, especially with increased risk of power outages.
- Increased health risks for outdoor workers on farms.
- Stress to livestock health—need for increased/improved ventilation and cooling.
- Longer growing season—increased atmospheric CO₂ and nitrogen, as well as a longer growing season, may boost yields or allow for additional plantings of some crops such as corn, soybeans, wheat and other cash crops.
- Inconsistencies in growing season.
- Greater yields for some crops.
- More diverse and newer resilient varieties of crops possible.
- Risk of loss of cooler weather crops.
- New or greater proliferation of pests/diseases e.g. bean leaf beetle, European corn borer—agricultural sector will need to manage.

Possible/Likely Associated Impacts of Wetter Weather

- Loss of crops and feed due to flooding, overwatering, mold and mildew, etc.
- Capacity of watercourses to handle higher flows—many headwater drainage features and smaller watercourses in agricultural areas may be especially vulnerable to short duration, more intense storms (wilder).
- Increased health risks from standing water.
- Erosion from flooding and loss of nutrients (including potential effects on water quality because of agricultural run-off of fertilizers and pesticides).
- Capacity of infrastructure (e.g. ditches, roads, culverts) to handle increased volumes of water, including in the non-growing season, and extreme weather variability.
- Increased need for absorption on the land (need to explore adaptive measures including cover crops, improved soil quality—increased organic matter, reducing tillage (for increased water absorption), enhanced tree canopy/natural heritage system, and tile drainage).
- Need for improvements of legacy stormwater management features throughout agricultural lands, including adaptation of older stormwater pond(s) to increase quantity and quality control capabilities including new dual irrigation/drainage systems.

Possible/Likely Associated Impacts of Wilder Weather

- Need for more resilient agricultural buildings—beyond current building standards (Building Code), particularly to address wind and snow load hazards to agricultural facilities.
- Need for more comprehensive stormwater management throughout agricultural lands to optimize capture and re-use opportunities, to off-set changes in rainfall-runoff patterns due to climate change this should include consideration of green infrastructure.
- Increased episodes of unpredictable freeze/thaw (flooding—excess water, crop damage, impacts to nutrient cycling including larger annual losses of nitrogen) and ice storms resulting in loss of crops and could potentially damage critical infrastructure (hydro, roads, wastewater facilities).
- Potential for reduction of effectiveness of herbicides and pesticides.
- Wind damage to farm buildings, infrastructure, crops, and aeolian topsoil erosion/loss.
- Increased need for resilient communications infrastructure and emergency response alerting.
- Access to food in extreme weather events:
 - Ensuring rural residents/the agricultural community has access to food.
 - Addressing lack of local food processing facilities.
 - Ensuring availability and access to feed for livestock.



Agriculture and Climate Change Policy Context and Alignment



Beyond the local DCCAP, climate change is addressed in provincial policy, including the 2014 Provincial Policy Statement, provincial land use plans (Growth Plan for the Greater Golden Horseshoe, Greenbelt Plan, Oak Ridges Moraine Conservation Plan), and the Province's Made-in-Ontario Environment Plan. The previous provincial government had developed Ontario's Five-Year Climate Change Action Plan which included consideration of agriculture.

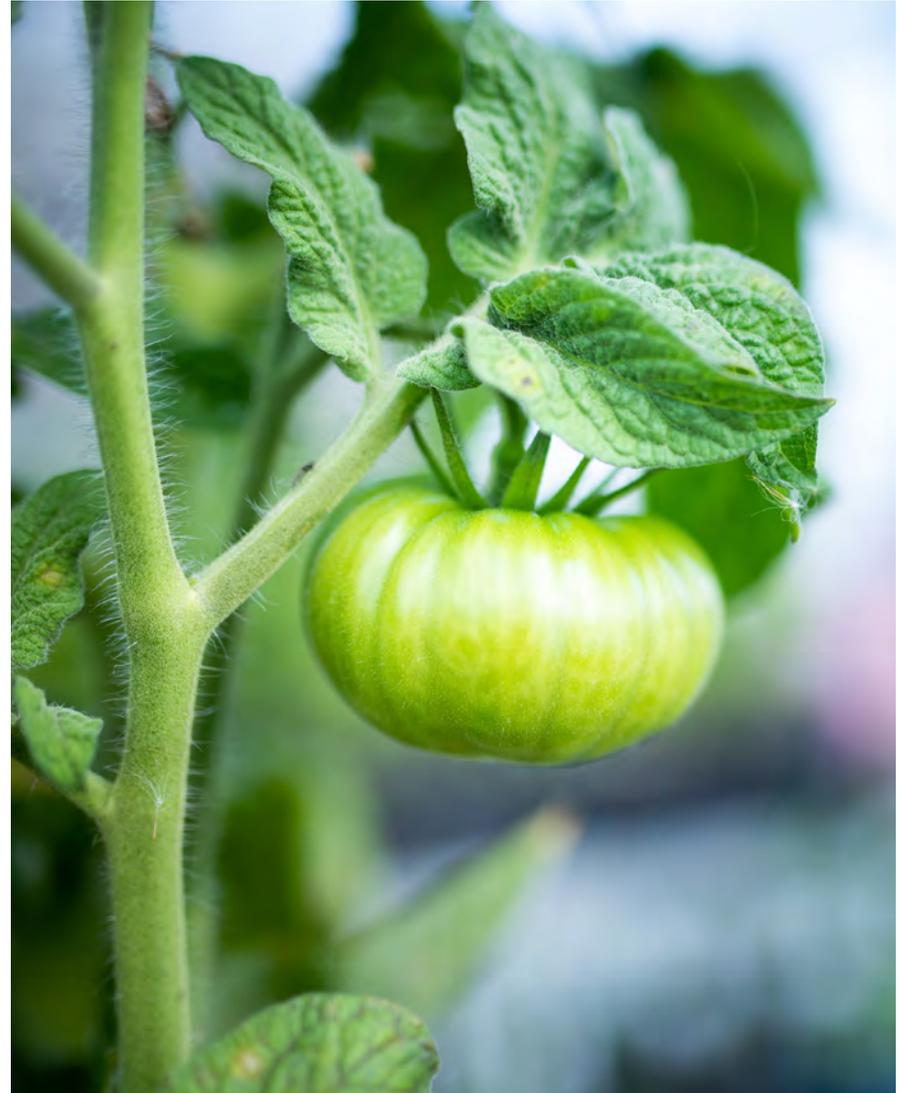
The Ontario Federation of Agriculture (OFA) has released [a position on climate adaptation](#) urging the federal and provincial governments to take action:

“Agricultural adaptation to the impacts of climate change is vital to maintain provincial and national food security, to support rural livelihoods, and grow a strong economy. Farmers need tools to apply on their own farm operations to reduce the effects of rising global temperatures and extreme weather events. OFA urges government to make significant investments to develop the tools, strategies, and research needed to ensure the Ontario agricultural sector can adapt to a changing climate.”

The OFA encourages the development of short-term and long-term agricultural adaptation strategies, as well as recommends: substantial investments in climate change research; improved weather forecasting and warning systems, research and development of improved plant- and animal-breeding programs; addressing emerging threats from new pest and invasive species; investment in energy, transportation, and digital infrastructure; and enhancement of agricultural insurance to address new risks associated with climate change. The Durham Agricultural Sector Climate Adaptation Strategy generally aligns with the OFA, as well as the Canadian Federation of Agriculture's [policies, positions, and directions on climate change adaptation](#).

The Durham Agricultural Sector Climate Adaptation Strategy also supports the Durham Region Agricultural Strategy (2013-2018) goals of ensuring continued agricultural viability, maintaining a supportive policy environment, and promoting outreach and education. This strategy recommends considerations for the update to the Durham Region Agricultural Strategy.

The Durham Agricultural Sector Climate Adaptation Strategy also supports the Durham Region Food Charter (2009), which promotes the identification of potential impacts to farmers and food production from climate change. Mitigation and adaptation strategies support the vision for **“a food secure Durham Region focused toward building a just and sustainable local food system as a foundation for population health.”** The Food Charter further encourages engagement of the broader community in research and development of local initiatives that improve regional food security. In this regard, the Durham Agricultural Sector Climate Adaptation Strategy was developed with extensive stakeholder input and embodies a collaborative approach whose success relies on community partnerships.





A close-up, low-angle shot of a center pivot irrigation system. The metal truss structure of the system is visible in the upper half of the frame. Below it, several nozzles are spraying water onto a lush green field of young crops. The water droplets are captured in mid-air, creating a misty effect. The background shows a clear blue sky and the horizon line of the field.

Strategic Objectives

The goal of this work, and the development of an agricultural sector climate adaptation strategy, was to proactively identify needs, programs and initiatives that will aid Durham Region's agricultural sector in responding and adapting to the challenges and opportunities associated with climate change.

It is acknowledged that the agricultural sector is inherently robust, has adapted to changing weather in the past, and will continue to do so. The Region will aim to support the local agricultural sector in climate adaptation efforts; recognizing our agricultural diversity; how impacts will be felt differently across agricultural sectors; and ensuring that program options are flexible and reflective of specific needs.

The ability of the local agricultural sector to adapt to climate change will rely on:

- A protected and healthy agricultural land base (amount of land, good quality soil).
- Resilient public and on-farm infrastructure.
- Diversification of farming operations and systems.
- Education and knowledge (best management practices, community-based research).
- Communication (information sharing, partnerships, consideration of agriculture and overlap with the work of other sectors, advocacy on matters beyond local control).
- Economic capacity.

Durham's Agricultural Sector Climate Adaptation Strategy is centered on the following themes:

- Increase local education and awareness of agriculture and climate change adaptation.
- Build community and research capacity.
- Enhance policy support for agriculture and climate change adaptation.
- Address agricultural sector climate adaptation through DCCAP cross-sectoral programs and other Regional programs and initiatives.

Focus and priority should be given to program options or initiatives that enhance adaptation for Durham's key agricultural sectors to achieve the greatest impact. Partnerships and community-led initiatives will be the cornerstone of adaptation in the agricultural sector. Collaboration is needed among stakeholders. It is important that programs are packaged, easily implemented by the agricultural sector, and streamlined with minimal administrative barriers such as lengthy applications or approvals. Efforts should be made to minimize costs to farmers for undertaking adaptation measures wherever possible.

Prioritized key initial actions that are recommended to be undertaken in the short-term by the Region have been listed. These actions address the key theme areas and will assist the region's agricultural sector in working toward climate adaptation and enhanced resiliency. Lead agencies and potential partners have been identified, along with a preliminary assessment of resource requirements.

Objective 1: Increase local education and awareness on agriculture and climate change adaptation

One of the determinants of adaptive capacity is social capital. Durham Region has a robust and well connected agricultural community, which will serve the Region well in climate change adaptation as communication and collaboration will be essential. Information sharing between farmers on adaptation measures is needed.

- The Region can assist in increasing local education and awareness on agriculture and climate change adaptation by communicating to the public the impacts and adaptation that the agricultural sector is experiencing and undergoing.
- Ensuring climate change is on the radar of local agricultural groups, associations, and identified stakeholders.
- Assisting with dissemination of Regional Climate Projections and other sources of climate data to allow for informed decision-making around climate adaptation.
- Hosting and promoting workshops and informational sessions in partnership with local agricultural stakeholders or other stakeholders such as academic institutions and the Ontario Climate Consortium, to disseminate information on key topics of relevance to climate adaptation.

Through consultation, suggested topics were put forward; these are included as part of Appendix 3. Opportunities for collaboration on existing projects/events should also be explored such as the DAAC Annual Farm Tour and the Natural Environment Climate Change Collaborative (NECCC) annual forum.

To support agriculture and climate adaptation in this sector, the Region should maintain an inventory of federal and provincial programs, such as the Agricultural Clean Technology Program (Agriculture and Agri-food Canada) that farmers can take part in to assist them in climate adaptation efforts and promote these broadly within the agricultural community. Preparation of Canada/Ontario Environmental Farm Plans (Ontario Ministry of Agriculture Food and Rural Affairs) by local farmers should also be encouraged.

The Region should pursue funding and partnership opportunities to initiate demonstration projects and pilot studies in this area. Funding streams are available through programs such as the Canadian Agricultural Partnership and the East Central Farm Stewardship Collaborative, many of which will assist with climate adaptation and improving resilience through the implementation of best management practices. Agricultural operators and farmers in Durham, as well as other key stakeholders, are encouraged to take advantage of available funding opportunities to implement adaptation projects. Another opportunity that should be explored is working with local Conservation Authorities to enhance agricultural programming and focus (e.g. Maitland Valley Conservation Authority Soil and Water Environmental Enhancement Plans).

The agricultural community has valuable on-the-ground information and insights that the Region should leverage through encouragement of reporting on deficiencies in public infrastructure, sightings or occurrences of invasive species, or environmental issues. Since some of these instances are preventable through routine maintenance, it could help to prevent or avoid major and costly impacts. Should the Region or area municipalities decide to adopt them, Smart Cities platforms could be an option for allowing this feedback.

Action	Timing/ Priority	Lead/Partners	Resources/Potential Funding Sources
A.1 Broadly promote the Strategy and the thematic priorities using various communication modes (could include development of videos, presentations to DCCAP Steering Committee and other stakeholders, and other modes of communications such as social media).	2019 and beyond	<ul style="list-style-type: none"> • CAO's Office; • Durham Region Economic Development Agriculture and Rural Affairs; • DAAC • Conservation Authorities. 	Existing capacity/resources, additional funding may be required for the development of communication tools such as an informational video. Partnerships could be explored.

Objective 2: Build community and research capacity

The success of adaptation in the agricultural sector will depend largely on community and research capacity. Collaboration will be essential to achieve the greatest outcomes. Effort should be undertaken to further determine local needs. As a starting point, through the development of this Strategy, a comprehensive list of partners and stakeholders was developed. These stakeholders should continue to be included in the discussions and actions around climate adaptation in the agricultural sector.

The Region should engage with academic institutions, government, and the private sector to bolster agricultural research on adaptation in Durham Region. Academic institutions should be encouraged to invest in courses/programming on agriculture and climate change (especially in related disciplines such as technology and natural sciences) and undertake demonstrations and pilot projects exploring the key risks and opportunities for the agricultural sector. Additionally, the Region could work with research organizations to investigate the opportunity for case studies on climate adaptation for Durham's key agricultural sectors (e.g. Ontario Centre for Climate Impacts and Adaptation Resources and the Ontario Climate Consortium have done some work on this for other parts of Ontario). Potential topics are identified in Appendix 3.

Opportunities should be explored with Parks Canada for research, pilot projects and demonstrations in the Rouge National Urban Park (RNUP). Agriculture is one of the RNUP's three key mandates, with a focus on research and education. The RNUP also shares an interest in climate mitigation and adaptation.

Communication plays a key role in the building of community and research capacity—both within the agricultural sector and for the broader community. To begin, the Region should work with the agricultural community to identify appropriate communications outreach activities and how to effectively engage this sector.

Through consultation, the agricultural community identified the need to better promote information. To help “get the word out,” information should be easily accessible (via social media sites such as Twitter and Facebook); enhanced by strong partnerships with well-established agricultural organizations; and should be available to local agricultural associations. As part of adaptation efforts, the Region should encourage and assist, where possible, our agricultural community to develop partnerships with their counterparts in warmer or different climates that are similar to Durham's future projected climate, in an effort to learn from their experiences.

It should be recognized that there are other factors outside the scope of this strategy that affect the continued operations of farms and their ability to adapt (regulations, policy, barriers, and relationships between different levels of government and different ministries). Wherever possible, the Region should strive to close these gaps and foster the establishment of better relationships and communication.

Action	Timing/ Priority	Lead/Partners	Resources/Potential Funding Sources
A2.1 Meet with academic and research institutions to determine how we can achieve more research presence in Durham around agriculture and climate change and connect farmers and researchers.	2019	<ul style="list-style-type: none"> • CAO's Office; • Durham Region Economic Development, Agriculture and Rural Affairs; • Parks Canada; • Academic institutions (Ontario Tech University, Durham College, Trent University, University of Guelph and other institutions); • Conservation Authorities. 	Existing capacity/resources.
A2.2 Initiate pilot projects and demonstrations with community partners.	2019 and beyond	<ul style="list-style-type: none"> • CAO's Office; • Durham Region Economic Development, Agriculture and Rural Affairs; • Agricultural community; • Academic institutions; • Conservation authorities; • Parks Canada; • Area Municipalities; • Other partners. 	Will require funding. May be able to obtain funding and in-kind support through partnerships or grants (e.g. Canadian Agricultural Partnership), research, and provision of land to conduct demonstrations and projects.

Objective 3: Enhance policy support for agriculture and climate change adaptation

Durham Region's agricultural adaptation efforts should be coordinated and aligned with those of other levels of government and other agricultural policy influencers (Canadian Federation of Agriculture, Ontario Federation of Agriculture, etc.).

To enable the best adaptation planning, the Region of Durham should continuously update local climate projections. It is recommended that the Region update climate projections using an ensemble approach and consider sources of data from agricultural organizations, such as Ontario Soil and Crop Improvement Association and Agricorp. The Natural Environment Climate Change Collaborative (NECCC), established as part of the DCCAP, has recently received funding from the Friends of the Greenbelt Foundation and will be undertaking this work in 2019.

Policy support for climate change and agriculture should be considered through the update of [Durham Region's Agricultural Strategy \(2013-2018\)](#). Regional and area municipal road design, maintenance, and operational policies and procedures should be revised or enhanced to consider climate change. For example, roads may need to be wider to accommodate wind breaks. Ditch maintenance was another issue that was raised in order to ensure ditches are deep enough and are maintained regularly to protect against flooding and spread of invasive plants. Other municipal policies and processes should be examined to ensure they are not causing unintended impacts on the agricultural sector.

The Region should also consider developing or encouraging the development of guidelines by area municipalities for agricultural structures (heat abatement, hurricane strapping, deeper footings for barns and other agricultural building structures, etc.). Where municipalities have sustainable development guidelines, they should be encouraged to consider inclusion of these structures. These are opportunities which could potentially be explored and addressed through the update of the Region's Agricultural Strategy, as the impacts extend beyond climate adaptation.

There is also significant concern that a lack of broadband capabilities will inhibit adaptive capacity. Through the implementation of the [Durham Regional Broadband Strategy](#), it is recommended that enhanced connectivity in the rural area be supported wherever possible—for improved emergency and extreme weather alerting and agricultural technology advancements—to support climate adaptation efforts.

Further, the Region is well-positioned to advocate for action at other levels of government and by other significant stakeholders to support local agricultural sector climate adaptation efforts.

The following matters were identified as matters the Region should advocate around:

- Requesting the Province consider changes to reduce barriers for farmers to obtain permits to take water, where appropriate, to better enable reuse of water.
- Consideration of climate change in update of federal Farm Building Code and application of the building code at the municipal level.
- Importance of the provincial emergency warning system (EWAR) to consider the need for the agricultural community to be reached.
- Management of publicly and privately-owned lands adjacent to actively farmed lands to mitigate adverse impacts (weeds, pests, etc.), on surrounding lands.

Action	Timing/ Priority	Lead/Partners	Resources/Potential Funding Sources
A3.1 Ensure consideration of this Strategy in the review and ongoing implementation of various Regional initiatives (including DCCAP, Durham Community Energy Plan, Regional Agricultural Strategy, Regional Broadband Strategy, Smart Cities initiatives, Source Protection etc.) and forward Strategy to area municipalities for consideration in the Vibrant North Durham Economic Development Plan local level strategic and operational planning.	Immediate and Ongoing	<ul style="list-style-type: none"> • CAO's Office, • Durham Region Economic Development, Agriculture and Rural Affairs; • Regional Works Department; • DAAC; • Area Municipalities. 	Existing capacity/resources.
A3.2 Develop/encourage development of guidelines or recommendations for agricultural structures to incorporate the relevant elements into Regional initiatives (including the DCCAP, Durham Community Energy Plan, Regional Agricultural Strategy, Source Protection, Official Plan etc.) and forward the Strategy to area municipalities for their planning considerations.	2020	<ul style="list-style-type: none"> • Building Sector Working Group; • Area Municipalities; • DAAC; • Regional Planning. 	May require funding for retention of a consultant or demonstrations.

Objective 4: Address agricultural sector climate adaptation through DCCAP cross sectoral programs and other initiatives

There is significant overlap between risks identified by the Agricultural Sector ETF and those identified by other DCCAP sector working groups. It is important to ensure that other Durham climate adaptation projects consider agriculture as part of their program design and implementation processes. Plus, the agricultural sector should consider and provide input into the projects of other sectors as appropriate. Potential cross-sectoral opportunities have been identified in Appendix 2 and include the following:

Roads/flooding

Regional agri-food asset mapping, anticipated to be updated in 2019 by Durham Region's Economic Development Division, could be utilized to assess infrastructure vulnerability for the agricultural sector and prioritize improvements to culverts/bridges/embankments based on vulnerability and concentration of agri-food assets.

Another critical adaptation measure will be consideration of climate change impacts through municipal roadside management. Ditch maintenance programs should be enhanced by Regional and area municipal Works Departments, in consultation with conservation authorities, to address issues, such as maintaining endangered species habitat, avoiding negative impacts to watercourses and wetlands, preventing flooding (including exploration of additional ways to retain water in the landscape), incorporating green infrastructure, and preventing the spread of invasive species from road rights of way to farmland and natural systems.



Food Security

The Food Security Climate Change Expert taskforce was formed in spring 2018 to develop a strategy to identify and respond to community and family-level food insecurity issues caused by extreme-weather related to climate change. There is overlap between the food security sector and the agricultural sector. Food security work could be enhanced to investigate and address issues of rural food security issues. This includes access to food by rural residents in extreme weather or emergencies and local food processing, but also is inclusive of access and availability of feed for livestock. Ontario Tech University has been doing some work in this field.

Natural Environment

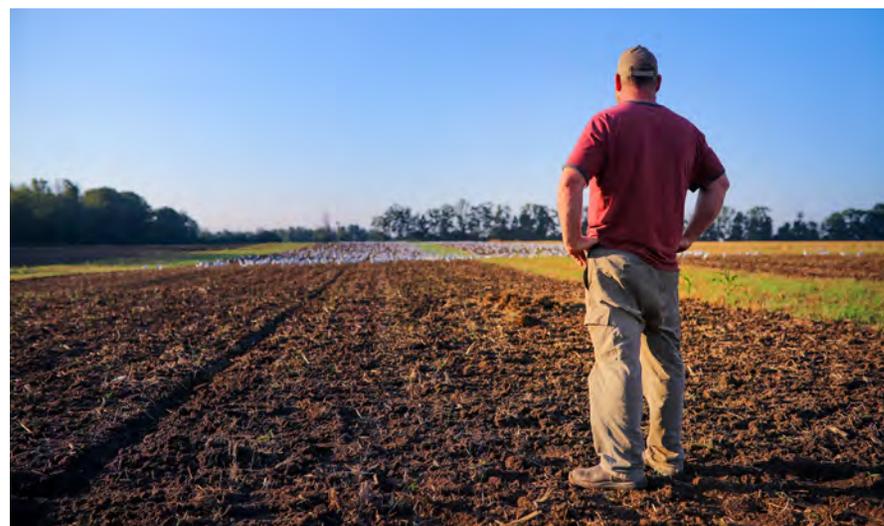
There is perhaps the most significant overlap between risks to the agricultural sector and risks to the natural environment. A potential opportunity for collaboration could include working with the Natural Environment Climate Change Collaborative on joint initiatives, including hosting of a summit focused on agricultural and natural environment climate adaptation or monitoring and addressing the spread of invasive species and pests related to climate change, particularly as it relates to those which impact the agricultural sector.

Green infrastructure enhancements should be considered on agricultural properties to increase the capacity of land for infiltration such as cover crops, plantations, hedgerows, natural systems, and bioswales/rain gardens. Increased natural cover can also have a temperature regulating effect and provide farm workers with respite from extreme heat.

Partnerships should be explored with agencies including conservation authorities; the Municipal Natural Assets Initiative; the Canadian Food Inspection Agency; and the Ontario Ministry of Agriculture, Food and Rural Affairs. Another potential area for communication and collaboration exists in building a climate resilient natural heritage system and identification of restoration opportunities in recognition of the co-benefits for agriculture. For example, a more resilient natural heritage system has a higher capacity to resist the spread of invasive species and pests, which can pose significant challenges for agriculture.

Human Health

Communication is needed with agencies, such as the Durham Region Health Department, Durham Emergency Management Office and public alerting agencies to ensure the rural area is considered and that accurate extreme weather alert systems reliably reach agricultural communities (adequate connectivity). It could also consider initiatives, such as the Farm 911–Emily Project, which is focused on getting civic address number signs for all properties in the rural area for emergency response services. Impacts of climate change on agricultural workers should also be considered, including increased exposure to diseases/harmful invasive species or pests and heat-related illness. Possible solutions include shade provision as well as a dedicated warning system for rural outdoor workers.



Electrical Sector

Availability of reliable electricity is essential for agricultural operations to continue. Electrical utilities should ensure there is capacity in the rural area for peak time demand/seasonal demand as well as current and projected growth of electricity consumption in rural areas. While most agricultural operations that require consistent sources of electricity do have backup generation systems in place, in the event of an outage, where possible, there should be a prioritization for restoration of power for agricultural operations. Additionally, the current electrical distribution system in the rural area in some cases is not sufficient to support certain agricultural operations (such as vegetable growers with large produce cooling systems). Consequently, some producers need to rely on other sources of energy including diesel.

Electrical utilities should also be made aware of and consider pricing and time-of-use challenges for the agricultural sector. Pricing for time-of-use cannot be taken advantage of by farmers who require round-the-clock electricity for production. Ongoing energy needs of the agricultural sector, and inability to adapt practices to time-of-use, should be recognized. It is anticipated that these challenges and costs related to electricity will increase for farmers as the climate changes and demands (e.g. cooling, ventilation) increase.

To assist with adaptation as well as food security, diversified sources of energy should be encouraged on farms and other agricultural operations to provide additional energy security, provided battery storage capacity is available.



Other Initiatives

Other initiatives which could assist the agricultural sector in adaptation efforts include the Durham 5 Million Trees Program, where consideration could be given to prioritizing rural applications/projects that provide shade for livestock, windrows for farmers, watercourse bank or slope stabilization, etc. Agricultural input should be sought for tree planting initiatives where applicable and appropriate. For example, the Trees for Rural Roads Program, a local program offered by the Municipality of Clarington in partnership with Ganaraska Region Conservation Authority, and Central Lake Ontario Conservation Authority provides trees to rural residents and farmers in Clarington.

Action	Timing/ Priority	Lead/Partners	Resources/Potential Funding Sources
A4.1 Ensure update to Regional Climate Projections captures agricultural sector considerations through ongoing consultation with DAAC and the agricultural community.	2019 (currently underway)	<ul style="list-style-type: none"> • CAO's Office; • Planning and Economic Development Department; • Greater Golden Horseshoe Food and Farming Alliance • NECCC; • DAAC. 	Existing capacity/resources; Friends of the Greenbelt Foundation grant funding.
A4.2 Hold DCCAP Steering Committee meeting to address sector overlaps and integrate, where appropriate, agricultural considerations in the on-going work of other working groups.	Spring 2019	<ul style="list-style-type: none"> • CAO's Office; • DCCAP Steering Committee and Working Group Chairs. 	May require funding to increase the scope of certain working group projects that are planned or underway.
A4.3 Partner with the NECCC to host an annual forum on the topic of agricultural sector/natural heritage climate adaptation.	2020 or 2021	<ul style="list-style-type: none"> • NECCC; • DAAC; • Other partners. 	Will require funding. May be able to obtain funding and in-kind support through partnerships or sponsorships.

Conclusion and Implementation



As an addendum to the DCCAP, the Durham Region Agricultural Sector Climate Adaptation Strategy is intended to aid agricultural producers in Durham Region to adapt to and thrive in an era of climate change. This will not be possible without:

- The foundational elements of building community and research capacity.
- Enhancing policy support for agriculture and climate change adaptation.
- Increasing local education and awareness of agriculture and climate change adaptation.
- Addressing agricultural sector climate adaptation through cross-sectoral programs and community partnerships.

The recommended actions contained within this Strategy will help the Region to work toward improved resilience in the agricultural sector; ensuring the continued viability of agriculture as a vital component of the Region's social and economic fabric.

In addition to the DCCAP, the update of the Region's Agricultural Strategy (2019-2024) is underway and will consider and incorporate the recommendations of this Strategy, as appropriate.

Implementation and continued monitoring of progress toward achievement of the identified actions and outcomes is expected to take place beginning in 2019, in close collaboration with the other DCCAP sector working groups and under the guidance of the DCCAP Steering Committee. This Strategy will be reviewed in conjunction with the DCCAP update. Flexibility should be provided to take advantage of funding and partnership opportunities that arise which would advance the objectives of this Strategy.

The Durham Agricultural Advisory Committee will serve as a resource for advising on the implementation of this Strategy.

Acknowledgments

The development of the Durham Region Agricultural Sector Climate Adaptation Strategy would not have been possible without the guidance of the members of the agriculture expert task force and the valuable input of community partners and stakeholders. A special thank you goes out to the following individuals and groups as well as University of Guelph Geography Course 3020, Global Environmental Change (Summer 2018).

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Contributing Community Stakeholders

Agricultural Advisory Committee of Clarington (AACC)

Central Lake Ontario Conservation Authority

City of Oshawa

City of Pickering

Durham Agricultural Advisory Committee (DAAC)

Durham College – W. Galen Weston Centre for Food

Durham Community Climate Adaptation Plan Food Security Task Force

Durham Community Climate Adaptation Plan Working Groups

Durham Environmental Advisory Committee (DEAC) Durham

Food Policy Council

Durham Integrated Growers

Durham Region Federation of Agriculture

Durham Region Roundtable on Climate Change (DRRCC)

Farms at Work

Ganaraska Region Conservation Authority

Lake Simcoe Region Conservation Authority

Ontario Centre for Climate Impacts and Adaptation Resources

Ontario Climate Consortium

Parks Canada

Swain Beef

Toronto Region Conservation Authority

Town of Whitby

Township of Uxbridge

Trent University

Ontario Tech University, Social Science and Humanities

Whitby Hydro

A photograph of a red apple orchard. The top half of the image is obscured by a dark blue horizontal bar. The bottom half shows several red apples hanging from a tree branch, with green leaves and other trees in the background.

Appendices

Appendix 1–Durham SENES Climate Projections by Municipality

Climate Parameter	Detailed Parameter	Ajax 2000-09	Ajax 2040-49	Whitby 2000-09	Whitby 2040-49
Extreme Precipitation	Max. in one Day (mm)	79	84	79	117
Extreme Precipitation	# days/year >25mm	5	9	6	10
Extreme Precipitation	Annual Total Precipitation (mm)	820	954	869	1004
Extreme rainfall	Max. in one day (mm)	79	84	79	117
Extreme rainfall	# days/year > 25mm	4	9	5	10
Extreme Snowfall	Max. in one day (cm)	29	14	28	17
Extreme Snowfall	# days/year > 5 cm	8	2	9	2
Extreme Heat	Average max daily (°C)	24	26	25	28
Extreme Heat	Extreme max. (°C)	31	40	33	40
Extreme Heat	# days/year > 30(°C)	1	6	2	17
Extreme Cold	Average min Daily (°C)	-7	0	-8	
Extreme Cold	Extreme min. (°C)	-24	-12	-25	-13
Extreme Cold	# days/year < -10(°C)	24	0	27	1
Extreme Cold	# days/year with min. <0 (frost days)	122	60	129	75
Wind Chill	Extreme Daily (°C)	-36	-17	-37	-19
Wind Chill	# days/year <-20 (°C)	13	0	15	0
Degree Days	# degree days/year > 24 (°C) (AC req'd)	4	17	8	49
Degree Days	# degree days/year > 0 (°C)	3342	4329	3444	4508
Degree Days	# degree days/year < 0(°C) (heating req'd)	444	50	475	70
Humidex	Max (°C)	43	48	47	51
Humidex	Average # days/year >40(°C)	1	6	3	19
Extreme Wind	Max hourly speed (km/hr)	65	57	62	54
Extreme Wind	Max. gust speed (km/hr)	120	74	119	74
Extreme Wind	# days/year with wind speed > 52 km/hr	3	0.3	2	0.1
Extreme Wind	# days/year with wind speed > 63 km/hr	0	0	0	0
Potential for Violent Storms	# days with high lightning potential/year	27	43	29	42
Potential for Violent Storms	# days/year with EHI > 1	11.2	13.5	15	17.2
Potential for Violent Storms	# days/year with EHI 2-5	-	-	4.9	7.5
Potential for Violent Storms	# days/year with EHI >= 5	-	-	0	0.3

Climate Parameter	Detailed Parameter	Oshawa 2000-09	Oshawa 2040-49	Clarington 2000-09	Clarington 2040-49
Extreme Precipitation	Max. in one Day (mm)	84	88	99	96
Extreme Precipitation	# days/year >25mm	6	10	6	9
Extreme Precipitation	Annual Total Precipitation (mm)	880	1023	883	977
Extreme rainfall	Max. in one day (mm)	84	88	99	96
Extreme rainfall	# days/year > 25mm	5	10	6	9
Extreme Snowfall	Max. in one day (cm)	29	18	27	21
Extreme Snowfall	# days/year > 5 cm	9	3	9	1
Extreme Heat	Average max daily (°C)	24	28	24	27
Extreme Heat	Extreme max. (°C)	32	40	32	40
Extreme Heat	# days/year > 30(°C)	1	11	1	9
Extreme Cold	Average min Daily (°C)	-8		-7	
Extreme Cold	Extreme min. (°C)	-25	-11	-25	-11
Extreme Cold	# days/year < -10(°C)	27	0	25	0
Extreme Cold	# days/year with min. <0 (frost days)	128	73	126	71
Wind Chill	Extreme Daily (°C)	-37	-17	-36	-17
Wind Chill	# days/year <-20 (°C)	16	0	14	0
Degree Days	# degree days/year > 24 (°C) (AC req'd)	6	38	5	32
Degree Days	# degree days/year > 0 (°C)	3415	4459	3420	4443
Degree Days	# degree days/year < 0(°C) (heating req'd)	474	69	457	64
Humidex	Max (°C)	46	50	45	48
Humidex	Average # days/year >40(°C)	3	16	2	13
Extreme Wind	Max hourly speed (km/hr)	65	56	70	56
Extreme Wind	Max. gust speed (km/hr)	120	77	113	77
Extreme Wind	# days/year with wind speed > 52 km/hr	2	0.2	3	0.1
Extreme Wind	# days/year with wind speed > 63 km/hr	0	0	1	0
Potential for Violent Storms	# days with high lightning potential/year	27	43	27	41
Potential for Violent Storms	# days/year with EHI > 1	12.8	15.8	10.9	12.9
Potential for Violent Storms	# days/year with EHI 2-5	-	-	-	-
Potential for Violent Storms	# days/year with EHI >= 5	-	-	-	-

Climate Parameter	Detailed Parameter	Uxbridge 2000-09	Uxbridge 2040-49	Port Perry 2000-09	Port Perry 2040-49
Extreme Precipitation	Max. in one Day (mm)	82	100	87	122
Extreme Precipitation	# days/year >25mm	7	11	7	11
Extreme Precipitation	Annual Total Precipitation (mm)	1025	1115	988	1104
Extreme rainfall	Max. in one day (mm)	82	100	87	122
Extreme rainfall	# days/year > 25mm	6	11	6	11
Extreme Snowfall	Max. in one day (cm)	40	26	39	25
Extreme Snowfall	# days/year > 5 cm	13	6	11	4
Extreme Heat	Average max daily (°C)	25	29	25	29
Extreme Heat	Extreme max. (°C)	37	43	35	44
Extreme Heat	# days/year > 30(°C)	5	28	5	27
Extreme Cold	Average min Daily (°C)	-9	-2	-9	-2
Extreme Cold	Extreme min. (°C)	-28	-14	-27	-14
Extreme Cold	# days/year < -10(°C)	36	2	36	2
Extreme Cold	# days/year with min. <0 (frost days)	141	91	144	92
Wind Chill	Extreme Daily (°C)	-41	-20	-40	-20
Wind Chill	# days/year <-20 (°C)	24	0	23	0
Degree Days	# degree days/year > 24 (°C) (AC req'd)	12	90	10	80
Degree Days	# degree days/year > 0 (°C)	3283	4378	3280	4384
Degree Days	# degree days/year < 0(°C) (heating req'd)	614	132	602	127
Humidex	Max (°C)	45	54	46	54
Humidex	Average # days/year >40(°C)	3	24	4	25
Extreme Wind	Max hourly speed (km/hr)	69	50	69	49
Extreme Wind	Max. gust speed (km/hr)	108	78	116	80
Extreme Wind	# days/year with wind speed > 52 km/hr	2	0	2	0
Extreme Wind	# days/year with wind speed > 63 km/hr	1	0	1	0
Potential for Violent Storms	# days with high lightning potential/year	26	32	25	32
Potential for Violent Storms	# days/year with EHI > 1	20.5	28.2	20.7	27.5
Potential for Violent Storms	# days/year with EHI 2-5	-	-	-	-
Potential for Violent Storms	# days/year with EHI >= 5	-	-	-	-

Climate Parameter	Detailed Parameter	Beaverton 2000-09	Beaverton 2040-49	Pickering 2000-9	Pickering 2040-9
Extreme Precipitation	Max. in one Day (mm)	85	88	81	97
Extreme Precipitation	# days/year >25mm	4	9	5	9
Extreme Precipitation	Annual Total Precipitation (mm)	828	955	822	960
Extreme rainfall	Max. in one day (mm)	85	88	81	97
Extreme rainfall	# days/year > 25mm	4	8	4	9
Extreme Snowfall	Max. in one day (cm)	27	31	33	29
Extreme Snowfall	# days/year > 5 cm	12	5	8	2
Extreme Heat	Average max daily (°C)	24	29	25	28
Extreme Heat	Extreme max. (°C)	33	40	35	43
Extreme Heat	# days/year > 30(°C)	4	26	4	15
Extreme Cold	Average min Daily (°C)	-10	-2	-8	
Extreme Cold	Extreme min. (°C)	-29	-15	-25	-13
Extreme Cold	# days/year < -10(°C)	39	2	27	1
Extreme Cold	# days/year with min. <0 (frost days)	141	82	129	72
Wind Chill	Extreme Daily (°C)	-39	-21	-37	-20
Wind Chill	# days/year <-20 (°C)	25	0.3	14	0
Degree Days	# degree days/year > 24 (°C) (AC req'd)	6	68	9	43
Degree Days	# degree days/year > 0 (°C)	3260	4365	3431	4490
Degree Days	# degree days/year < 0(°C) (heating req'd)	627	121	463	62
Humidex	Max (°C)	45	54	48	53
Humidex	Average # days/year >40(°C)	4	25	4	17
Extreme Wind	Max hourly speed (km/hr)	75	59	62	57
Extreme Wind	Max. gust speed (km/hr)	106	84	108	74
Extreme Wind	# days/year with wind speed > 52 km/hr	4	0.6	2	0.2
Extreme Wind	# days/year with wind speed > 63 km/hr	1	0	0	0
Potential for Violent Storms	# days with high lightning potential/year	22	29	29	44
Potential for Violent Storms	# days/year with EHI > 1	19.3	25.1	15.6	16.7
Potential for Violent Storms	# days/year with EHI 2-5	-	-	-	-
Potential for Violent Storms	# days/year with EHI >= 5	-	-	-	-

Appendix 2–Cross Sectoral Collaboration Opportunities

Flooding Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Urban Flooding	Major and minor system conveyance, stormwater facilities, roads and transportation, sanitary services, erosion, pollution, electrical services, communication services, social services, EMS, police, fire, public use of floodplains	-	Greater impermeable surfaces related to urban sprawl and paving can have impacts on downstream and adjacent farmland. Ensure that agricultural properties are fairly represented in stormwater management programming, recognizing their unique challenges and needs related to stormwater infrastructure.
Riverine Flooding	Social disruption, insurance, damage to private assets, business disruption, public safety.	-	Rural culverts, bridges and embankments are vulnerable to damage due to increased riverine flooding associated with climate change.
Warning and Emergency Response	Monitoring, forecasting, emergency communications, access for emergency vehicles	-	Monitoring, forecasting to plan for planting, harvest and livestock security; emergency communications and access for emergency vehicles are concerns to rural areas.
Natural Hazard Definition	Existing mapping, standards, methods, flood hazard policies and management, hazard reduction	-	Vulnerable infrastructure assessment, existing mapping, standards, methods, flood hazard policies and management, and hazard reduction.

Natural Environment Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Groundwater Quantity	-	Changes to shallow aquifers, groundwater discharge and recharge areas.	Changes to shallow aquifers, groundwater discharge and recharge areas a concern for household and livestock water supply and irrigation.
Surface Water Quantity	Changes to stream erosion, extreme high flows	Changes in base flows, seasonal flows.	Surface water quantity is a concern for irrigation and livestock.
Terrestrial Species	Changes to species range and presence, insects and diseases, life history traits	-	Monitor and address the spread of invasive species and pests related to climate change (in partnership with conservation authorities). Partnerships should be explored with agencies including the Canadian Food Inspection Agency and Ontario Ministry of Agriculture, Food and Rural Affairs.

Buildings Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
New Industrial, Commercial and Institutional (ICI) Buildings	-	Backed up drains/septic, flood damage to service equipment, failure of air conditioning (A/C) systems, collapse of light structures, damage to adjacent buildings, secondary interior damage, roof structure failure.	Additional considerations for agricultural buildings/structures (including specialized livestock buildings).
Existing ICI Buildings	Roof structure failure, backed-up drains/septic, flood damage to service equipment, A/C failure, damage to exterior, secondary damage to interior	Heating failure, structural damage, building devastation, collapse of light structures, damage to adjacent buildings.	Additional considerations for agricultural buildings/structures (including specialized livestock buildings).

Electrical Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Extreme Heat	Sagging and splitting wires. Reduced asset life, accelerates challenges of aging infrastructure	Sagging and splitting of wires—phase-to-phase short, transmission and distribution outages.	Additional consideration for rural residences and livestock operations that are reliant on electricity for cooling.
Temperature	Vegetation management - longer growing season leading to damage and outage	-	Vegetation control on hydro corridors and on rural roads.
Freezing Rain (ice storms)	-	Infrastructure failure leading to outages (due to ice accretion and trees falling on lines).	Power outages due to freezing rain can result in livestock death and damage to property due to freezing pipes and flooding.
Extreme Winds	-	Outages caused by infrastructure damage.	Power outages, due to extreme winds, can result in livestock death, due to lack of heating, cooling and ventilation.

Human Health Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Extreme Heat	Heat related death and illness	-	Extra consideration for the effects on extreme heat on agricultural workers and rural residents.
Infectious Diseases	-	Tick-borne Lyme disease, mosquito borne disease	Extra consideration for the effects of infectious diseases related to climate change on agricultural workers and rural residents
Extreme Weather Events and Natural Hazards	-	Extreme weather events and natural hazards	Extra consideration for the effects of extreme weather events and natural hazard on agricultural workers and rural residents.

Roads Sector	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Extreme Storm Events	Failure of culverts/bridges, storm sewers, and road embankments	Bluff failure along waterfront, road failure through subsoil failure, and pavement structure failure	Extra consideration given to rural roads, bridges, culverts and embankments are sized to future climate projections to avoid impacting agricultural operations. Need for enhanced infrastructure repair, maintenance and upgrading, particularly with regard to ditch maintenance.

Food Security	High-risk Impacts	Medium-risk Impacts	Overlap with Agricultural Sector
Food provision during climate-related emergencies	Disruption to food supply and lack of food for vulnerable people during extreme weather-related emergencies	Disruption to food supply and lack of food for vulnerable people during extreme weather-related emergencies	Investigation of rural food security issues (e.g. access to food by rural residents in extreme weather or emergencies, local food processing) and inclusive of access and availability of feed for livestock.

Appendix 3—Supplemental Agriculture and Climate Change Research and Project Ideas

The following is a list of potential research topics, pilot projects, and informational sessions and workshops that could be undertaken (but that are not necessarily part of immediate next steps/actions that the Region will be undertaking).

- Partnering with local seed producers to evaluate the “pace” of genetic modification of seeds for increased tolerance to extremes in the context of climate change, as well as the costs of such “resilient” seeds/species to see if the business case allows for easy uptake.
- Research and experimentation with new crops.
- Research on soil health and soil organic matter to support climate resiliency (in explanation, increasing soil health and soil organic matter may help stabilize yields, decrease nutrient losses, allow crops to grow better in times of drought, etc.).
- Evaluating the effectiveness of crop/farm insurance in the face of climate change.
- Evaluation of how the entire food system in Durham is/ could be affected by climate disruptions, similar to City of Toronto study, [Resilient Food Systems, Resilient Cities\(2018\)](#).
- Research on carbon sequestration as it relates to agriculture.
- Examine ways for farmers to reduce nitrogen use derived from rarifying petrol.
- Research on supply management as it relates to international trade agreements.
- Study on rural food security and climate change.
- Research on rural energy security including on-farm renewable energy generation
- Research on resiliency measures for agricultural buildings and structures
- Research on the use of drone technology on farms for matters related to climate adaptation including invasive species identification
- Consideration of a “One Health” approach to climate adaptation in Durham’s agricultural areas—including investigation of human and livestock health impacts of a changing climate (West Nile Virus, African Swine Fever, dangerous plants).
- Potential workshop/informational session topics:
 - Soil and tilling practices.
 - Diversification:
 - Crops—different kinds of crops, more resilient varieties, crops being grown in comparable climates to what is anticipated in Durham.
 - Alternative growing environments (indoor/urban agriculture including vertical gardening).
 - Pests/invasive species.
 - Water taking permit education/awareness.
 - Water conservation/pricing.
 - Crop Insurance.
 - Green infrastructure for agricultural lands (Green Infrastructure Ontario).
- Hosting a follow-up Symposium to the Joint Symposium held on February 9, 2018 by the Durham Agricultural Advisory Committee, Durham Environmental Advisory Committee and Durham Region Roundtable on Climate Change on a topic of interest.
- Pilot project/demonstrations on benefits of stormwater management improvements on agricultural lands to support adaptive management for climate change (e.g., on-line stormwater pond retrofit, along with additional upstream retention/reuse improvements that address adapted design criteria).





More information:

For background information on the Durham Region Community Climate Adaptation Plan and its development, please visit:
durham.ca/ClimateChange

Please direct any questions or comments to:
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Connect with the Region of Durham:

