

# Climate Change Risk Assessment for Agriculture in Grey, Bruce and Huron Counties

Climate Change Risk Assessment Summary



## Context and Overview

Agriculture is an important industry in the counties of Grey, Bruce and Huron. According to 2016 Census of Agriculture, the area is home to 6,700 farms, cultivating approximately 1,300,000 acres of farmland. The main commodities include calves and cattle, hogs, dairy, soybeans, and poultry, while oilseed and grain farming represent the largest number of farms by industry group. Regional differences in both crop and livestock production are present, reflecting soil and climate characteristics of the region.

All else being equal, warmer temperatures could be beneficial to agriculture in the Great Lakes region, resulting in longer growing and grazing seasons, increased crop yields, and the potential to grow new crop species in a warmer climate.

The changing climate may also introduce new or accentuate existing risks to agriculture including but not limited to soil erosion and nutrient depletion, delays in farming operations, increased runoff and water contamination, reduced yields, increased susceptibility to disease, and higher production costs.

In order to adequately assess climate-related risks, seven (7) key themes were delineated with components or sub-sectors identified. These include:

- Field crops (soybeans, corn, wheat, hay and clover),
- Livestock (calves and cattle, hogs, dairy, poultry and eggs),
- Fruit and vegetables (apples),
- Soil (soil quality and fertility),
- Water resources (surface water, groundwater),
- Farm infrastructure (buildings, power sources),
- Farm operations (planting, harvesting, pesticide application).

A literature review was conducted to identify key climate hazards, impacts, opportunities, and risks for the main components of the agricultural sector, and a draft risk registry was produced to assess and quantify risk. Risk scenarios were developed to consider how a climate hazard can cascade to direct and indirect impacts for different components of the sector.

Consultations with stakeholders representing the local farming community, agricultural organizations, municipalities and conservation authorities helped obtain information about their experiences of past changes in relation to climate change impacts, risks and weather concerns. An online engagement session was held to review and present risk assessment findings and discuss options for priority climate risk and information products. Considering the feedback, the assessment plan was developed to address key hazard and risk issues, and develop several information products, including infographics, case studies of successful implementation of best management practices (BMPs), and web maps of (a) key climate hazard indicators and risk sensitivity factors and (b) areas most likely to benefit from adoption of BMPs.

For this assessment a conservative approach was taken to assigning likelihoods. The likelihood refers to the occurrence of the climate event (like drought as a result of low precipitation) and the cascading impacts are assumed to also occur. This is a precautionary approach, as in a “real-life” scenario the climate event occurring may not always result in all other impacts. Severity of impact consequences was assessed in four categories: financial losses, environmental damage, infrastructure damage and service disruption, and human health and public safety.

This summary document complements the full assessment plan and risk registry and presents risk assessment results for seven major components of the agricultural sector, defined above. It provides a complete list of risk scenarios, likelihood, consequence and risk scores and organizes the information in ways that facilitate the development of risk information and communication products, including infographics and web mapping products.

Criteria and scales for assigning likelihood and consequence scores as well as calculating overall risk scores are provided in the Appendix.

## Drought Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Field crops	Soybeans	<ul style="list-style-type: none"> <li>– Delay in plant development</li> <li>– Reduced yield</li> </ul>	Possible 3	Likely 4	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 12
Field crops	Corn	<ul style="list-style-type: none"> <li>– Reduced pollen viability and grain fill</li> <li>– Reduced yield</li> </ul>	Possible 3	Likely 4	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 12
Field crops	Wheat	<ul style="list-style-type: none"> <li>– Limited root development and crop growth</li> <li>– Reduced yield</li> </ul>	Possible 3	Likely 4	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 12
Field crops	Hay and clover	<ul style="list-style-type: none"> <li>– Reduced productivity</li> <li>– Decreases in yield and nutritional value</li> </ul>	Possible 3	Likely 4	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 12
Soil	Soil quality and fertility	<ul style="list-style-type: none"> <li>– Reduced soil moisture and soil organic matter</li> <li>– Decline in soil suitability to support crop growth</li> <li>– Poor nutrient uptake by crops</li> <li>– Lower crop yields and product quality</li> </ul>	Possible 3	Likely 4	Major 4	Moderate 3	Negligible 1*	Negligible 1*	High 11	High 14

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
<b>Water</b>	Surface water and groundwater	<ul style="list-style-type: none"> <li>– Lower water levels</li> <li>– Shortage of water in reservoirs</li> <li>– Reduction in groundwater recharge</li> <li>– Increased heavy metal contamination</li> <li>– Increased irrigation demands</li> <li>– Higher production costs</li> </ul>	<b>Likely 4</b>	<b>Almost certain 5</b>	<b>Negligible 1*</b>	<b>Major 4</b>	<b>Negligible 1*</b>	<b>Minor 2</b>	<b>High 12</b>	<b>High 15</b>

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## Heavy Precipitation and Flooding Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Field crops	Soybeans	<ul style="list-style-type: none"> <li>Plant damage or death due to lack of oxygen during waterlogging</li> <li>Poor root development</li> <li>Reduced yield</li> </ul>	Likely 4	Almost certain 5	Moderate 3	Minor 2	Negligible 1*	Negligible 1*	Moderate 6	Moderate 8
Field crops	Corn	<ul style="list-style-type: none"> <li>Plant damage or death due to lack of oxygen during waterlogging</li> <li>Poor root development</li> <li>Reduced yield</li> </ul>	Likely 4	Almost certain 5	Moderate 3	Minor 2	Negligible 1*	Negligible 1*	Moderate 6	Moderate 8
Soil	Soil quality and fertility	<ul style="list-style-type: none"> <li>Soil erosion</li> <li>Degraded topsoil</li> <li>Reduced water storage and nutrient depletion</li> <li>Reduced crop yields</li> </ul>	Likely 4	Almost certain 5	Moderate 3	Moderate 3	Negligible 1*	Negligible 1*	High 12	High 15

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
<b>Water</b>	Surface water and groundwater	<ul style="list-style-type: none"> <li>– Increased runoff and non-point source pollution</li> <li>– Phosphorus loss and surface water contamination</li> <li>– Algal blooms</li> <li>– Oxygen depletion</li> <li>– Leaching of nutrients and chemicals into groundwater</li> <li>– Water quality degradation</li> </ul>	<b>Likely</b> 4	<b>Almost certain</b> 5	<b>Negligible</b> 1*	<b>Major</b> 4	<b>Moderate</b> 3	<b>Minor</b> 2	<b>High</b> 12	<b>High</b> 15
<b>Farm operations</b>	Planting	<ul style="list-style-type: none"> <li>– Soil water logging</li> <li>– Planting delays</li> <li>– Increased runoff and lower nutrient retention</li> <li>– Poor early plant development</li> </ul>	<b>Likely</b> 4	<b>Almost certain</b> 5	<b>Moderate</b> 3	<b>Minor</b> 2	<b>Negligible</b> 1*	<b>Negligible</b> 1*	<b>High</b> 10	<b>High</b> 13
<b>Farm operations</b>	Harvesting	<ul style="list-style-type: none"> <li>– Harvesting delays</li> <li>– Increased potential for decreased crop quantity and disease infestations</li> </ul>	<b>Likely</b> 4	<b>Almost certain</b> 5	<b>Moderate</b> 3	<b>Minor</b> 2	<b>Negligible</b> 1*	<b>Negligible</b> 1*	<b>High</b> 10	<b>High</b> 13
<b>Farm infrastructure</b>	Buildings	<ul style="list-style-type: none"> <li>– Infrastructure damage</li> <li>– Increased repair and replace costs</li> <li>– Damage to and loss of harvested crop, livestock</li> </ul>	<b>Likely</b> 4	<b>Almost certain</b> 5	<b>Moderate</b> 3	<b>Negligible</b> 1*	<b>Major</b> 4	<b>Minor</b> 2	<b>High</b> 12	<b>High</b> 15

\* Scores ranked *Negligible*\* were believed to be not explicitly relevant to the scenario. When a *Negligible*\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are *Negligible*\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

## Extreme Heat Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Field crops	Soybeans	<ul style="list-style-type: none"> <li>Heat stress</li> <li>Reduced pollen production and germination</li> <li>Reduced yield</li> </ul>	Possible 3	Almost certain 5	Moderate 3	Minor 2	Negligible 1*	Negligible 1*	Moderate 5	Moderate 8
Field crops	Corn	<ul style="list-style-type: none"> <li>Faster crop development</li> <li>Shortened phenological stages</li> <li>Heat stress</li> <li>Reduced yield</li> </ul>	Possible 3	Almost certain 5	Moderate 3	Minor 2	Negligible 1*	Negligible 1*	Moderate 5	Moderate 8
Field crops	Wheat	<ul style="list-style-type: none"> <li>Heat stress</li> <li>Reduced yield</li> </ul>	Likely 4	Almost certain 5	Major 4	Minor 2	Negligible 1*	Negligible 1*	High 12	High 15
Field crops	Hay and clover	<ul style="list-style-type: none"> <li>Increased susceptibility to diseases</li> <li>Reduced yield</li> </ul>	Likely 4	Almost certain 5	Major 4	Minor 2	Negligible 1*	Negligible 1*	High 12	High 15
Livestock	Cattle and calves	<ul style="list-style-type: none"> <li>Heat stress</li> <li>Suppressed appetite</li> <li>Decreased weight gain</li> <li>Lower fertility rates</li> <li>Increased mortality</li> </ul>	Possible 3	Almost certain 5	Moderate 3	Negligible 1*	Negligible 1*	Negligible 1*	Moderate 9	High 15

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.



Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Livestock	Dairy	<ul style="list-style-type: none"> <li>– Heat stress in cows</li> <li>– Decreased milk production</li> <li>– Decreased fertility and conception</li> <li>– Increased mortality</li> </ul>	Possible 3	Almost certain 5	Moderate 3	Negligible 1*	Negligible 1*	Negligible 1*	Moderate 9	High 15
Livestock	Hogs	<ul style="list-style-type: none"> <li>– Decreased feed intake and weight gain</li> <li>– Increased mortality</li> </ul>	Possible 3	Almost certain 5	Moderate 3	Negligible 1*	Negligible 1*	Negligible 1*	Moderate 9	High 15
Livestock	Poultry and eggs	<ul style="list-style-type: none"> <li>– Heat stress</li> <li>– Increased mortality</li> </ul>	Likely 4	Almost certain 5	Moderate 3	Negligible 1*	Negligible 1*	Negligible 1*	High 12	High 15

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

## Increased Fall and Winter Temperatures Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Field crops	Wheat	<ul style="list-style-type: none"> <li>– Increased sensitivity to freezing temperatures in winter</li> <li>– Reduced yield</li> </ul>	Possible 3	Almost certain 5	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 15
Field crops	Hay and clover	<ul style="list-style-type: none"> <li>– Compromised fall hardening</li> <li>– Increased sensitivity to freezing temperatures in winter</li> </ul>	Possible 3	Almost certain 5	Major 4	Minor 2	Negligible 1*	Negligible 1*	Moderate 9	High 15
Fruit and vegetables	Apples	<ul style="list-style-type: none"> <li>– De-hardening of trees</li> <li>– Increased susceptibility to cold damage</li> <li>– Winter tree injury</li> <li>– Reduced yield</li> </ul>	Almost certain 5	Likely 4	Minor 2	Minor 2	Negligible 1*	Negligible 1*	Moderate 10	Moderate 8
Farm operations	Pesticide application	<ul style="list-style-type: none"> <li>– Increased rates of pest survival</li> <li>– More pest generations per year</li> <li>– Increases in pesticide applications</li> <li>– Higher production costs</li> <li>– Increased chances of soil and water contamination</li> </ul>	Likely 4	Almost certain 5	Minor 2	Major 4	Negligible 1*	Minor 2	High 12	High 15

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

## Spring and fall Frost Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
Field crops	Wheat	<ul style="list-style-type: none"> <li>– Stem and leaf damage</li> <li>– Sterility and reduced yield</li> </ul>	Likely 4	Rare 2	Major 4	Minor 2	Negligible 1*	Negligible 1*	High 12	Moderate 6
Field crops	Hay and clover	<ul style="list-style-type: none"> <li>– Damage to leaves</li> <li>– Compromised fall hardening</li> <li>– Increased sensitivity to freezing temperatures in winter</li> <li>– Reduced yield in the following growing season</li> </ul>	Almost certain 5	Possible 3	Major 4	Minor 2	Negligible 1*	Negligible 1*	High 15	Moderate 9
Fruit and vegetables	Apples	<ul style="list-style-type: none"> <li>– Cold damage to fruit trees</li> <li>– Reduced yield</li> </ul>	Almost certain 5	Possible 3	Extreme 5	Minor 2	Negligible 1*	Negligible 1*	High 18	High 11

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

## Extreme Storm Events Risk Scenarios:

Sector	Sub-sector	Impacts	Scenario Likelihood (/5)		Severity of Consequences (/5)				Risk Score (/25)	
			Current (1981-2010)	Future (2050s)	Financial Losses	Environmental Damage	Infrastructure Damage & Services	Human Health & Public Safety	Current (1981-2010)	Future (2050s)
<b>Farm Infrastructure</b>	Power source	<ul style="list-style-type: none"> <li>– Damage to critical power supplying infrastructure</li> <li>– Power outages</li> <li>– Heat stress in poultry and livestock</li> <li>– Jeopardized milk production</li> </ul>	<b>Likely 4</b>	<b>Almost certain 5</b>	<b>Major 4</b>	<b>Negligible 1*</b>	<b>Major 4</b>	<b>Minor 2</b>	<b>High 12</b>	<b>High 15</b>

\* Scores ranked Negligible\* were believed to be not explicitly relevant to the scenario. When a Negligible\* score was assigned for one of the consequence scenarios, it was excluded from the average consequence. For example, if the Infrastructure and Human Health scores are Negligible\*, the 'average consequence' is only a product of the Environmental Damage and Financial Loss categories.

## Appendix: Risk Scoring Criteria

### Risk Scoring Details:

A mixed method (qualitative and quantitative) approach was used for assessing each identified risk scenario, drawing on climatological expertise and climate data to inform likelihood scores, and literature and expert judgement to inform consequence scores. The likelihood and consequence associated with each risk scenario have been used to calculate each total risk score. The likelihood of the climate hazard and the associated consequence categories are all scored using 5-point scales. The total risk score is calculated by averaging the consequence component scores and multiplying the average consequence score by the likelihood score. This method results in a risk score range for from one (1) to twenty-five (25).



Likelihood Scoring Criteria:

WHAT IS THE FREQUENCY / PROBABILITY OF THE CLIMATE HAZARD?		
Category	Score	Definition
Rare	1	Expected to happen less than about once every 30 years or less, annual probability <3%
Unlikely	2	Expected to occur once in 11 to 29 years, annual probability between 3% and 9%
Possible	3	Expected to occur once in 6 to 10 years, annual probability between 10% and 17%
Likely	4	Expected to occur about once every 3 to 5 years, annual probability between 29% and 33%
Almost Certain	5	Expected to occur once every 2 years or more frequently, annual probability ≥50%

## Consequence Scoring Criteria:

Category	Negligible 1	Minor 2	Moderate 3	Major 4	Extreme 5
<b>Financial Losses</b>	Little or no impact on farm revenue. Less than 3% yield loss or livestock mortality and productivity decrease.	Minor impact on farm revenue, some yield, capital and operational losses (3.0 to 9.9% yield loss and increase in livestock mortality and productivity decrease). Temporary interruption of socio-economic activity.	Moderate impact on farm revenue due to decreased yield and livestock productivity (10 to 29.9% yield loss and increase in livestock mortality and productivity decrease). Short-term interruption of socio-economic activity.	Significant impact on farm revenue due to crop damage/loss and decreased livestock productivity/increased mortality. (30% to 50% yield loss and increase in livestock mortality and productivity decrease). Months-long interruption of socio-economic activity.	Very significant impact on farm revenue due to crop damage/loss and decreased livestock productivity/increased mortality (over 50% decrease in yield and increase in livestock mortality and productivity decrease). Long-term interruption of socio-economic activity.
<b>Environmental Damage</b>	Impact is not measurable within the ecosystem.	Localized impact on the environment, exceeds natural variability with minor shifts in species abundance, decreased soil and water quality. Recovery possible within months (under a year).	Localized or reversible environmental damage, depletion of soil and water resources, recovery within 2 to 5 years.	Widespread environmental damage, recovery taking over 5 years. Strong effects from loss of ecosystem function, soil and water quality degradation.	Widespread and irreversible environmental damage, collapse of ecosystem processes, destruction of resources is permanent and irreversible.
<b>Infrastructure Damage and Service Disruption</b>	Minor, isolated, and/or cosmetic damage to property. Minimal, short-term service interruption. Temporary nuisance.	Moderate, or limited loss of physical property. Hours-long disruption in infrastructure services.	Significant, localized loss of property or moderate damage or loss on a wider scale. Days-long disruption of services. Major impediment to daily life.	Significant loss of property on a wide scale. Weeks-long disruption in services. Major impediment to daily life.	Widespread severe damage or loss of key assets, leading to cascading impacts. Months-long disruption of infrastructure services.
<b>Human Health and Public Safety</b>	Little or no impact on a person's ability to carry on regular activities. Minimal disruption to daily life.	Localized disturbance, disruption to daily activities/quality of life, temporary psychological impacts (fear, anxiety).	Permanent disability. Significant disruption to daily activities/quality of life, seasonal loss of livelihoods.	Fatality; permanent disability. Significant disruption to daily activities/quality of life. Localized, permanent loss of livelihoods. Long-term psychological impacts.	Multiple fatalities; permanent disability. Catastrophic impact on quality of life. Long-term psychological impacts. Erosion of community institutions and social cohesion.

Risk Scoring Matrix:

<b>Likelihood</b>	<b>Almost Certain</b> 5	Moderate 5	High 10	High 15	Extreme 20	Extreme 25
	<b>Likely</b> 4	Low 4	Moderate 8	High 12	High 16	Extreme 20
	<b>Possible</b> 3	Low 3	Moderate 6	Moderate 9	High 12	High 15
	<b>Unlikely</b> 2	Negligible 2	Low 4	Moderate 6	Moderate 8	High 10
	<b>Rare</b> 1	Negligible 1	Negligible 2	Low 3	Low 4	Moderate 5
		<b>Negligible</b> 1	<b>Minor</b> 2	<b>Moderate</b> 3	<b>Major</b> 4	<b>Extreme</b> 5
<b>Consequence</b>						



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