Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Carleton UNIVERSITY

Canada

Extreme weather events and agriculture: Identifying and characterizing key impacts to corn and soybeans at the regional scale

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June 1, 2016

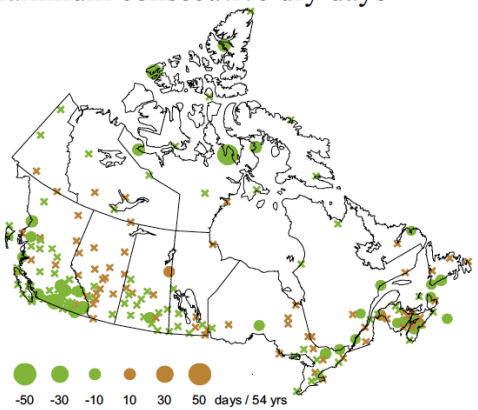
Extreme weather and agriculture


Photo: Tim Smith, The Canadian Press

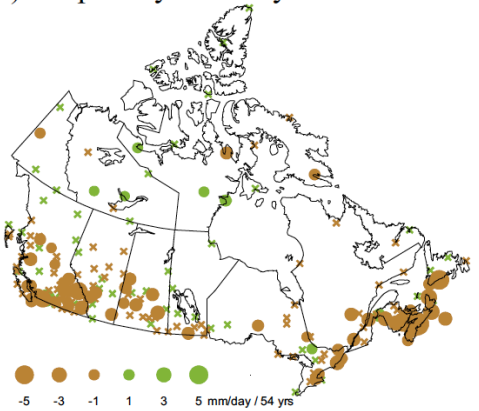

Photo: Bob Nichols; USDA

Generic weather extremes

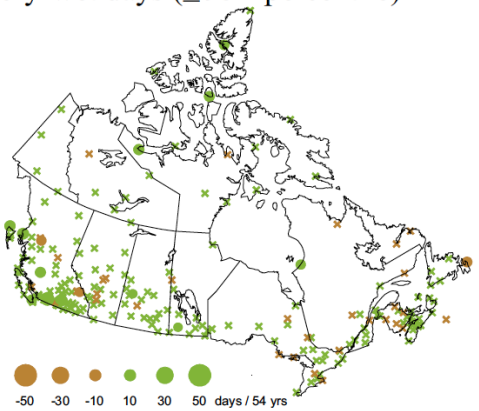
a) Maximum consecutive dry days



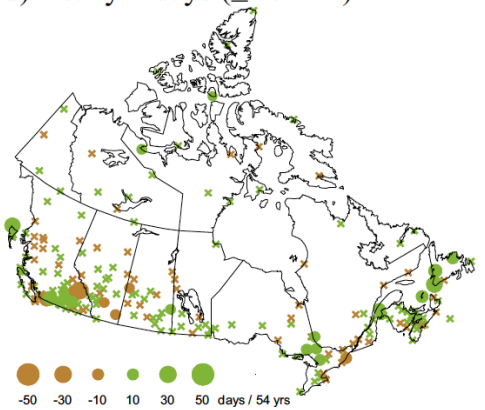
b) Simple day intensity index of P



c) Very wet days ($\geq 95^{th}$ percentile)



d) Heavy P days (≥ 10 mm)



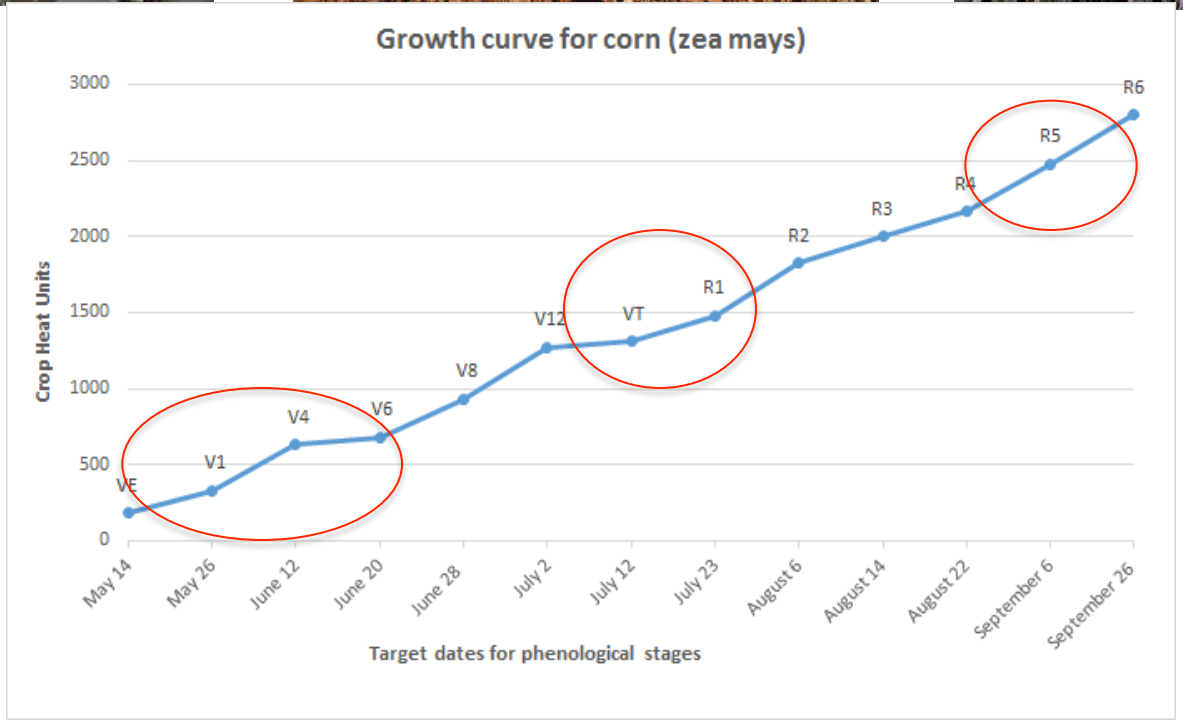
Source: Vincent and Mekis (2006)

Crop-specific weather extremes

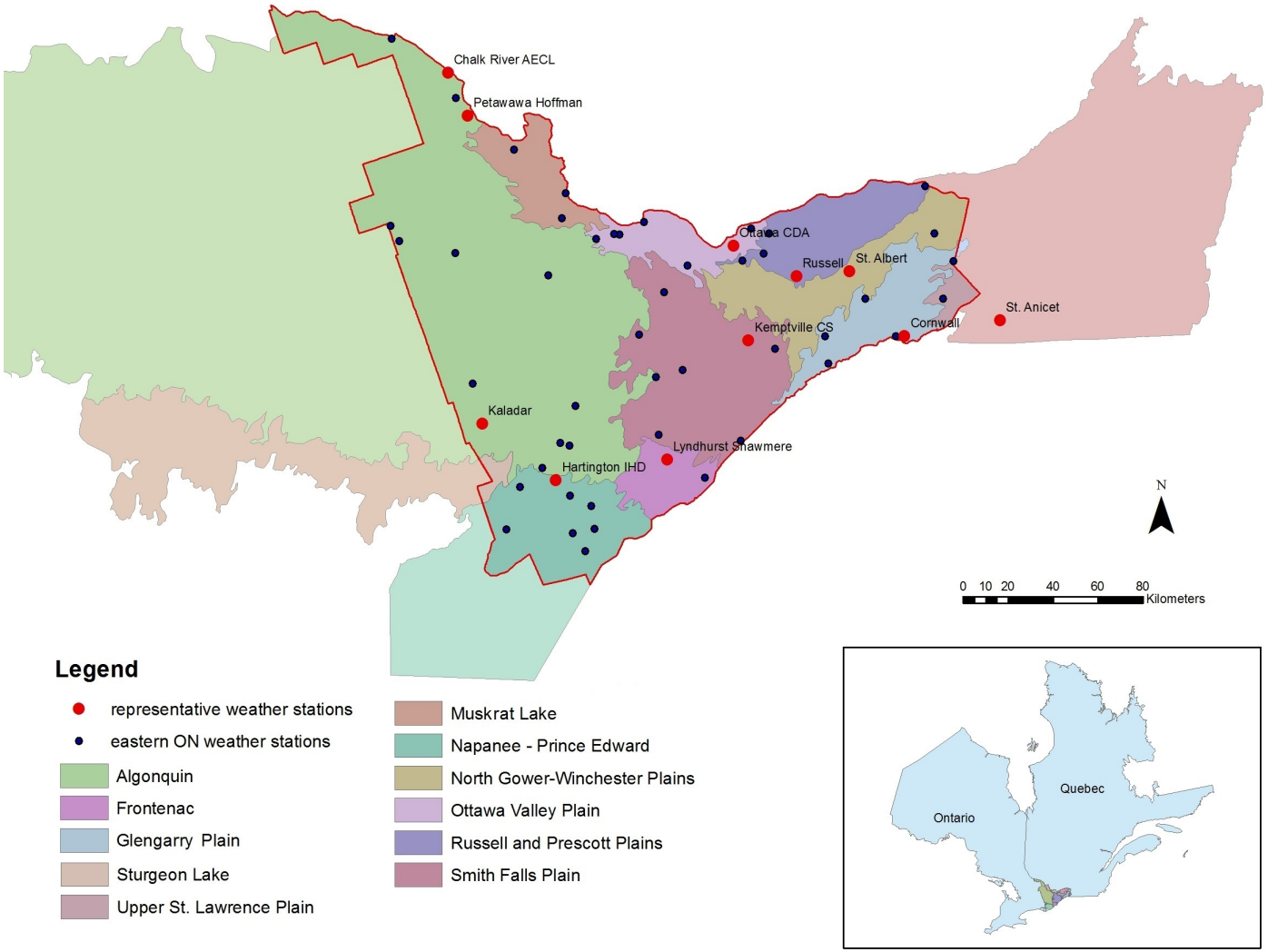

Photo: Nati Harnik, AP


Photo: Oklahoma Farm Report


Photo: Howard F. Schwartz, CSU



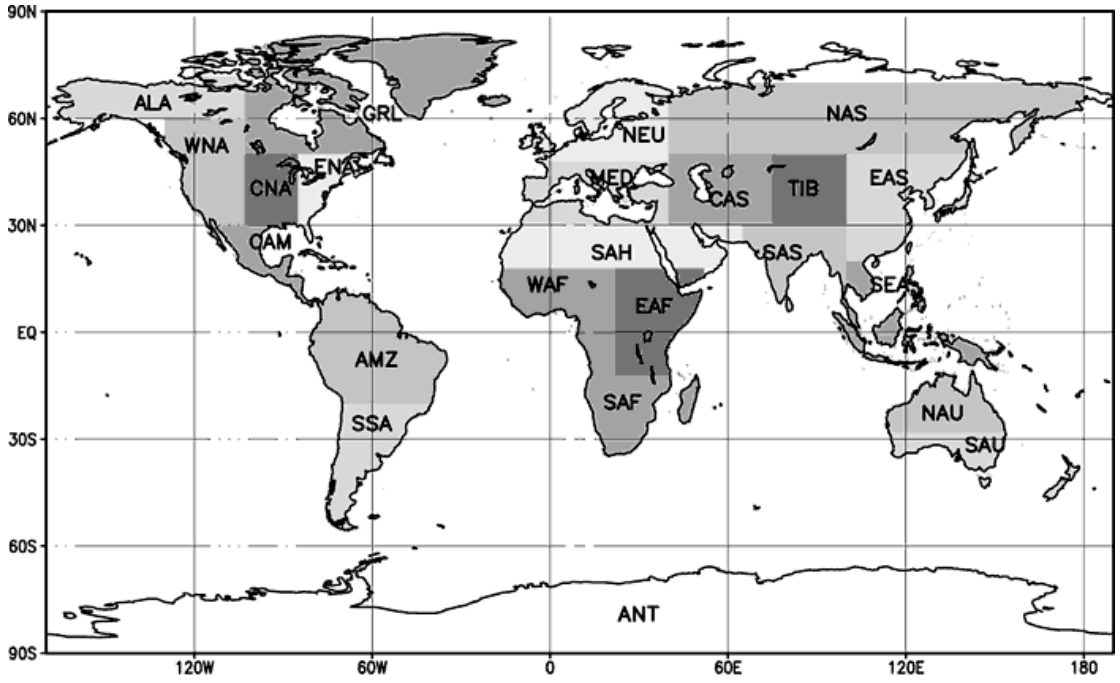
Study area


Chalk River AECL
Petawawa Hoffman
Ottawa CDA
Russell
St. Albert
St. Anicet
Cornwall
Kemptville CS
Kaladar
Lyndhurst Shawmere
Hartington IHD
N
0 10 20 40 60 80
Kilometers
Legend
representative weather stations
eastern ON weather stations
Algonquin
Frontenac
Glengarry Plain
Sturgeon Lake
Upper St. Lawrence Plain
Muskrat Lake
Napanee - Prince Edward
North Gower-Winchester Plains
Ottawa Valley Plain
Russell and Prescott Plains
Smith Falls Plain
Ontario
Quebec

Climate data

- Quality controlled gap filled data for daily min and max temperature and daily precipitation from 1961 to 2010. (Sources: EC, Schroeter and Associates)

- High resolution downscaled daily temperature and precipitation data for an ensemble of 12 models used in CMIP5 under RCP 8.5 from 2011 to 2035. (Source: Pacific Climate Impacts Consortium)



ALA	Alaska	NEU	Northern Europe	NAS	Northern Asia
WNA	Western North America	MED	Mediterranean	TIB	Tibet
CNA	Central North America	CAS	Central Asia	EAS	Eastern Asia
ENA	Eastern North America	SAH	Sahara	SAS	Southern Asia
GRL	Greenland	WAF	West Africa	SEA	South East Asia
CAM	Central America	EAF	East Africa	NAU	Northern Australia
AMZ	Amazonia	SAF	Southern Africa	SAU	Southern Australia
SSA	Southern South America	ANT	Antarctic		

Source: Giorgi and Fransisco 2000

Indicator development

- Extensive literature review (close to 100 sources reviewed)
- Expert consultations (AAFC, OMAFRA)
- Crop tolerance thresholds to T and P conditions at various phenological stages were identified
- Yield loss percentages associated with threshold exceedance were studied

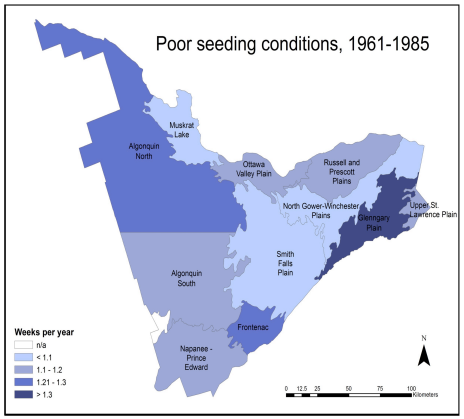
Corn-specific indices

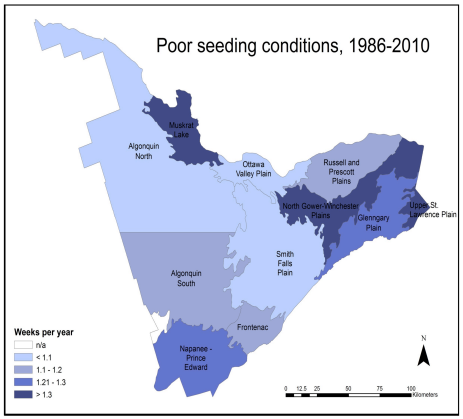
Index name	Definition	Units
Corn:		
Poor seeding conditions	**Weekly precipitation 30% greater than weekly mean precipitation (between April 23 and May 20)**	**weeks/year**
Early flooding	**Weekly precipitation 30% greater than weekly mean precipitation with 1 to 780 accumulated CHUs**	**weeks/year**
Pollination drought	**CDD >10 with 1,301 to 1,600 accumulated CHUs**	**annual occurrence (Yes or No)**
R2 (blister) drought	**P<45mm with 1,601 to 1,825 accumulated CHUs**	**annual occurrence (Yes or No)**
R3 (milk) drought	**P<45mm with 1,826 to 2,000 accumulated CHUs**	**annual occurrence (Yes or No)**
Early killing frost	Tmin <=-2°C with 2,165 to 2,475 accumulated CHUs	days/year
R4 (dough) drought	**P<8mm with 2,001 to 2,165 accumulated CHUs**	**annual occurrence (Yes or No)**
Fall killing frost	Tmin <=-2°C with 2,476 to 2,600 accumulated CHUs	days/year

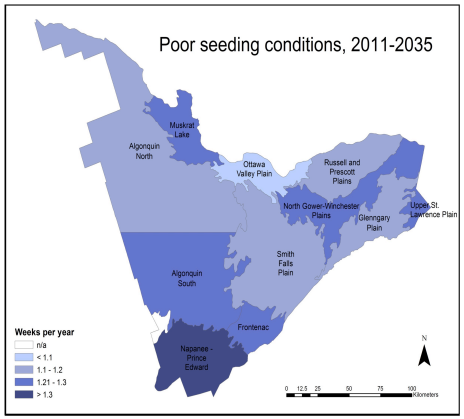
Soybean-specific indices

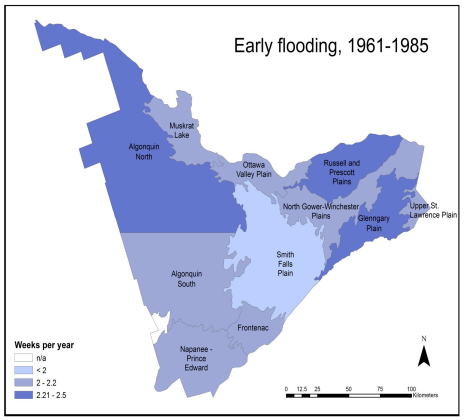
Index name	Definition	Units
Soybeans:		
Poor seeding conditions	**Weekly precipitation 30% greater than weekly mean precipitation (weeks between May 7 and June 10)**	**weeks/year**
Spring killing frost	Tmin <0°C 26 to 50 days after seeding	days/year
Early flooding	Precipitation 30% greater than weekly precipitation 25 to 45 days after seeding	weeks/year
Cool nights	Tmin <10°C for 5+ days 45-55 days after seeding	annual occurrence (Yes or No)
Warm nights	Tmin>=24°C 55 to 100 days after seeding	days/year
Mid-season flooding	Precipitation >90mm 60 to 80 days after seeding	annual occurrence (Yes or No)
Pod filling drought	**Precipitation <10mm 81 to 95 days after seeding**	**annual occurrence (Yes or No)**
Early killing frost	Tmin <-1°C between 90 and 100 days after seeding	days/year
Extreme heat	Mean Tmax>33°C 95-120 days after seeding	days/year
Fall killing frost	Tmin <-1°C 101 to 110 days after seeding;	days/year
Seed development drought	**P<5mm 96-115 days after seeding**	**annual occurrence (Yes or No)**

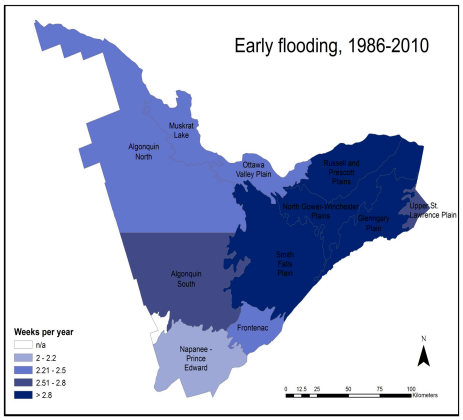
Results (Corn)

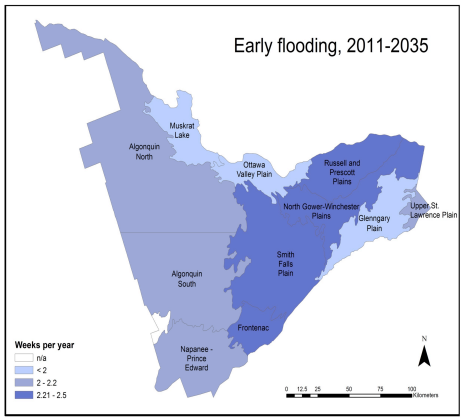


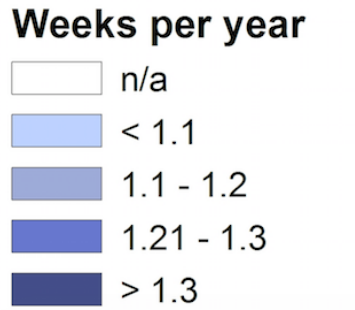


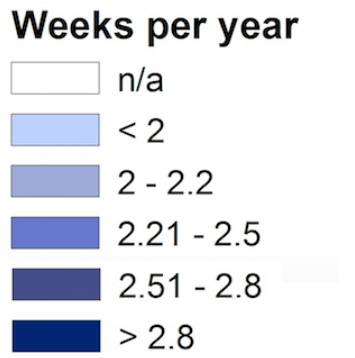




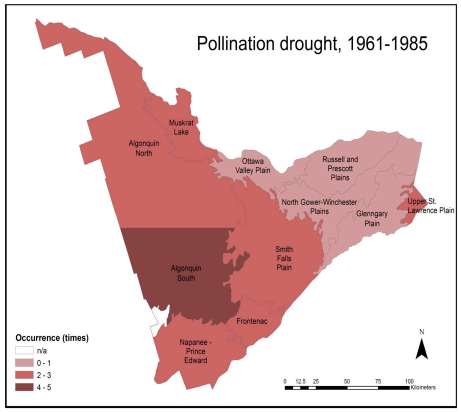


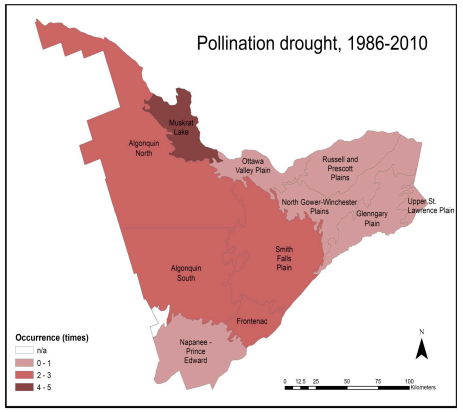


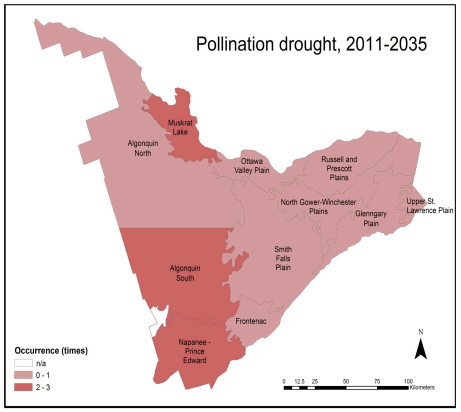


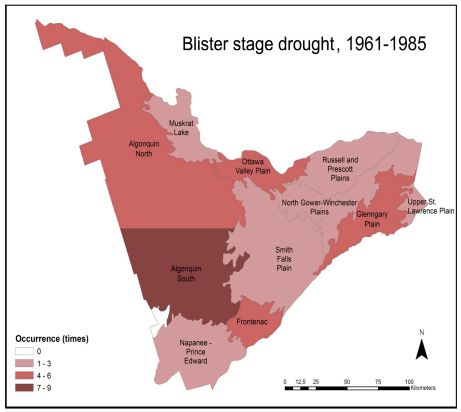


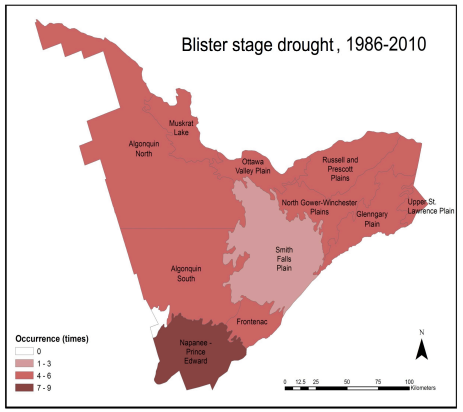
Results (Corn)

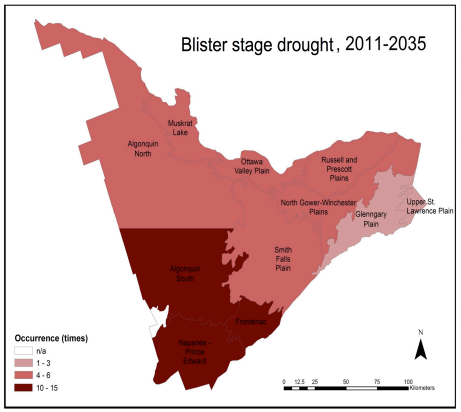


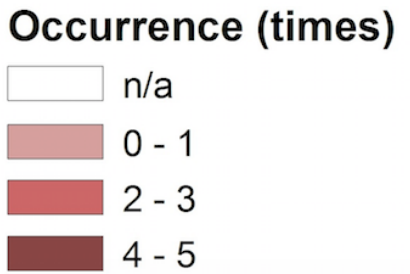


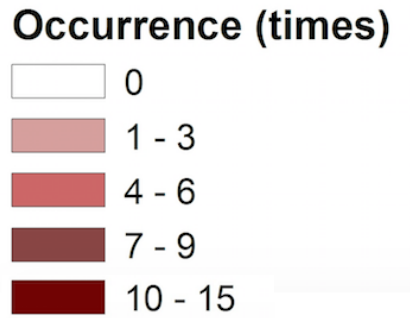




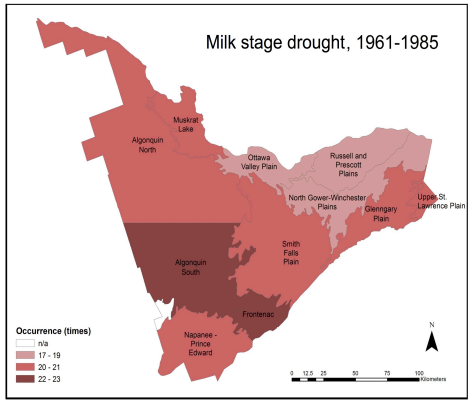


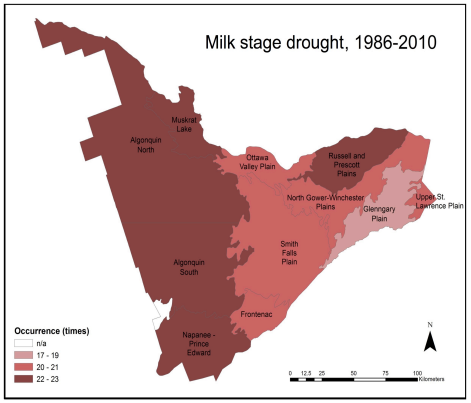


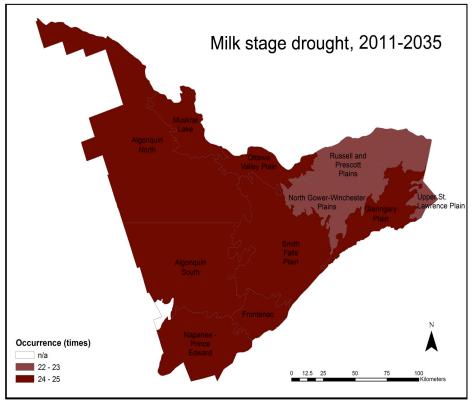


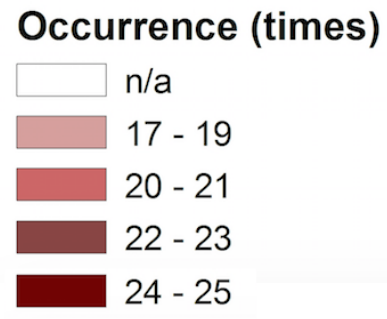


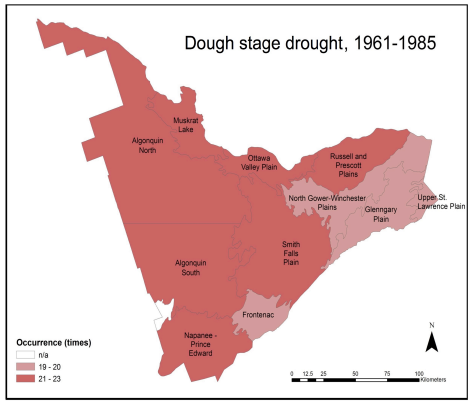
Results (Corn)

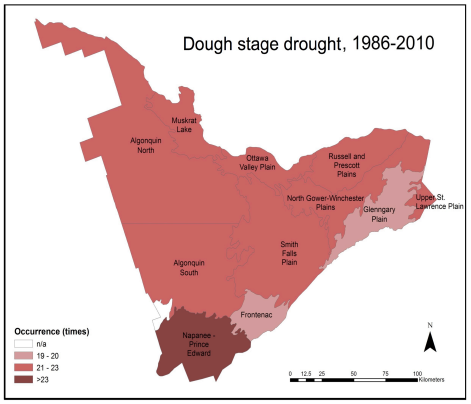


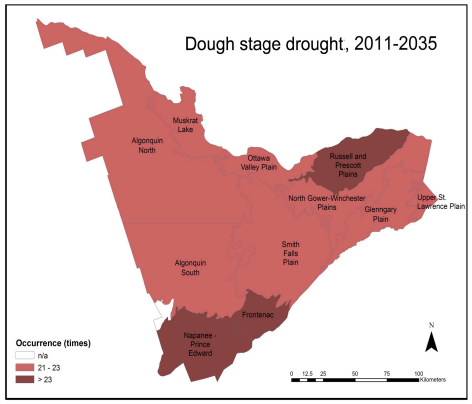


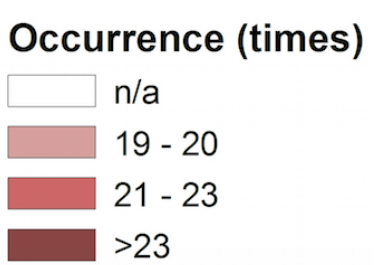




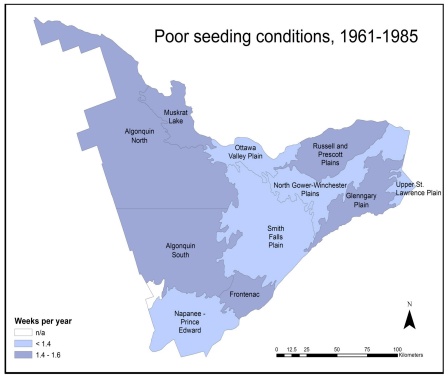


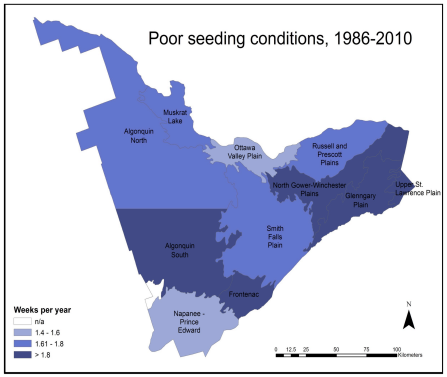


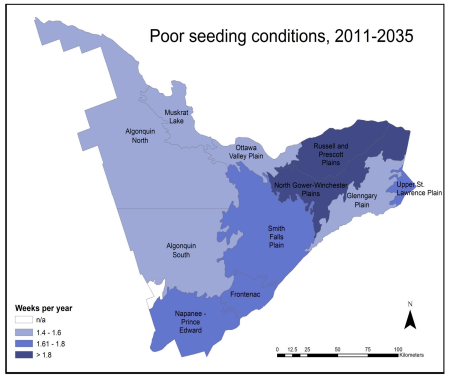


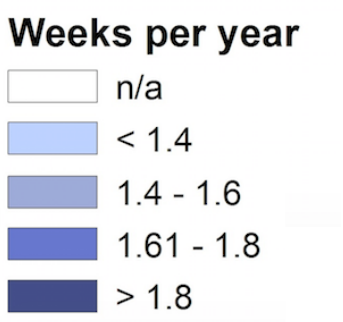


Results (Soybeans)









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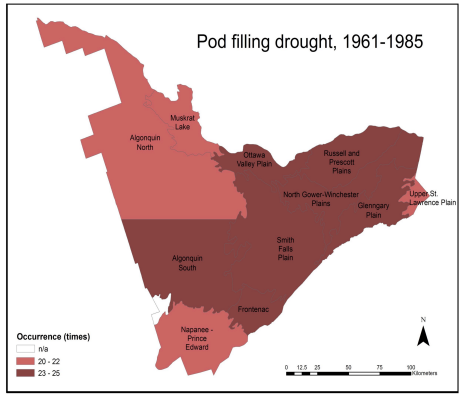

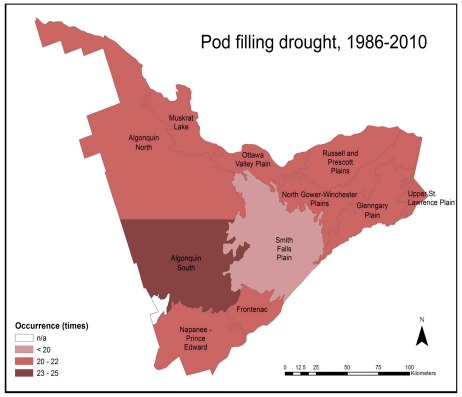

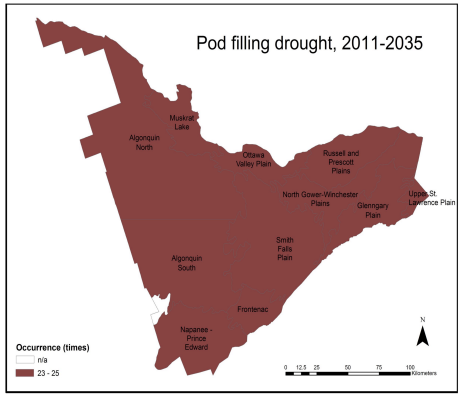

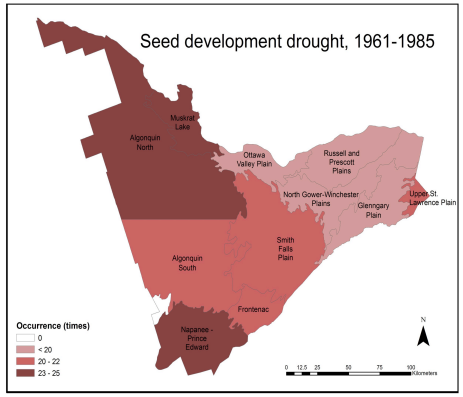

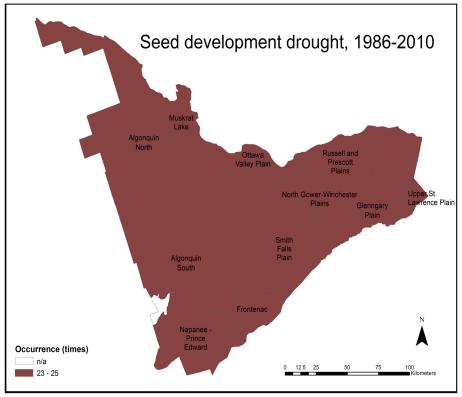

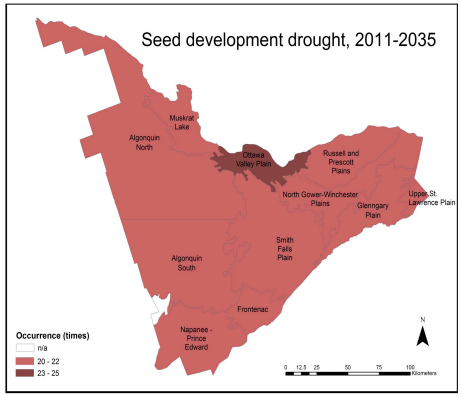

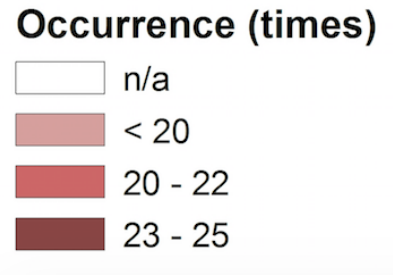

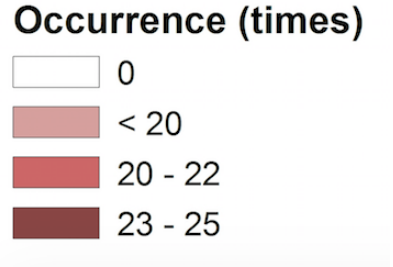

Further research directions

- Refine indicators by incorporating soil moisture and evapotranspiration calculations in formulas
- Analyze indicator performance using historic production data
- Conduct a more in-depth analysis using future projections data
- Apply methods in other regions using different crops

Thank you!