ClimateWest, a central hub for climate services in Manitoba, Saskatchewan, and Alberta, is proud to host Alberta's Adaptation Resilience Training module recordings and resources.

Check out climatewest.ca for all training material available through ART and other initiatives.

ClimateWest
Building Prairie Resilience

The aim of the Adaptation Resilience Program (ART) is to build the capacity of professionals in Alberta to adapt to climate change. This module was recorded in September, 2021.

Professionals across the Prairie region may find this training useful.

Supported by the Natural Resources Canada's Building Regional Adaptation Capacity and Expertise (BRACE) Program and the Government of Alberta

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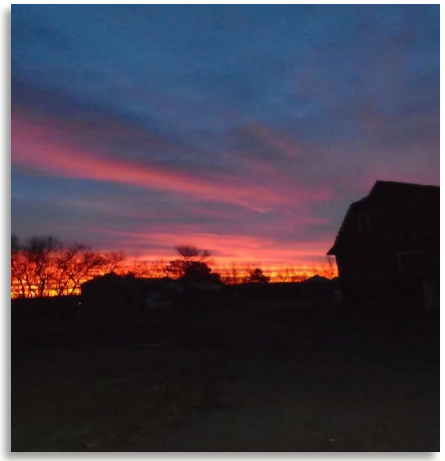

Session 1: Climate Change and its Impact on Agriculture

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September 15, 2021

Photo credits: Left V Wheaton, Centre and Right: E Wheaton

Climate, Agriculture, Farms, Drought and Excess Water

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Photo: N Jensen

Objectives: provide overview of

Current and future expected **climatic** changes important for agriculture

Agricultural areas at risk include crops, livestock, soil and water, infrastructure, health

Current and future possible climatic **impacts** to agriculture

Some relevant adaptation/ risk management options

Main Messages

Climate resources for agriculture have **changed** and will continue to change

Agroclimatic **resources** include growing season length, crop heat units, temperature-humidity indices, heat spells, timing of precipitation, droughts, excess moisture …

Impacts are many, including on crops, forage, pasture, soil, water, livestock, infrastructure, people, and communities

Indirect impacts include diseases, weeds and insects

Future climate change will bring both positive and negative impacts to agriculture

Net benefits to agriculture depend on the success of **adaptation** options to reduce risk

Some Terms

Adaptation means adjusting to actual and/or expected climate and its effects in order to reduce negative impacts and attain advantages

Risk assessment and management is a part of the adaptation process

Risk of agro-climate hazard = f (likelihood * impacts)

Agro-climatic variables are those climatic variables that are designed to relate to agriculture

The **capacity** to adapt depends on many capitals, e.g., natural, financial, human, social, institutional, political infrastructure, technology …

Adaptation is a Process

Steps include:

1) Determine past agro-climates

2) Assess past agricultural impacts

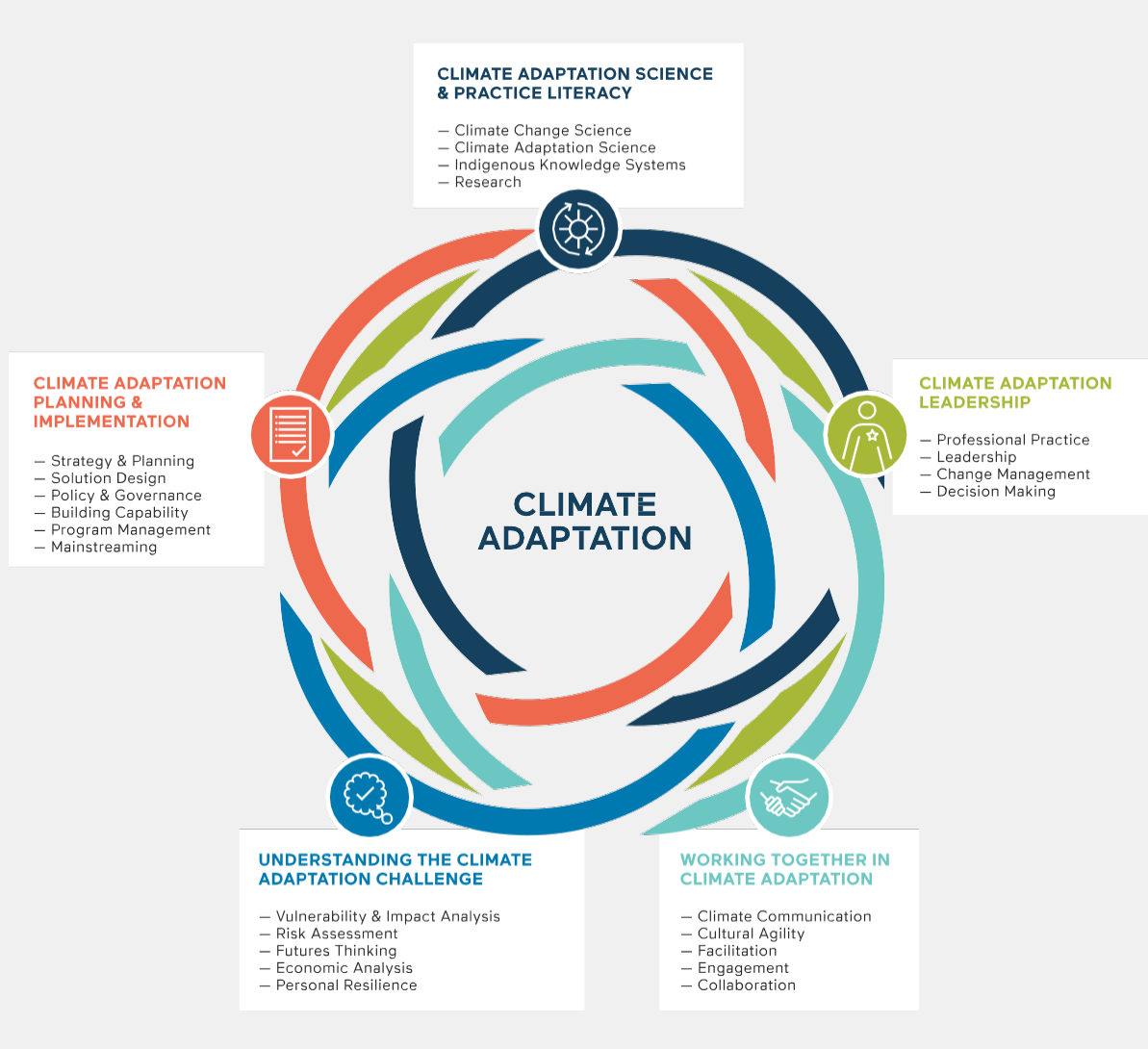
3) Explore future possible agro-climates

4) Estimate future possible impacts and vulnerabilities

5)Manage the risk, monitor, evaluate, learn, improve

Knowledge of the problem is critical for successful solutions.

Climate Change Adaptation Competency Framework (Cox et al 2021)



Why bother finding out about the agricultural risks of current and future climate change?

Agriculture is very sensitive to climate, some cases:

Droughts result in considerable agricultural losses (Wheaton et al 2008)

- the drought of 2001-2 resulted in a reduced Canadian GDP of almost $6Billion, for example

- AB agricultural losses were > $1.3B (2001-2)

Excess moisture and **flooding** result in crop losses and infrastructure damage, for example

Why bother finding out about the agricultural risks of current and future climate change?

Agriculture is very sensitive to climate, some cases:

Human and livestock **health** are affected by heat stress and disease-related effects of climate, e.g., West Nile Virus

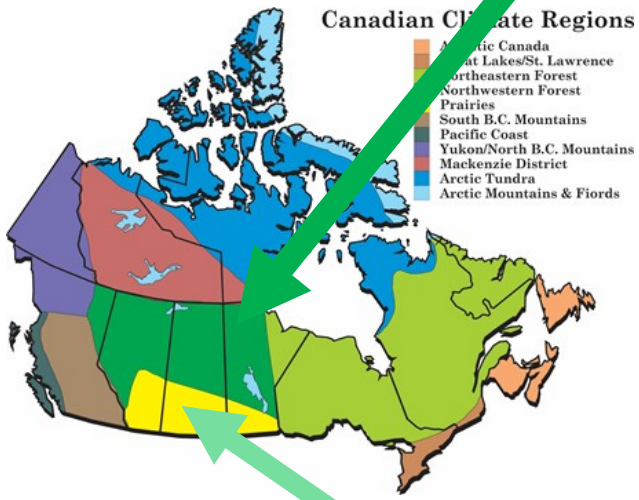
Reliable water supplies (quantity and quality), infrastructure, transportation, and other services are threatened

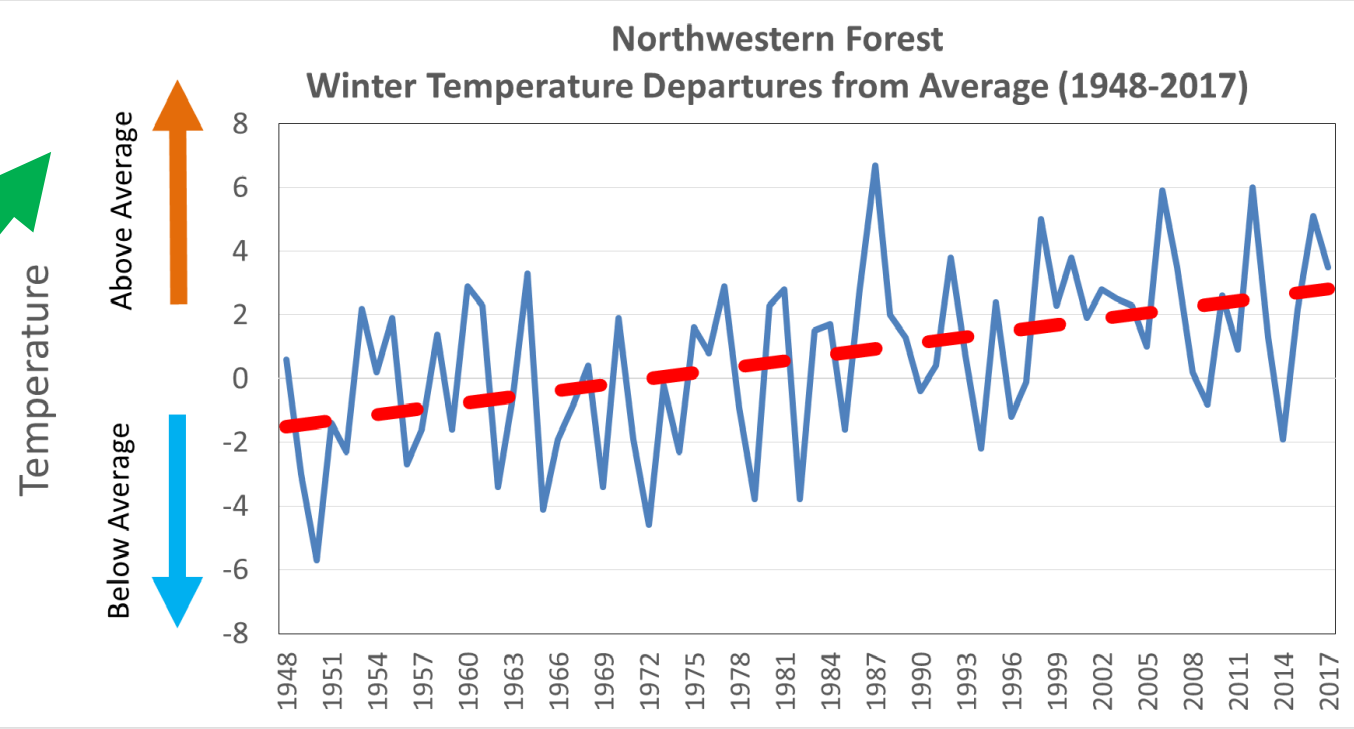
Effects **combine** to affect the economy, society, and environment. The result can be $billions in damages, disruption, and significant non-monetary losses

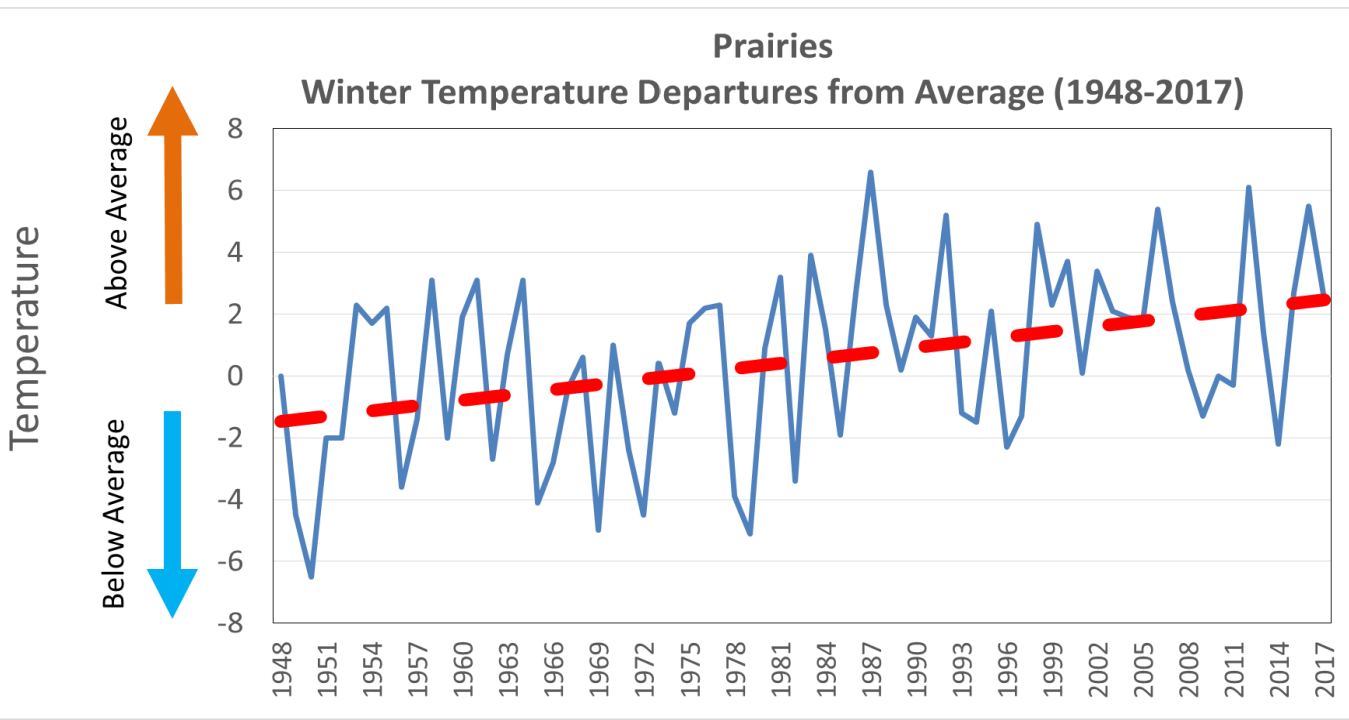
Step 1: Past Climatic Risks to Agriculture

Winter is Fading

Data: Environment and Climate Change Canada 2017

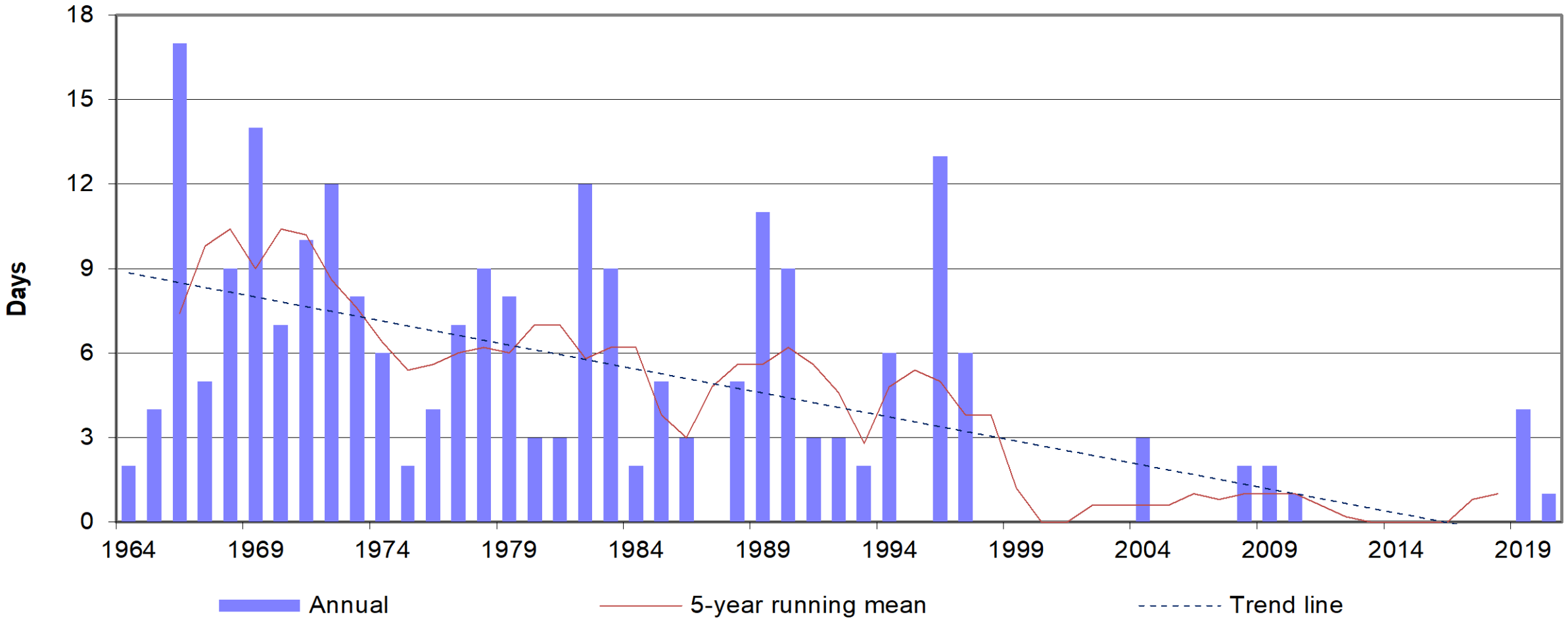




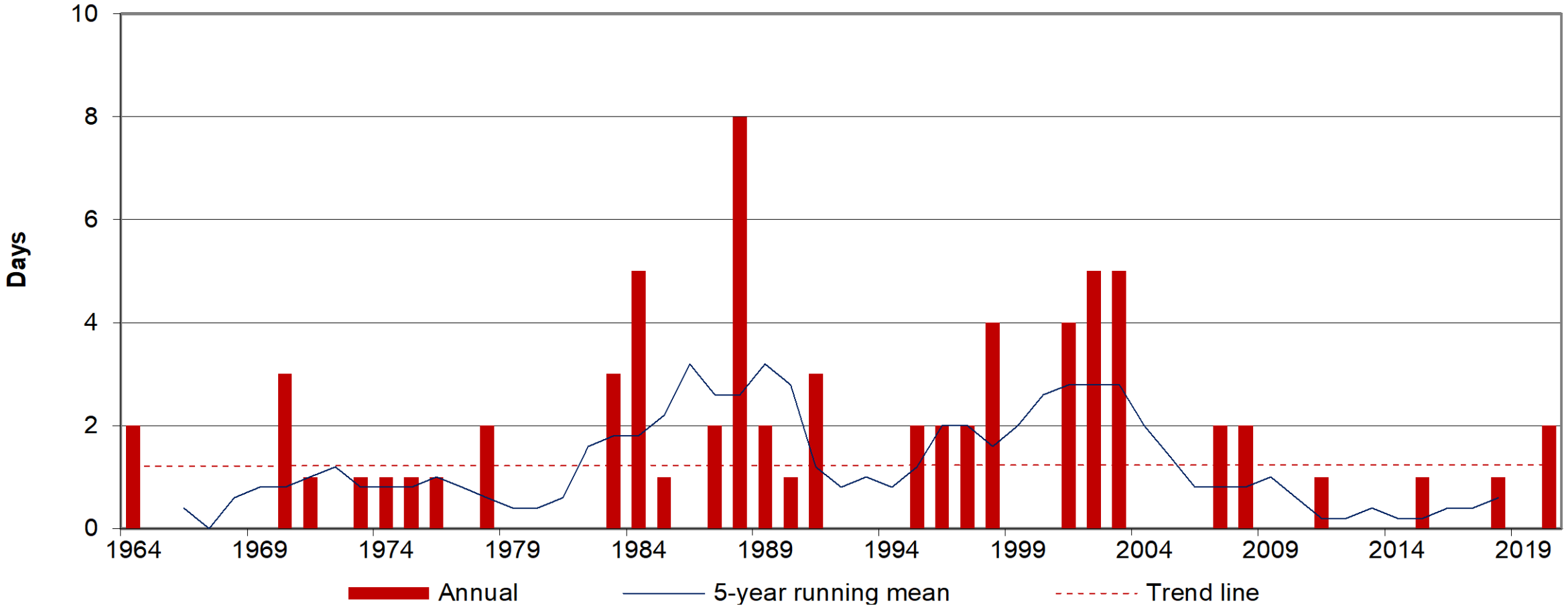


Extreme cold days (-35C and less) are almost vanishing

(Saskatoon, Wittrock 2021)



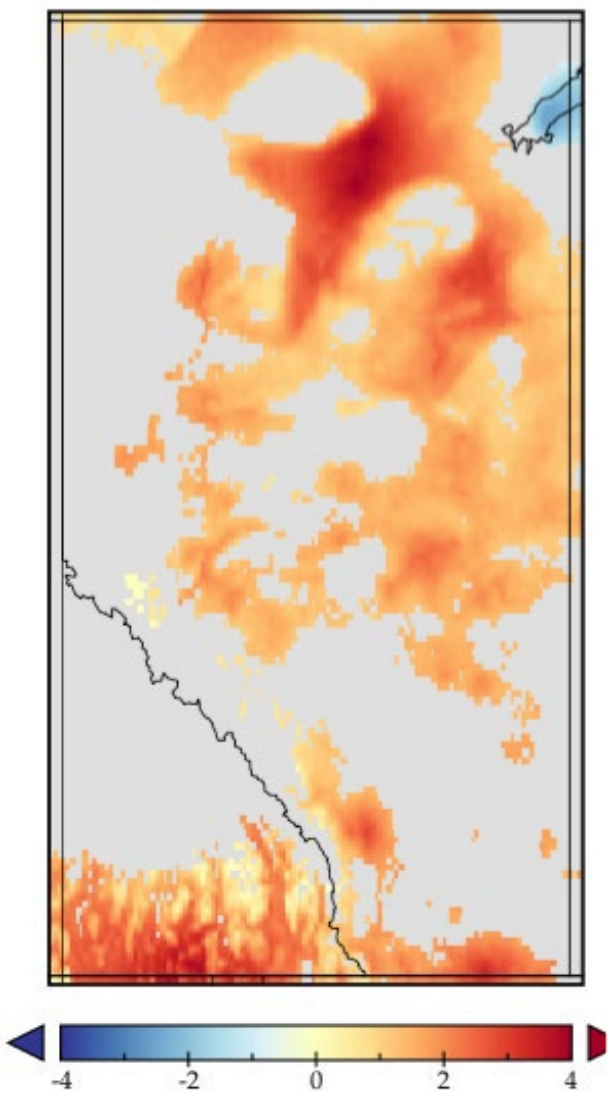
Number of Hot Days (35°C or greater) is changing less than cold days (Saskatoon, Wittrock 2021)

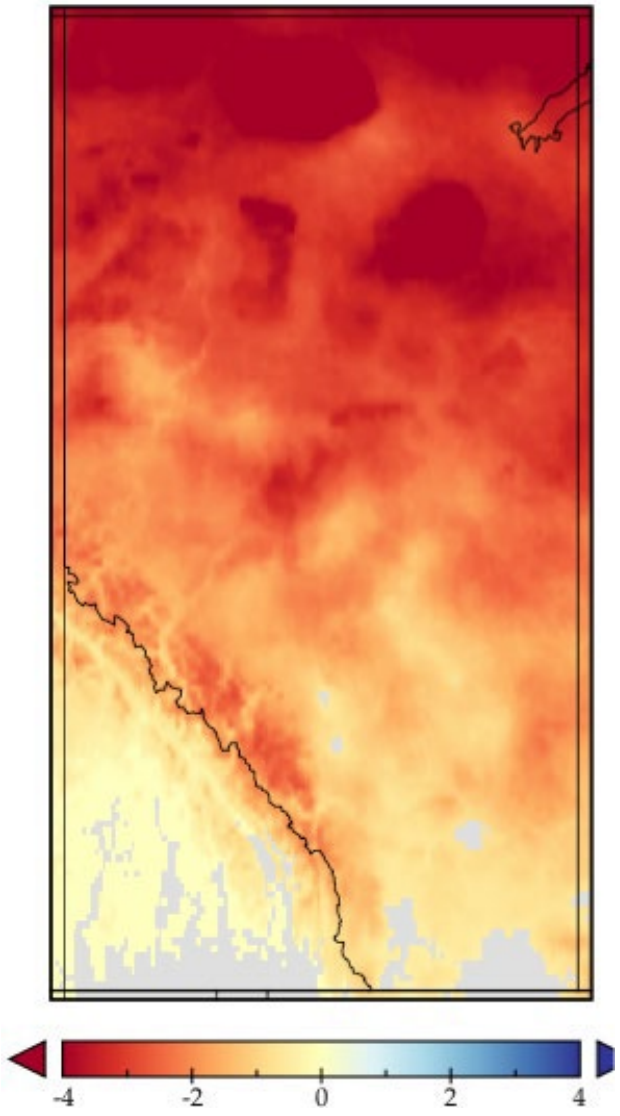


Warm days per year (left, max T>25C) have increased and cold days per year have decreased (right, min T <-30C)

1950-2013

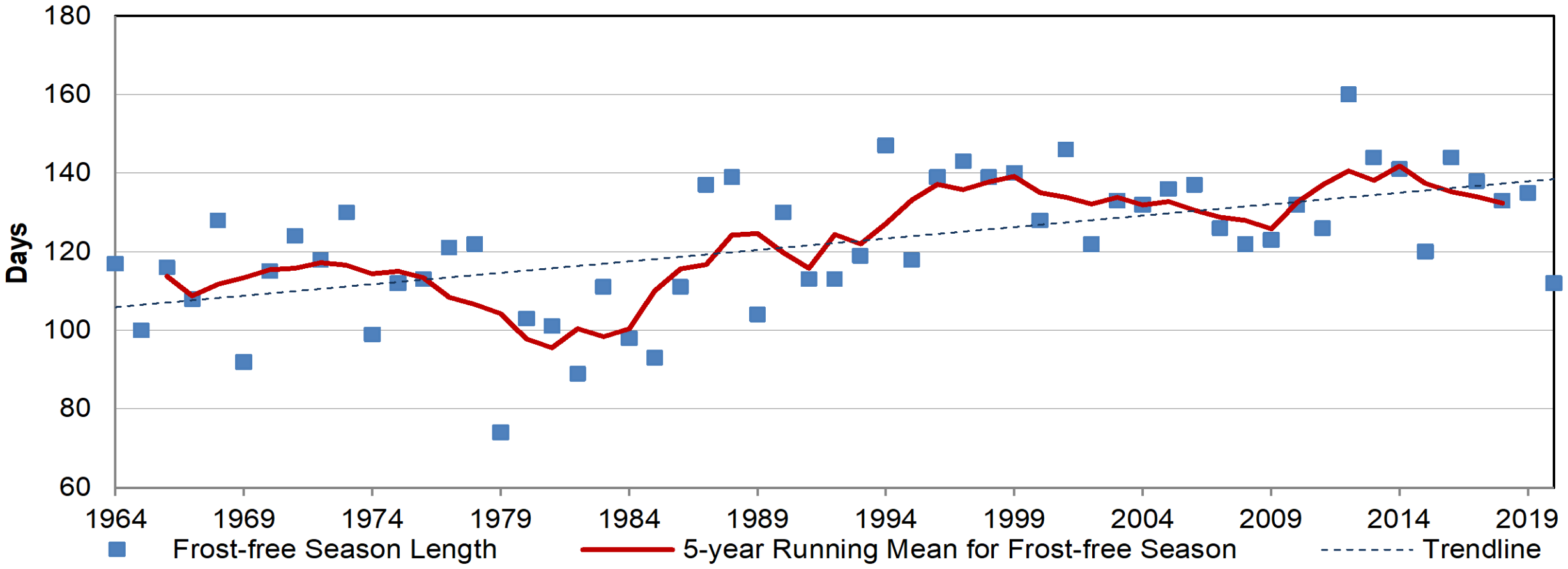
(Hayhoe Stoner 2019)





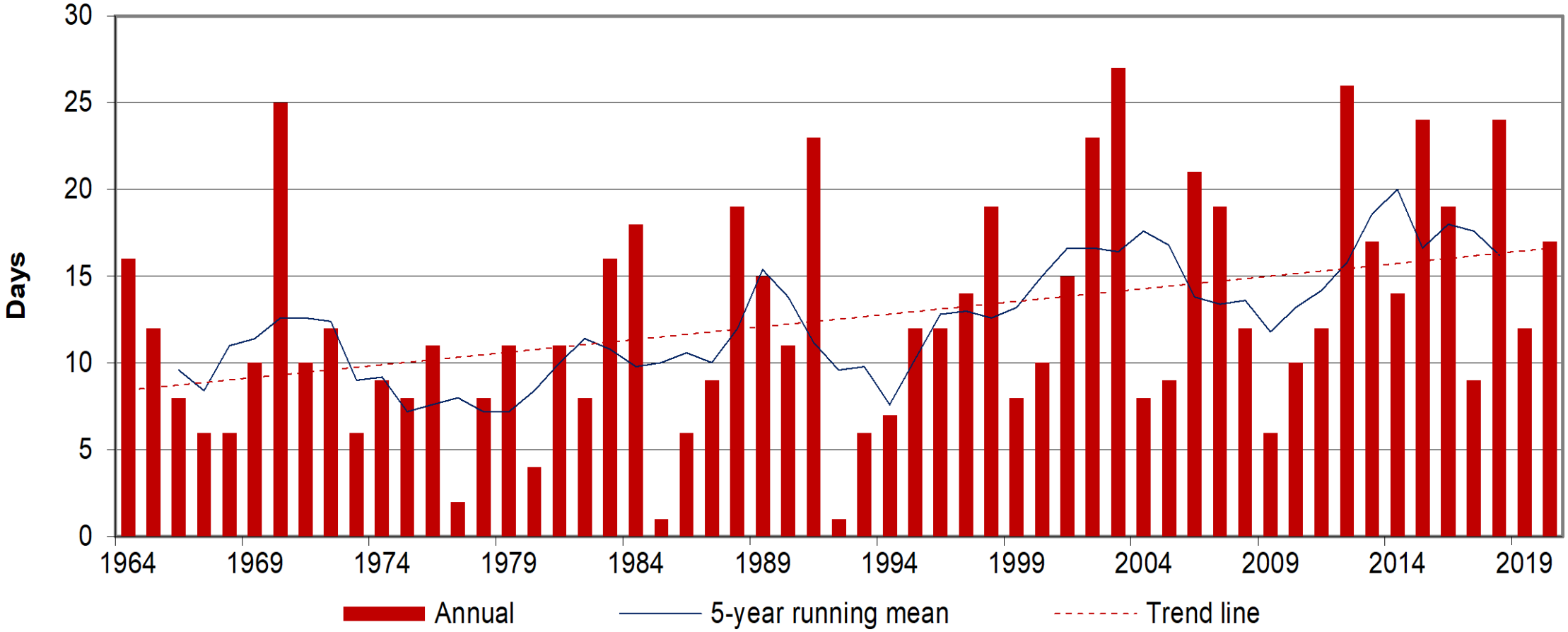
Frost-Free Season is Growing - About a month since the 1960s

(Saskatoon, Wittrock 2021)



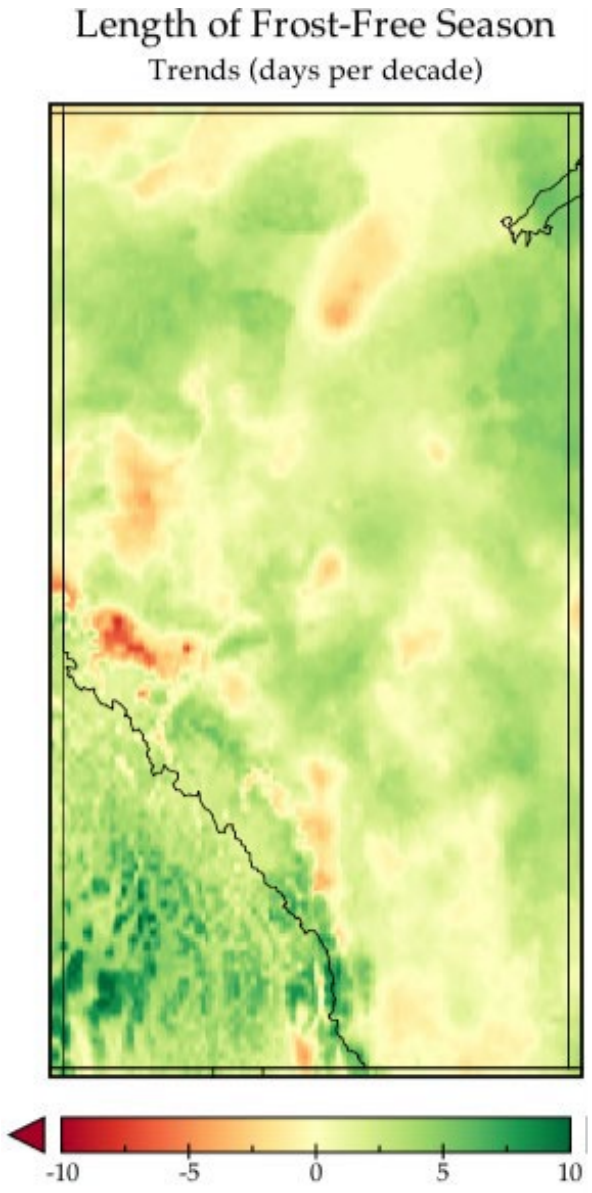
Increasing minimum temperatures affect Agriculture

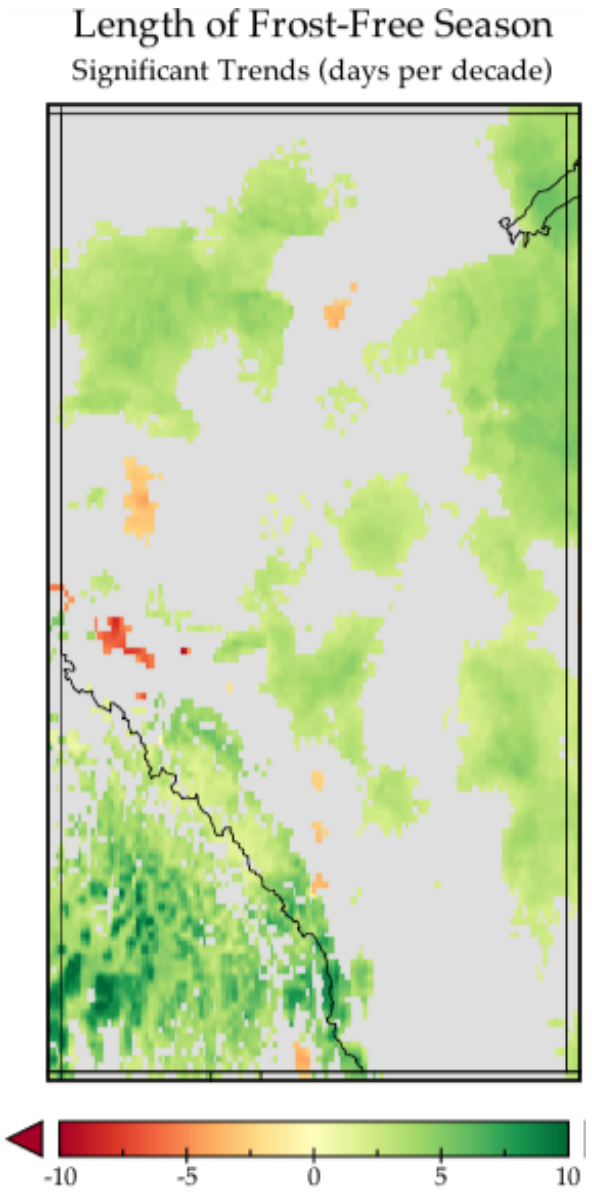
(Days with minimum temperatures 15C or greater, Wittrock 2021)



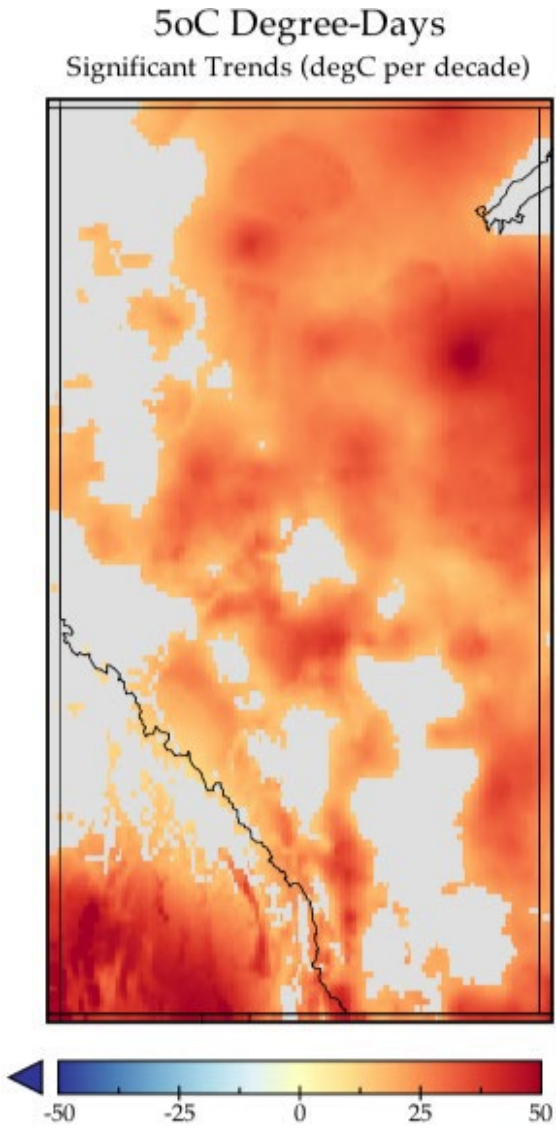
Increasing frost-free season length 1950-2013

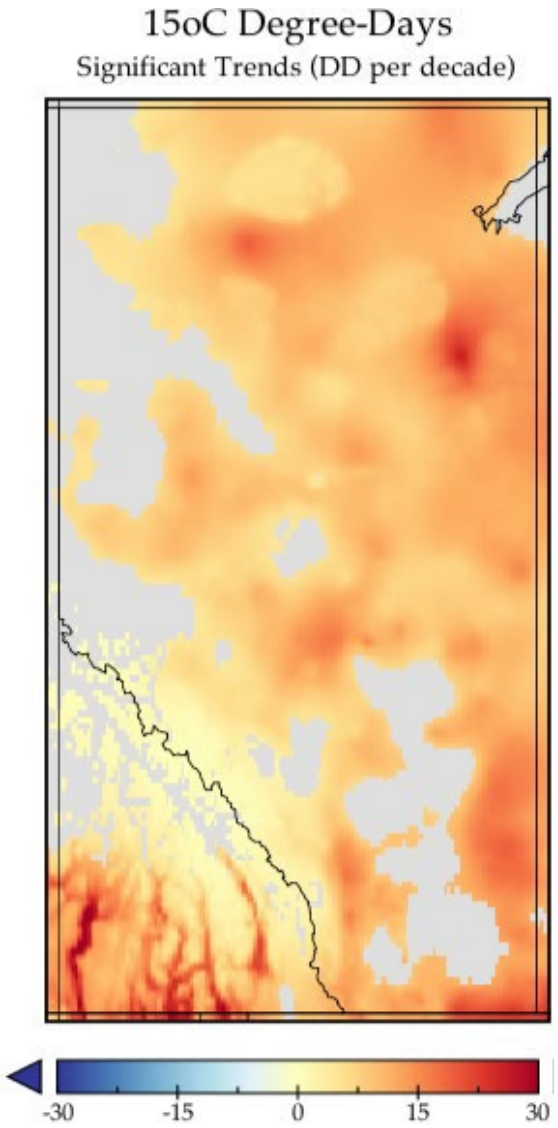
(Hayhoe and Stoner 2019 F12) Gray= insignificant trends 95th



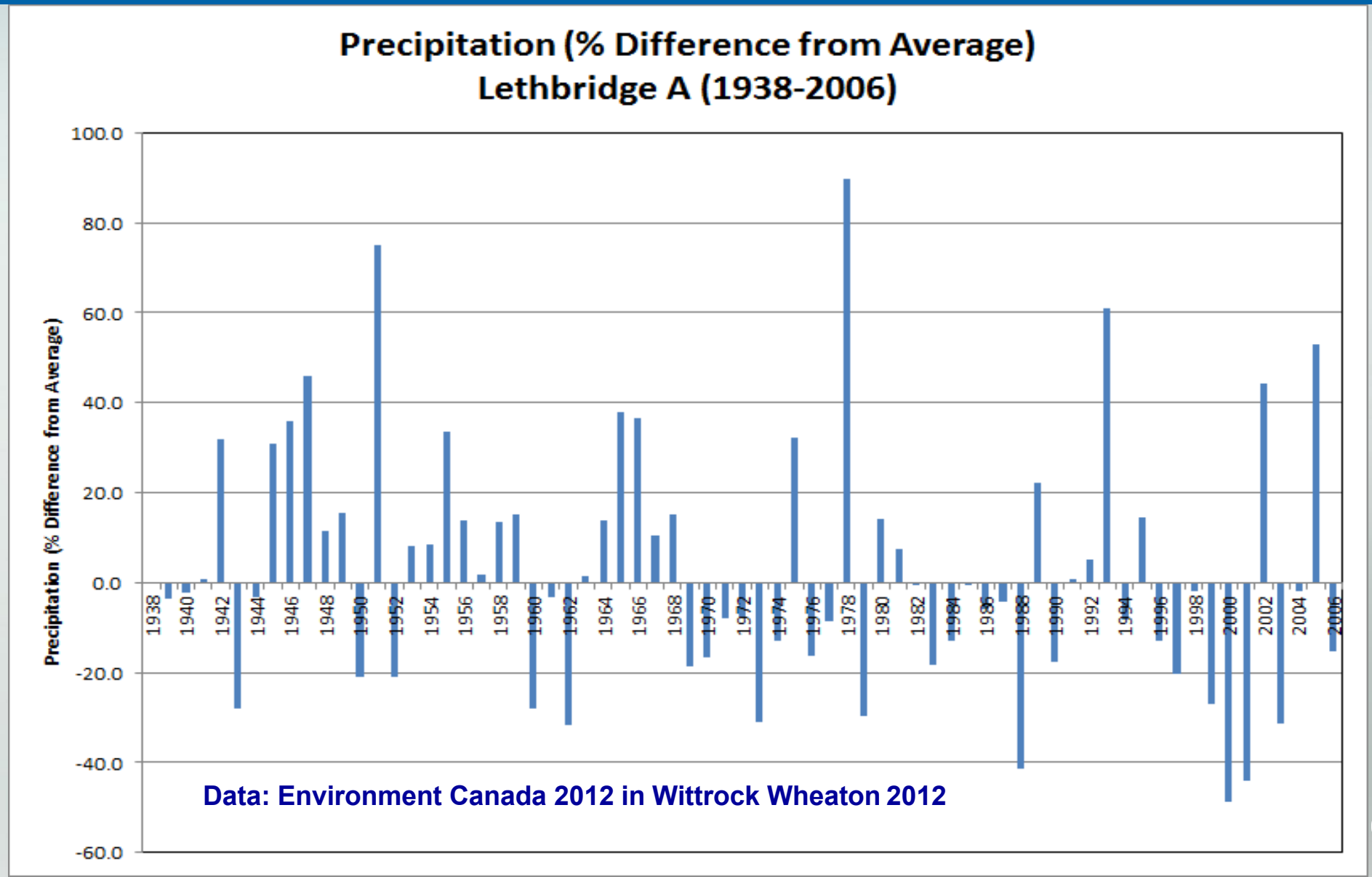


Degree-days over 5C and over 15C 1950-2013 already increasing (Hayhoe and Stoner 2019 F12) Gray= not significant

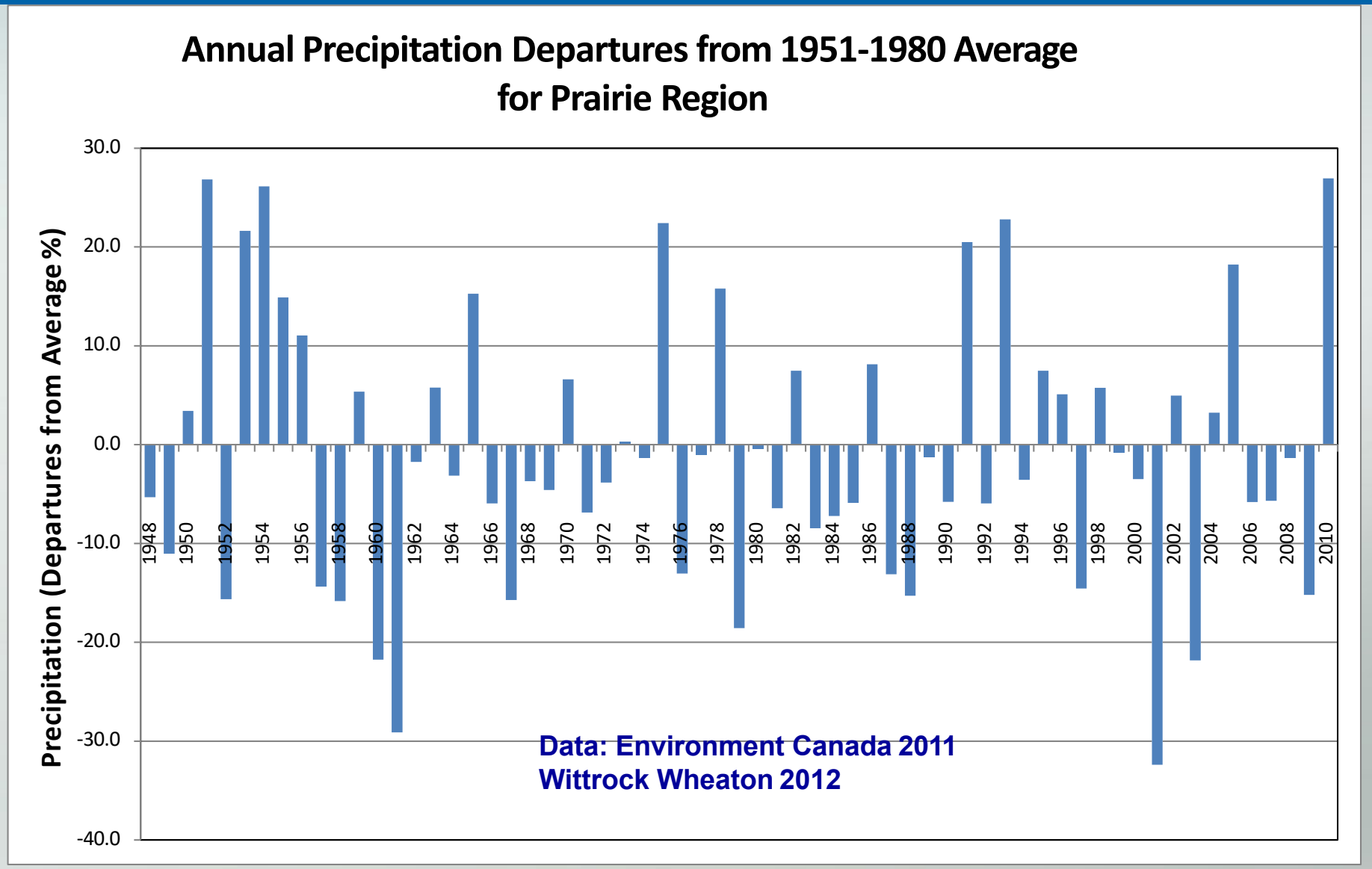




Precipitation Pattern at Lethbridge: variability
Wettest Year is 1978 and Driest is 2000

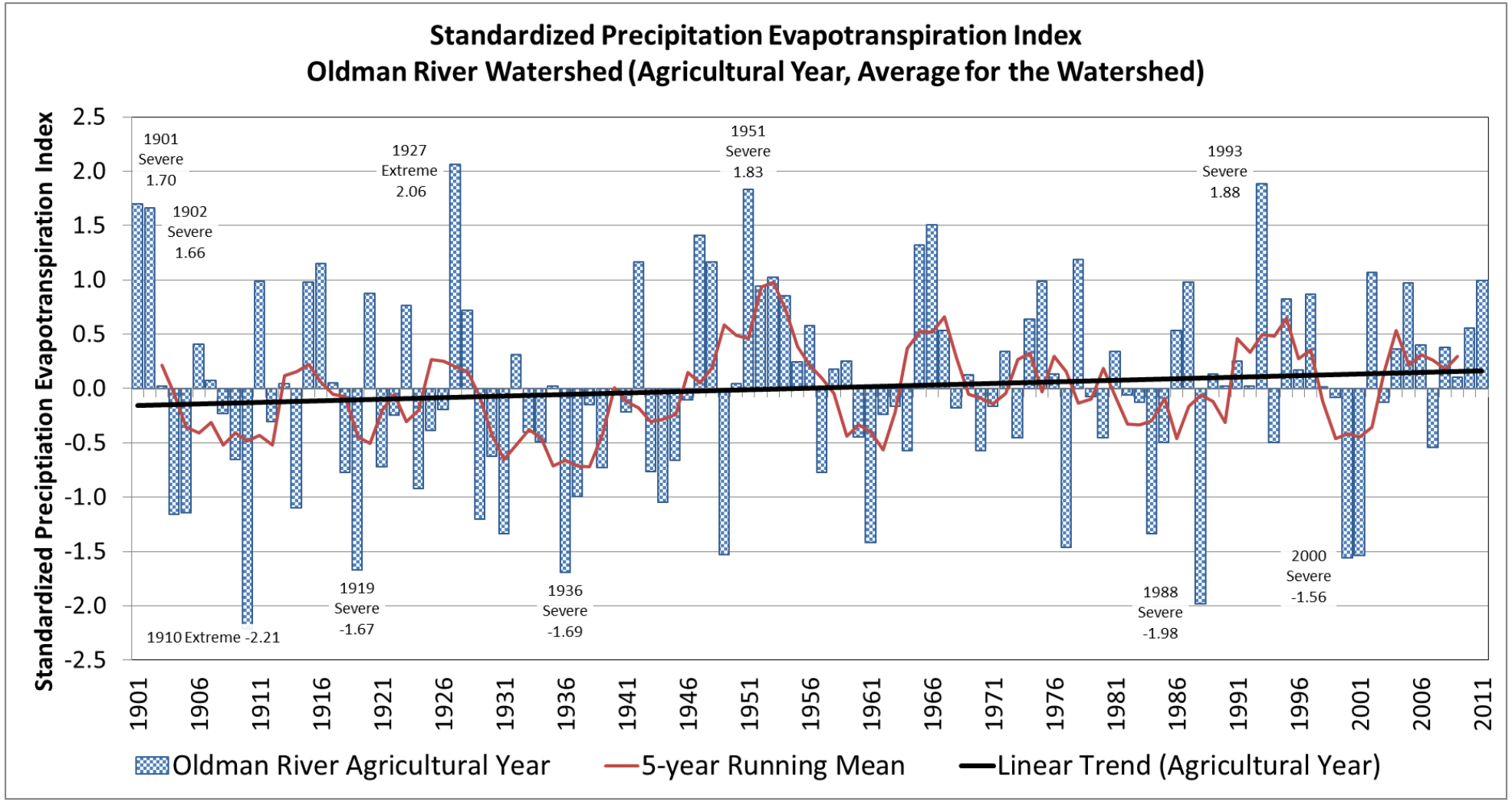


Precipitation patterns for the prairies show much variability with extreme highs and lows

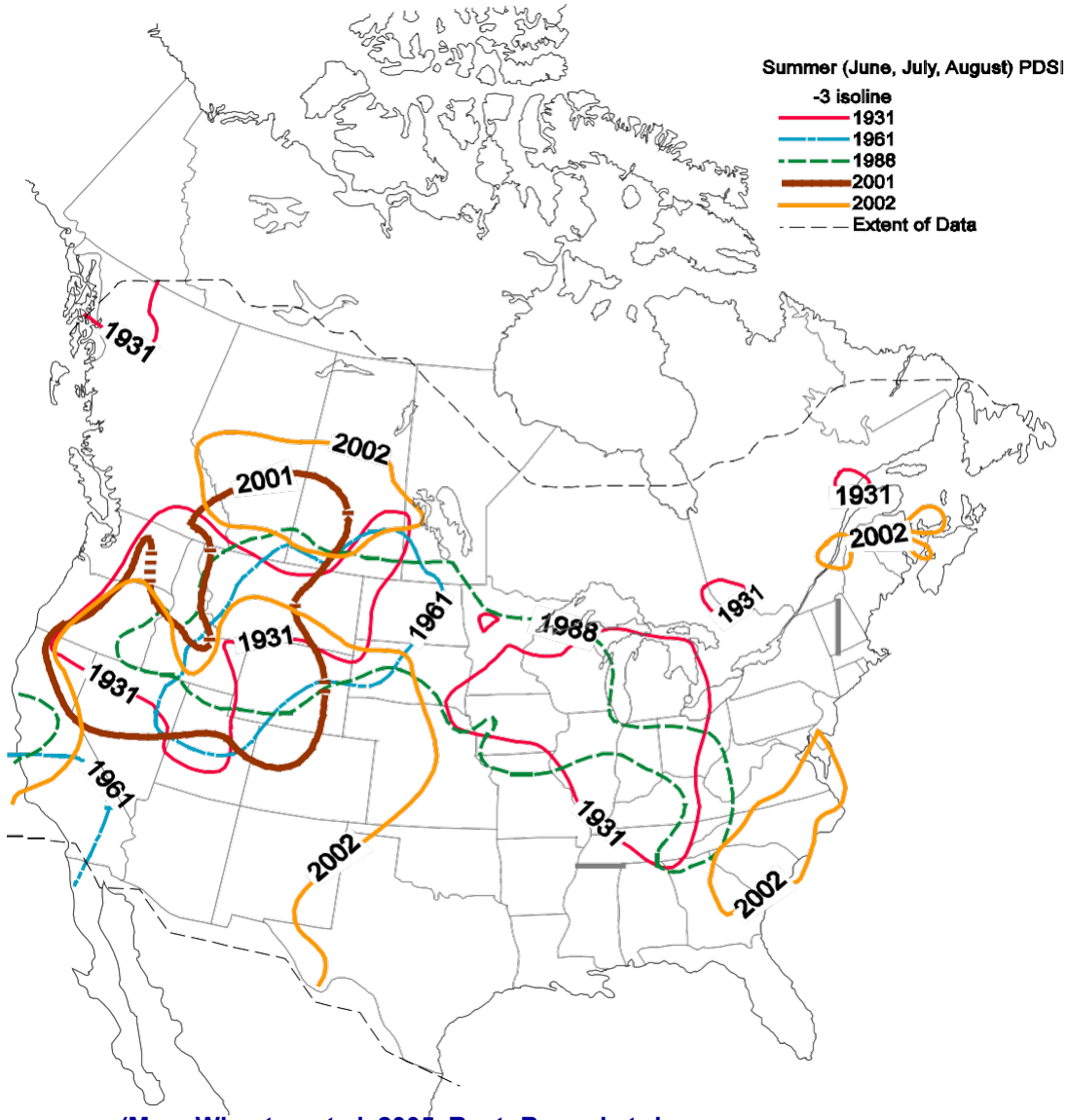


Water balance is highly variable

(Wittrock et al 2014)



Drought Spatial Patterns are changing



(Map: Wheaton et al, 2005, Rest: Bonsal et al 2011)

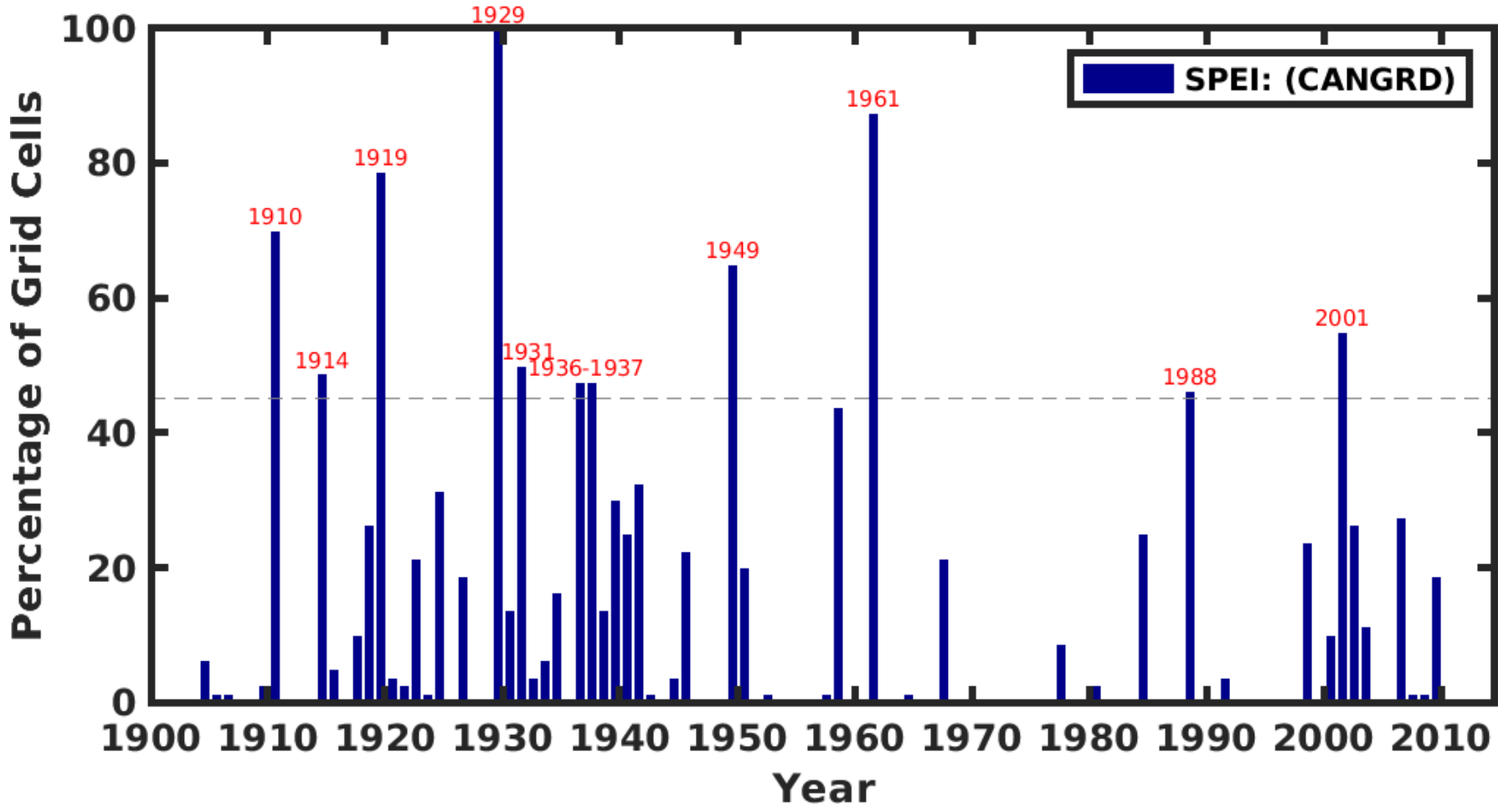
- **Preferred** area for droughts in Canada is the southern prairie provinces

New Findings:

- Droughts **migrate** from other areas such as the US
- May **expand** into areas that are normally wetter
- **Winter** and snow drought signals are important
- **Causes** are complex and likely changing

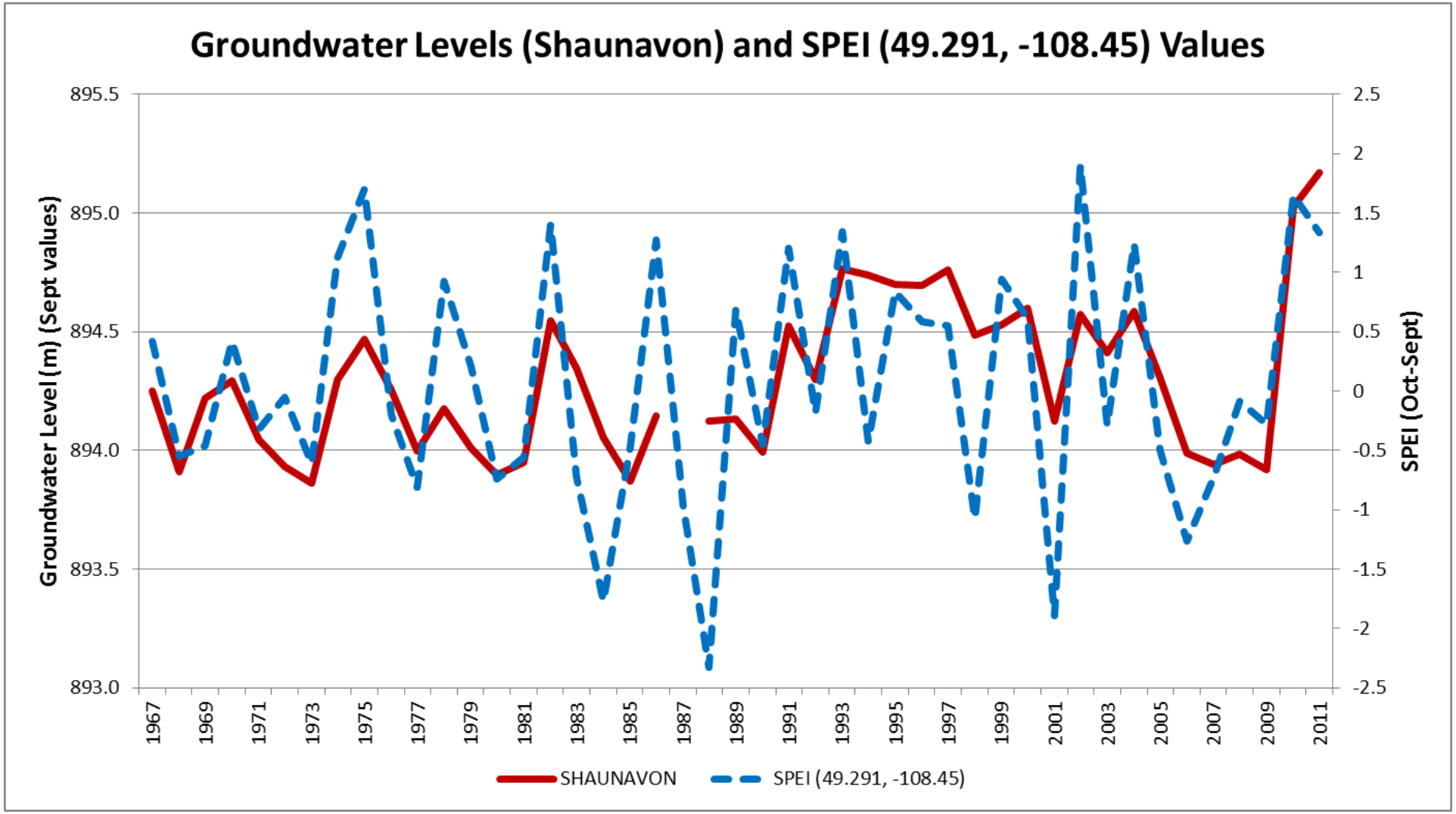
Past major severe droughts in the prairie agricultural area 1900-2014

(Bonsal et al 2020, SPEI for severe drought and worse for> 45% area)



Groundwater Levels are influenced by climate

(Wittrock, Wheaton, Bonsal 2015 r2 0.6)



Snowcover has many benefits and some challenges for Agriculture

Photo: J Wheaton

Snow-cover at end of March has decreased considerably in the prairies to near zero, on average (Wittrock 2021)

Glaciers are receding and are especially needed to contribute to river flow in dry summers

Winter **benefits** are being lost: a time of lower water use and snowcover needed for water storage and vegetation protection

New changes expected

Other extremes, storms, wind, heat can be very damaging (Wittrock Wheaton 2012)

Dust storms and wind erosion

Tornados and plow winds

- E.g., Southern Alberta – 2008

Multi-day precipitation events

- E.g., June 2002

Extended heat waves

- E.g. June 1988

Hail Storms

Hail Stones
Just south of Saskatoon
Aug 13, 2010
Photo E. Wheaton

Changed Climate Resources for Prairie Agriculture: Summary (Wittrock 2021)

Frost-free season has lengthened more than 25 days in central regions

Crop **heat** units, growing degree-days have increased

Number of **hot** days (35C and higher) has increased slightly

Number of **cold** days (-35C or less) has decreased considerably

Winter advantages are decreasing

Jet stream and storm tracks seem to becoming loopier and lazier (Francis & Vavrus 2012)

Step 2: Agricultural effects of past climate change risks and their lessons

Photo E Wheaton

Plant Hardiness Changes (McKenney et al 2015)

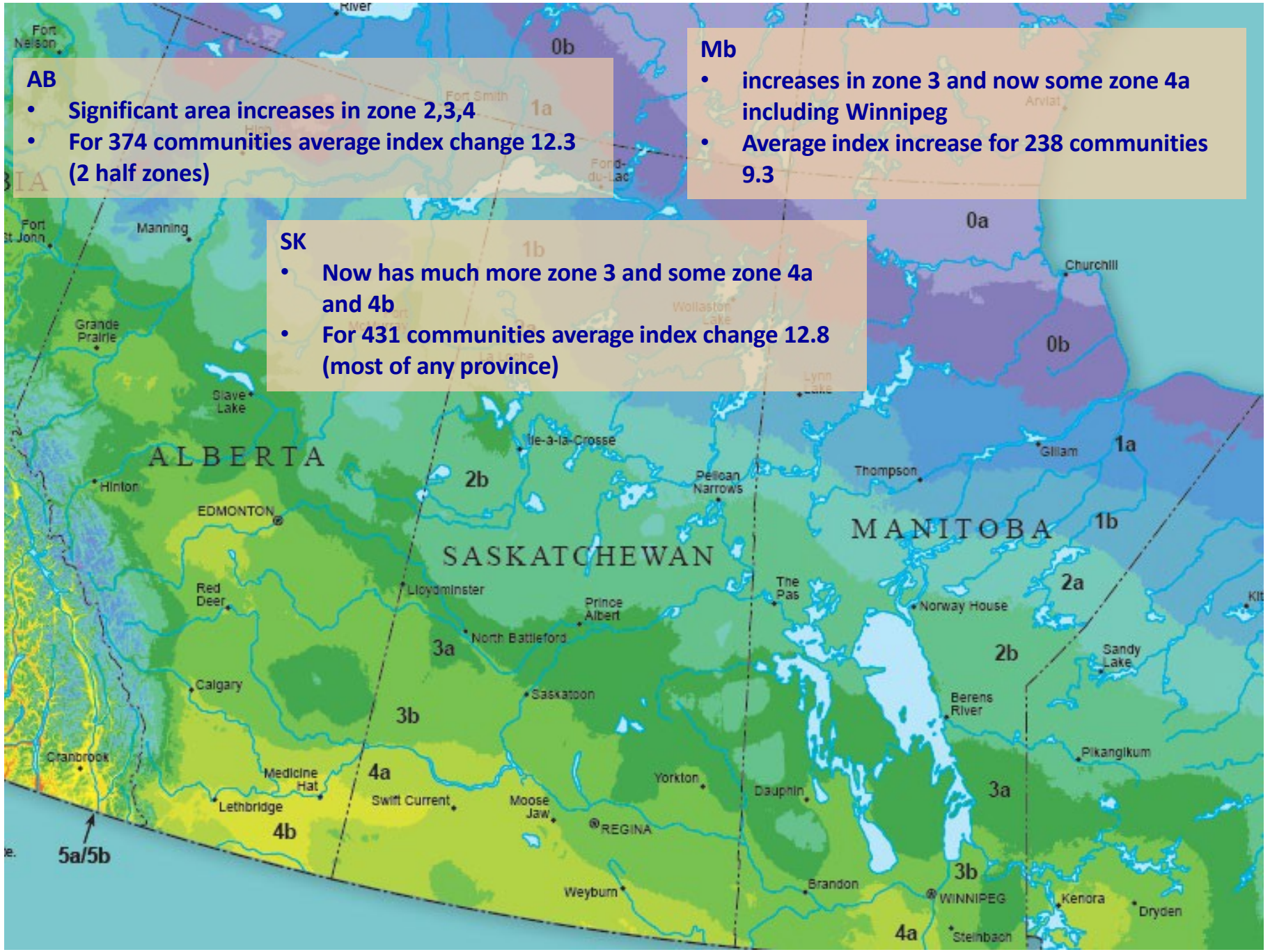
Canada's plant hardiness zones have changed dramatically in some regions.

Plants are now growing in more different zones than people realize

New crops and varieties are increasingly possible

Extreme events including cold spells may limit the extent to which these shifts translate into planting success

Photo E Wheaton


AB
• Significant area increases in zone 2,3,4
• For 374 communities average index change 12.3 (2 half zones)
Mb
• increases in zone 3 and now some zone 4a including Winnipeg
• Average index increase for 238 communities 9.3
SK
• Now has much more zone 3 and some zone 4a and 4b
• For 431 communities average index change 12.8 (most of any province)
ALBERTA
SASKATCHEWAN
MANITOBA
0a
0b
1a
1b
2a
2b
3a
3b
4a
4b
5a/5b
Fort Nelson
Fort St John
Manning
Grande Prairie
Slave Lake
Hinton
EDMONTON
Red Deer
Calgary
Cranbrook
Medicine Hat
Lethbridge
Swift Current
Moose Jaw
REGINA
Weyburn
Lloydminster
North Battleford
Saskatoon
Yorkton
Prince Albert
Ile-a-la-Crosse
Pelican Narrows
The Pas
Thompson
Gillam
Churchill
Norway House
Sandy Lake
Berens River
Pikangikum
Dauphin
Brandon
WINNIPEG
Kenora
Dryden
Steinbach

Changing Climate Zones Affect Plants and Animals

Spring blossom dates are almost a month earlier than long ago (Beaubien & Freeland 2000)

Many other plants and animals are changing ranges and other characteristics

Insects and diseases have expanded ranges

Many implications for agriculture

Expect many more changes

Climate trends and insects: early warnings

Grasshoppers prefer drought and hot weather

Culex tarsalis **mosquito** (can carry West Nile Virus etc.) does well in hot weather and long summers

Mountain pine **beetles** can expand their ranges with warmer winters

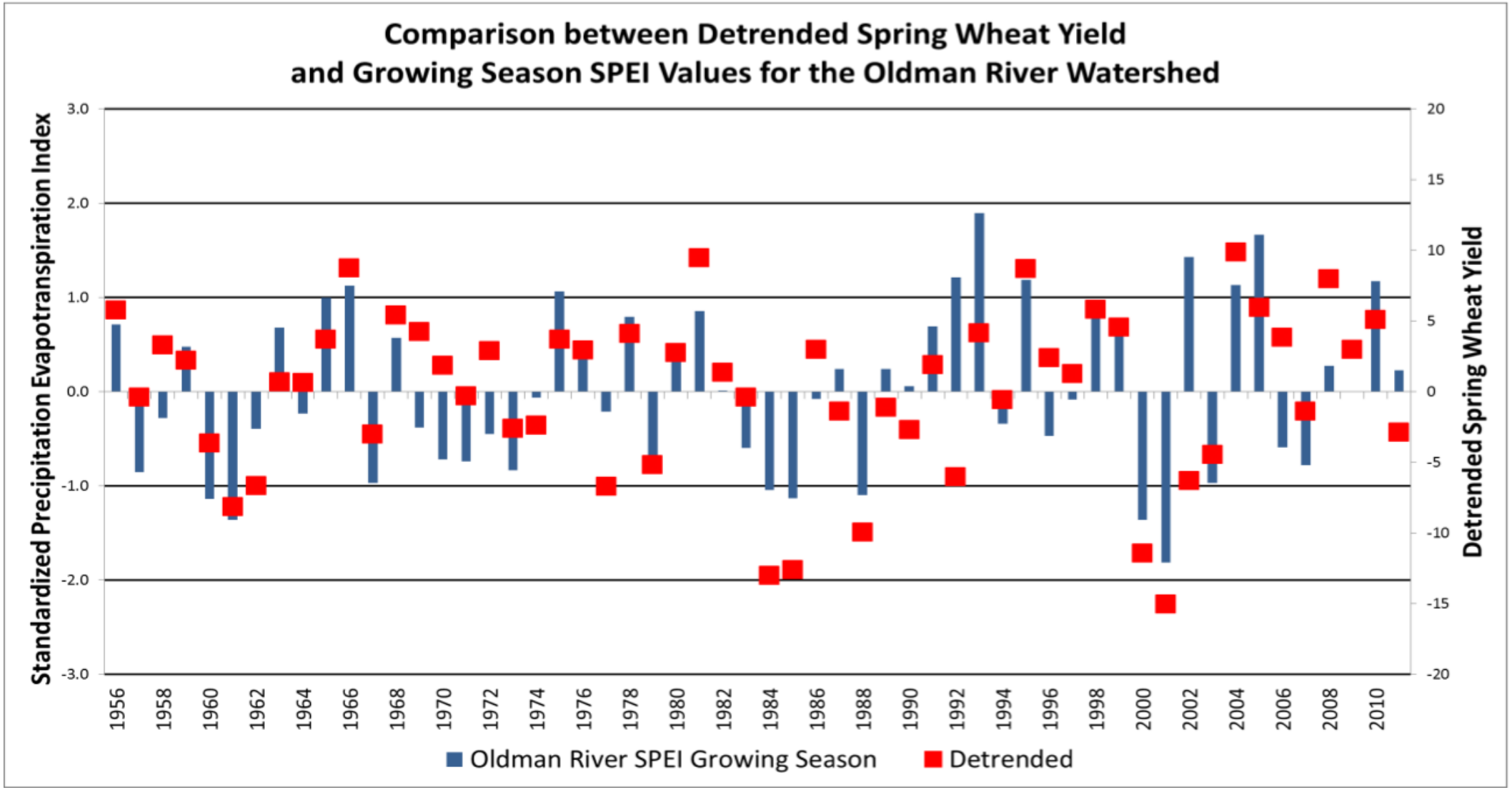
Many other insects, such as **ticks** also do well in warmer weather and appear to be shifting into new areas

What about other insects and diseases?

Photo: E Wheaton

Crop Yields depend on Climate

(Wittrock et al 2014)



Impacts of Drought, Dust Storms and Wind Erosion are many and are serious (Wheaton Chakravarti 1990)

- Soil lost by wind erosion has long-term and high **costs**, often taking decades or longer to restore
- Vegetation damage, lower yields, health risks, air pollution
- Many other costly, damaging effects
- Photo of a field damaged by wind erosion

Photo E Wheaton

Step 3: Future expected agroclimates: be aware and informed of the risks

Soil moisture and water supplies continue as main important limitations

Increasing heat has risks

Increasing growing season length has benefits

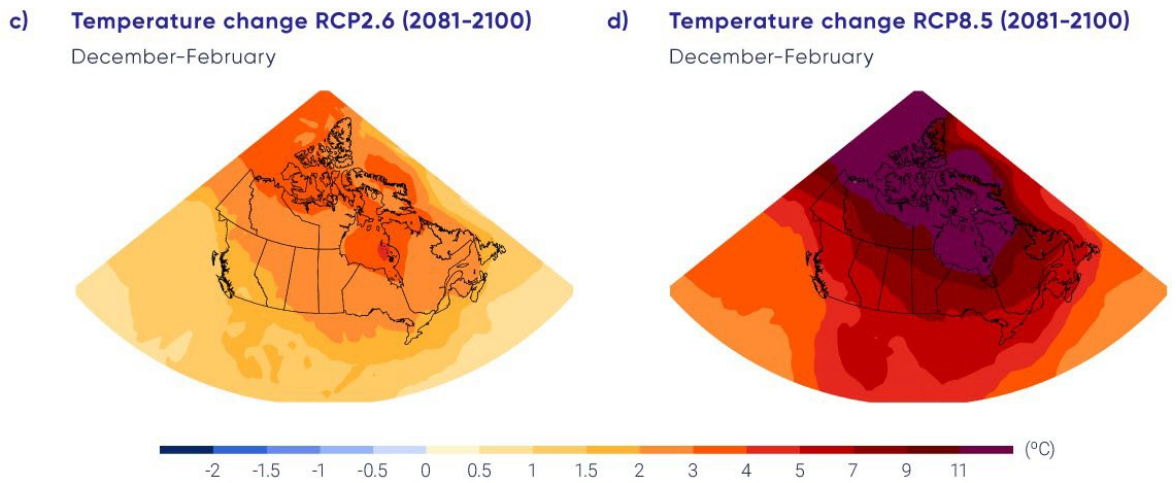
Benefits depend on successful risk management

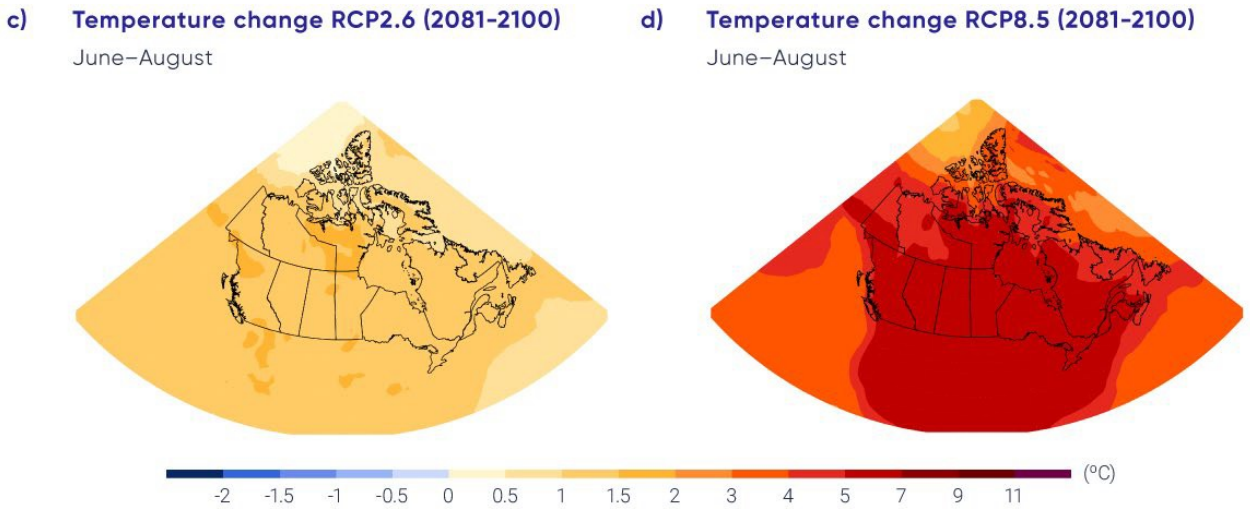

Photo E Wheaton

Canadian Prairies (CCCR2019)

- Annual mean temperature has already increased by about 1.9°C between 1948 – 2016 *
- Winter: 3.1°C, Spring: 2.0°C; Summer: 1.8°C; Autumn: 1.1°C
- Projected annual temperature to increase in range of†:
  - 1.5°C – 2.3°C (2031 to 2050)
  - 1.9°C – 6.5°C (2081 to 2100)

*Approximate value; based on CANGRD dataset
†Relative to the 1986-2005 average; RCPs 2.6 -8. 5

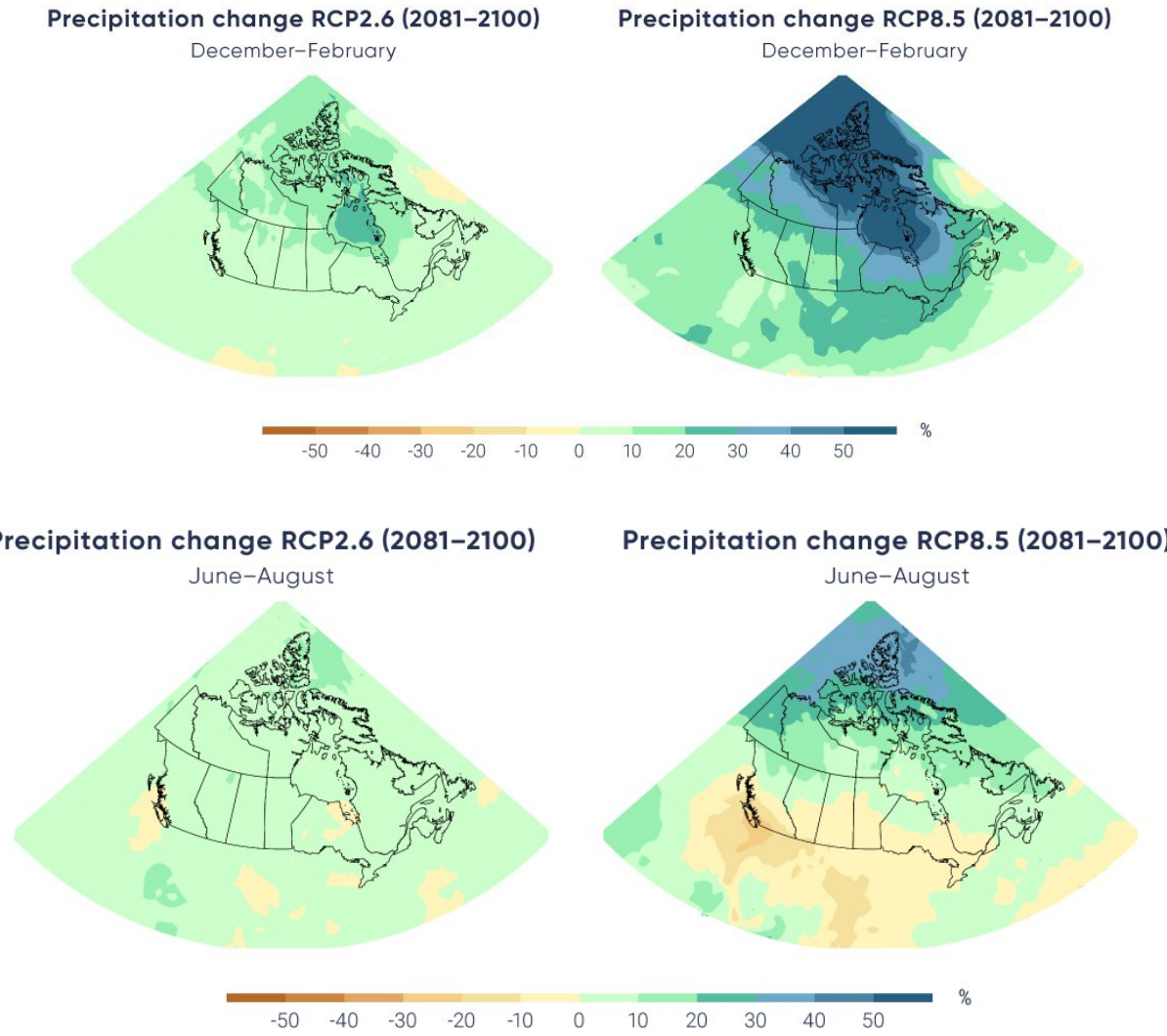




Canadian Prairies (CCCR 2019)

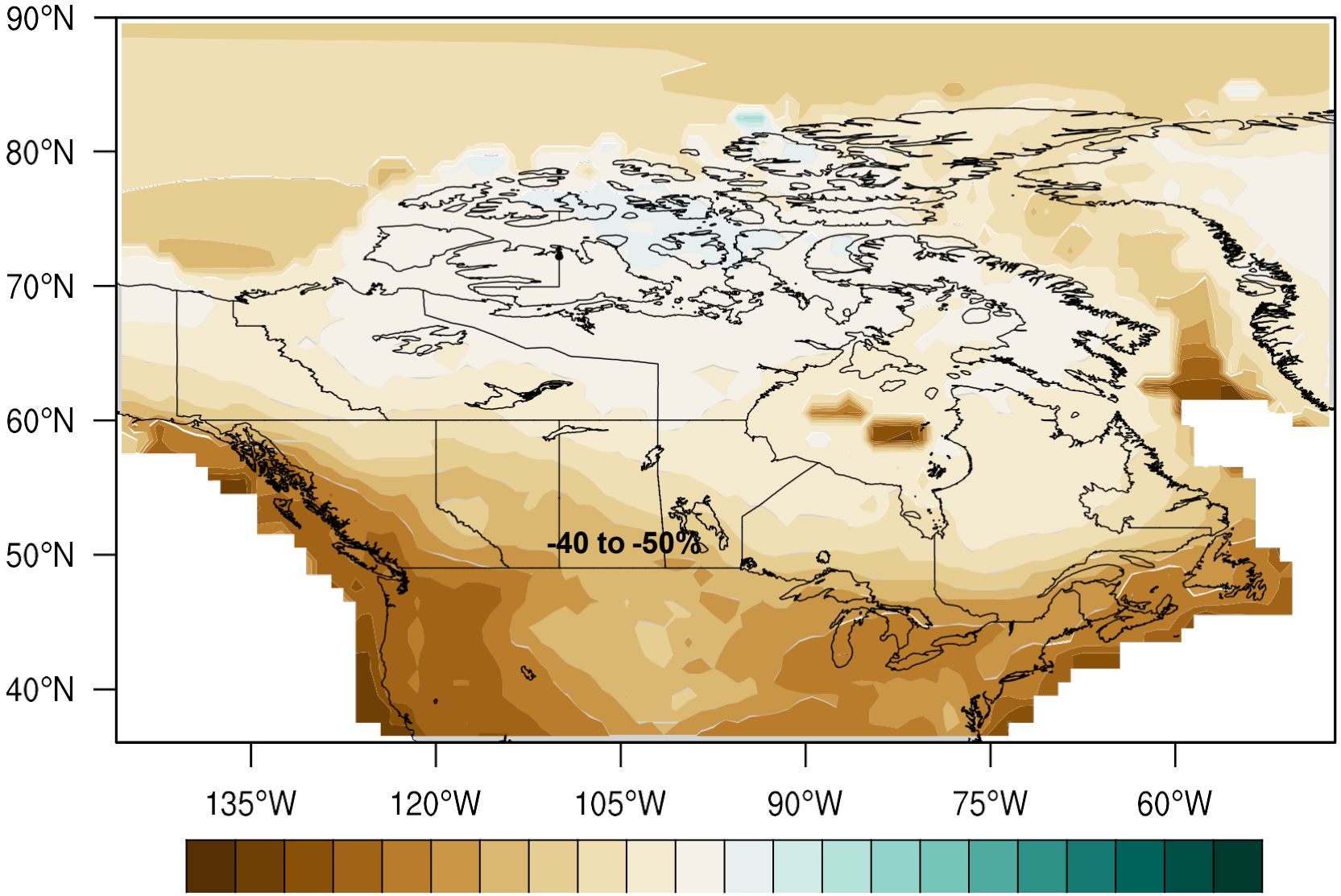
- Annual precipitation has increased by about 7% between 1948 – 2012*
- Winter: -5.9%; Spring: 13.6%; Summer: 8.4%; Autumn: 5.8%
- Annual precipitation increase in the range of†:
  - 5.0% - 6.5% (2031-2050)
  - 5.9% - 15.3% (2081-2100)
- Less snow and more rain

*Approximate value; based on CANGRD dataset
†Relative to the 1986-2005 average; RCPs 2.6 -8.5



Future Expected Change in Snow Depth

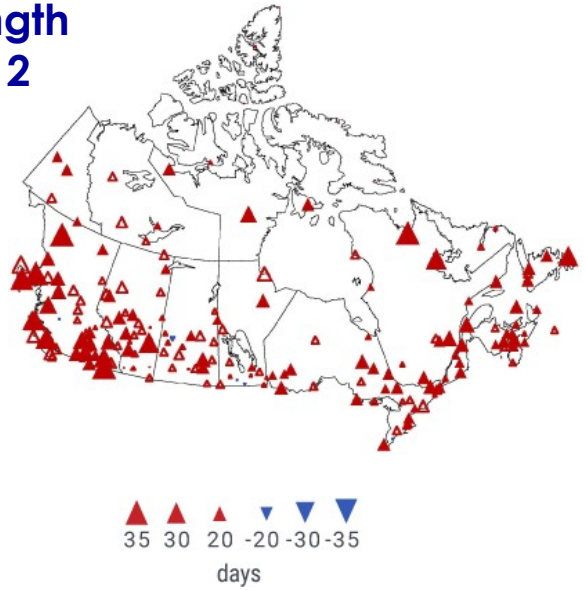
(2046-2065, Environment Climate Change Canada CCDS site)



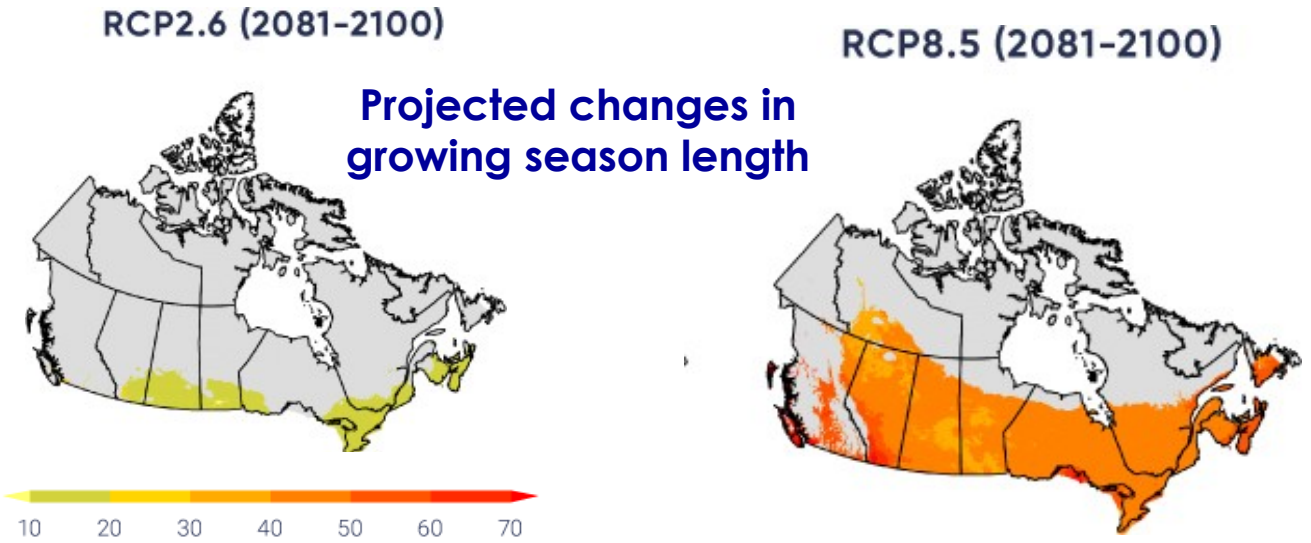
Growing seasons have already increased & this trend continues CCCR2019

- Length of the growing season has increased by about 10 to 25 days between 1948 – 2016 *
- Projected to increase in range of†:
  - 11.5 – 15.5 days (2031 to 2050)
  - 13.5 – 43.6 days (2081 to 2100)

Changes in growing season length 1948-2012



Projected changes in growing season length



*Six consecutive days with daily mean temperature > 5ºC in spring and ends when this condition fails to be met in autumn
†Relative to the 1986-2005 average; RCPs 2.6 - 8.5

Future Expected Droughts and Risks

(Wheaton et al. 2013)

Chances of **multi-year** droughts increase

Increases in intensity, severity, area

Droughts **overwhelm** the increases in average precipitation

Drought **risks**, e.g., agriculture, fire, health, industries, etc., expected to increase

Expect **surprises**, such as fast switches from drought to extreme rainfalls, increased variability

Photo: Wallace 2015, La Ronge area

Prairies have Canada's extremes; expect more damage with climate change

Highest temperature records in Canada at 45°C, July 1937 in southeast Sk (Yellowgrass and Midale). Note: exceeded in 2021

Greatest rainfall extremes

- Record one-hour rainfall at Buffalo Gap (south SK) with 250mm (May 1961)
- Record 8h storm at Vanguard SK with 375mm (July 2000) (Phillips 1993, Hunter et al 2003)

E. Wheaton 2018

Future Expected Climates: Summary


Photo: E. Wheaton 2009

Accelerated changes in current conditions, e.g., longer growing seasons, milder winters, decreased snow cover, increased heat waves, precipitation variability

Past **droughts** may seem mild compared with future droughts

Increased potential for major **storms** and floods

More **switches** of dry/wet and hot/cold with loopier & lazier jet stream

Expect the unexpected with less **stable** climates

Wheaton 2015, Wittrock and Wheaton 2015

Step 4:
Future expected impacts on agriculture: crops, rangelands and pasture, water resources, health, infrastructure communities, etc

Photo: J Wheaton

Agricultural impacts expected in the future: some risks and benefits

Crop **yields**/ biomass could increase with increasing growing season lengths and heat units

Further plant **hardiness** zone changes

Warm weather vegetation would do better, including **weeds**

Wild cards are increasing drought, intense rainfall, and heat waves, insect and disease pests, all detrimental

Higher **variability** is a challenge as well as scarcity of water resources

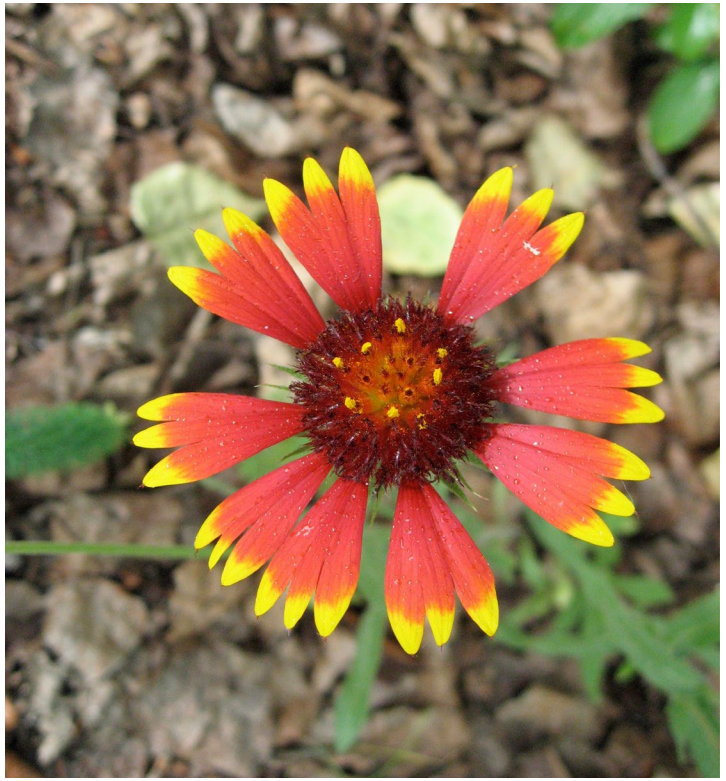


Photo E Wheaton

Water resources expected to become less reliable

Snow-cover **season** length and **area** continue to decrease

More intense **precipitation** and more rain in winter

Glaciers continue to retreat

Evaporation demand increases with longer warm season and higher temperatures

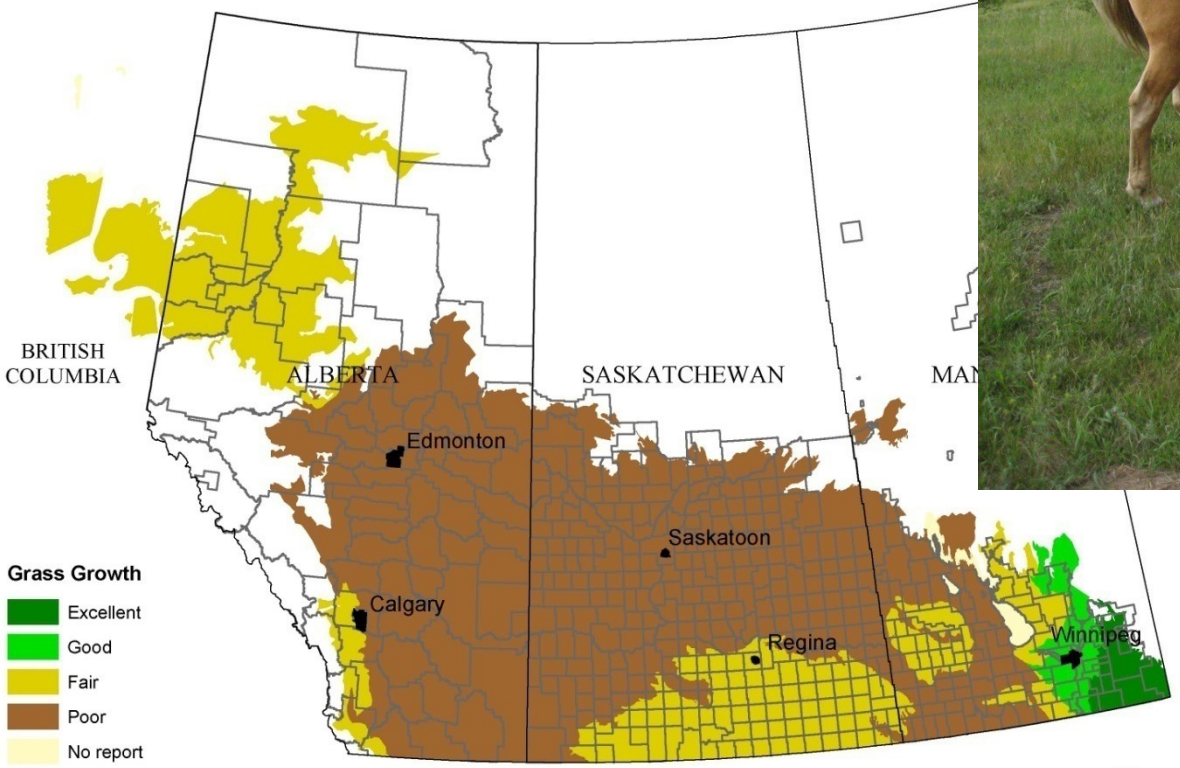
Water **quality** also degrades

More **demand** is put on all water supplies, more conflict may result

But, plan for surprises

Grasslands Suffer during Droughts

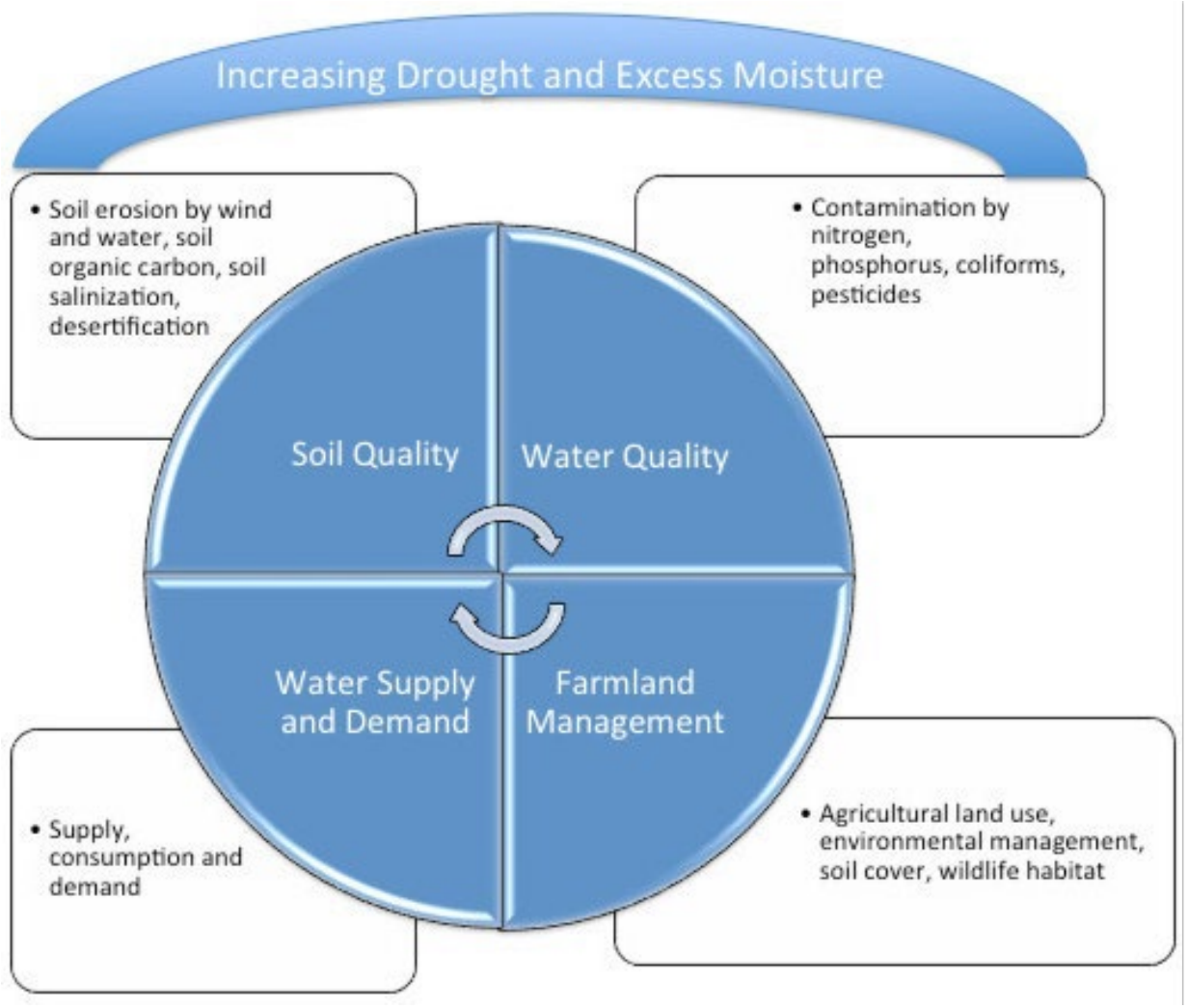
Grass Growth on Pastures for 6 June 2002



Canada

Climate change affects agricultural resources and management

(Wheaton Kulshrestha 2017 Agro-environmental indices and extremes)



Modelled changes in future crop yields in the Canadian Prairies (2041-70) (Qian 2018, various references)

Some yield increases are generally expected because of climate change

Increases are mostly related to carbon dioxide fertilization, ranging around 30% for C3 crops

Spring wheat yield increases of 8 to 37%

- Several locations across the prairies

Canola yield decreases of 21-44%

- For Brandon, MB

Timothy increases >24%

- Edmonton, Fort Vermillion, Melfort, Dauphin locations

Implications for Markets and Food Security?

Canada is a major exporter of grains, oilseeds and pulses

Canada is an important source of food for other countries

Warmer countries are expected to have adverse effects on food production sooner than colder places

Many knowledge gaps

Step 5: Agroclimatic Adaptation Planning

Context: Albertan Farms **Census of Agriculture 2018**

Farmers and families, 57,605 total operators

Farms 40,638

Farmland > 20M ha total area

Grains and oilseeds >7M ha

Cattle and calves >5M

Total farm capital $143,927M

Gross farm receipts $17,730M

Census of Agriculture 2018

Photo: L Heltman

Risk solutions targeted to the changing climate: the missing link

Increase awareness of these changes, both climate risks and consequences

Match risk solutions to the changing climate

Find out about myths and realities of climate change, use reliable information

Risk management occurs at many levels, producer, municipal, provincial and federal governments

Risk Management Paths (AB Gov 2016)

✓Plan and prepare, e.g. review the suite of risk management programs and products

✓Monitor, e.g., use the AB Agroclimatic Information Service, AAFC's services

✓Respond, e.g., tools are many and include beneficial management plans, environmental farm plans

✓Review and improve

Options are many and their use and effectiveness depend on several factors

Farm level adaptations, examples

Seeding and harvesting dates and other management

Soil and water conservation, e.g., min till, stubble management, irrigation

Finance and insurance

Crop varieties, cover crops, diversity of crop types and locations

Technology, e.g., precision agriculture, drones, remote sensing, etc

Farm level adaptations, examples

Livestock and rangeland management, e.g., rotational grazing

Integrated pest management

Enhanced use of early warning systems and climate-smart agriculture

NOTE: much information is available from many sources. The knowledge GAP is how well they work to reduce negative risks and enhance benefits of a changing climate.

How to gain opportunities for agriculture?

First step is awareness that the past climate information is no longer sufficient

Then learning and use of climate change information

Be aware of effects of climate impacts on yields, insects, weeds, diseases, soil, water, health, infrastructure, transportation, ports, etc

Innovations and changing risk management are required

What are the implications for sustainability?

Watch for effects in competing countries (e.g., Australia, Russia, US): affects markets and prices

Conclusion: Main Messages

Climate resources and risks for agriculture have **changed** and will continue to change

Agroclimatic **resources** include growing season length, crop heat units, temperature-humidity indices, heat spells, timing of precipitation, droughts, excess moisture …

Impacts are many, including on crops, forage, pasture, soil, water, livestock, infrastructure, people, and communities

Conclusion: Main Messages

Indirect impacts include disease, weed and insect problems

Climate change is occurring now with both positive and negative impacts to agriculture

Net benefits to agriculture depend on the success of **adaptation** options to reduce risk

Be aware of the limits and **barriers** to adaptation

What do these changes mean for agriculture, agribusiness, food security, communities?

Some Additional Information Sources

Prairie Climate Centre and Canadian climate atlas:
https://climateatlas.ca/climate-atlas-version-2

Environment and Climate Change Canada's climate services:
https://climatedata.ca

Canada in Changing Climate Report 2019:
https://changingclimate.ca

Some Additional Information Sources

Prairie chapter of the Regional Report of Canada in a Changing Climate:https://www.nrcan.gc.ca/maps-tools-publications/publications/climate-change-publications/canada-changing-climate-reports/canada-changing-climate-regional-perspectives-report/21092

Alberta Agriculture and Food

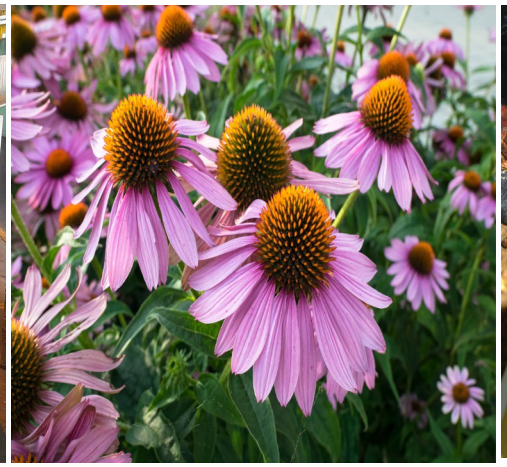
Agriculture and Agri-Food Canada

ClimateWest (https://climatewest.ca)


Photo E Gratrix

Time for Questions

Associated Engineering | 75 YEARS



Adaptation Resilience Training

Agriculture: Climate Change Adaptation

Melanie Piorecky, P.Ag., Associated Engineering

September 15, 2021
Photo credits: Melanie Piorecky

Current Efforts – a Quick Peak

Efforts and Resources – International, Federal, AB

- ISO standards to quantify carbon offsetting
- Farmers for Climate Solutions
- Beef Research Drought blog
- AB Govt Climate Smart Agriculture Resources
- AB Field Crop Development Centre

AB Project Assistants – ART Internship

Fresh grads, new ideas, working in communities as a collective response to climate change

#2 Dana Mears – What we do when drought creeps in.

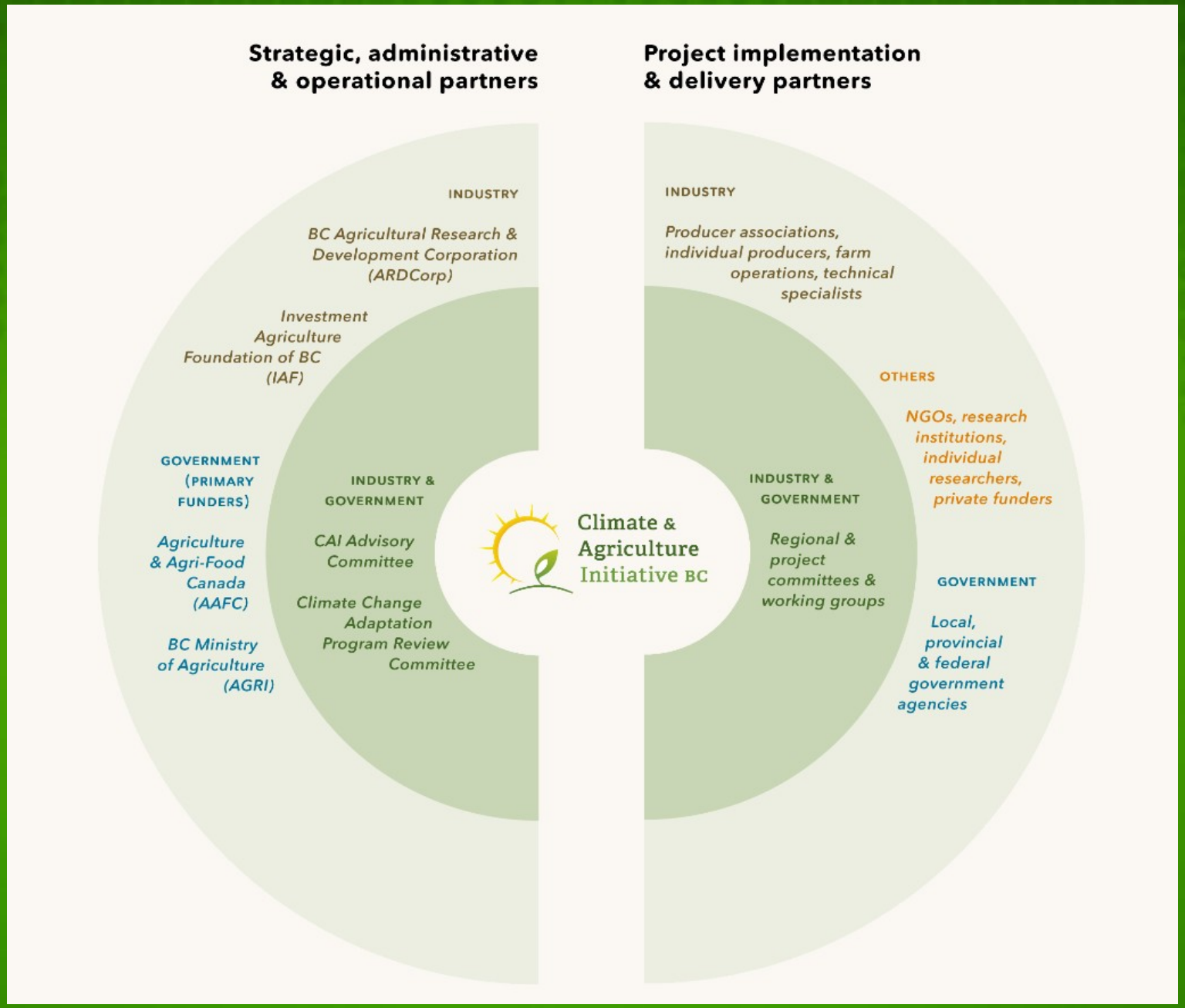
#11 Eric Boswell - Hail and its Devastating Effects on Agriculture: An Alberta Perspective

#14 Sofia Bahmutsky - Smart phones, smart homes, smart… food?

https://www.youtube.com/playlist?list=PLOzG_HrdGwSrE4X1fSgDEWmpBJDYPjvMD

BC Climate and Agriculture Initiative, *est. 2008*

- Facilitate collaboration
  - Deliver programs
- Develop tools and resources
  - Share information



BC CAI Partnerships

Guiding Principles

Increase knowledge and awareness

Combine data/research with practical knowledge

The involvement of local government with industry partnership

Test and demonstrate new approaches

Regional Adaptation Program ~ Identify and Prioritize

- Develop an adaptation plan specific to a region by:
  - Building Partnerships
  - Conducting background research
  - Hosting workshops
  - Write regional adaptation plan
- Implement projects ~ on-going

Farm Adaptation Innovator Program ~ Fund

Farm-level Applied Research

An example:

BC Forage Council + Peace River Forage Association + Producers investigate innovative practices and technologies to **improve soil health and boost yields while enhancing resilience to drought conditions and extreme rainfall**.

Farm Adaptation Resource

Examples for the Peace Region

- Soil, water and residue management in the Peace: fact sheet
- Understanding runoff and erosion in the Peace: fact sheet
- Erosion mapping in the Peace: fact sheet
- Runoff, drainage and erosion webinar
- Best practices for on-farm management of runoff, drainage and erosion
- Risk and opportunity assessment of grain and oilseed production in the Peace
- Pest monitoring in the Peace region
- When to use supplemental irrigation: fact sheet

Lots of resources and more coming!

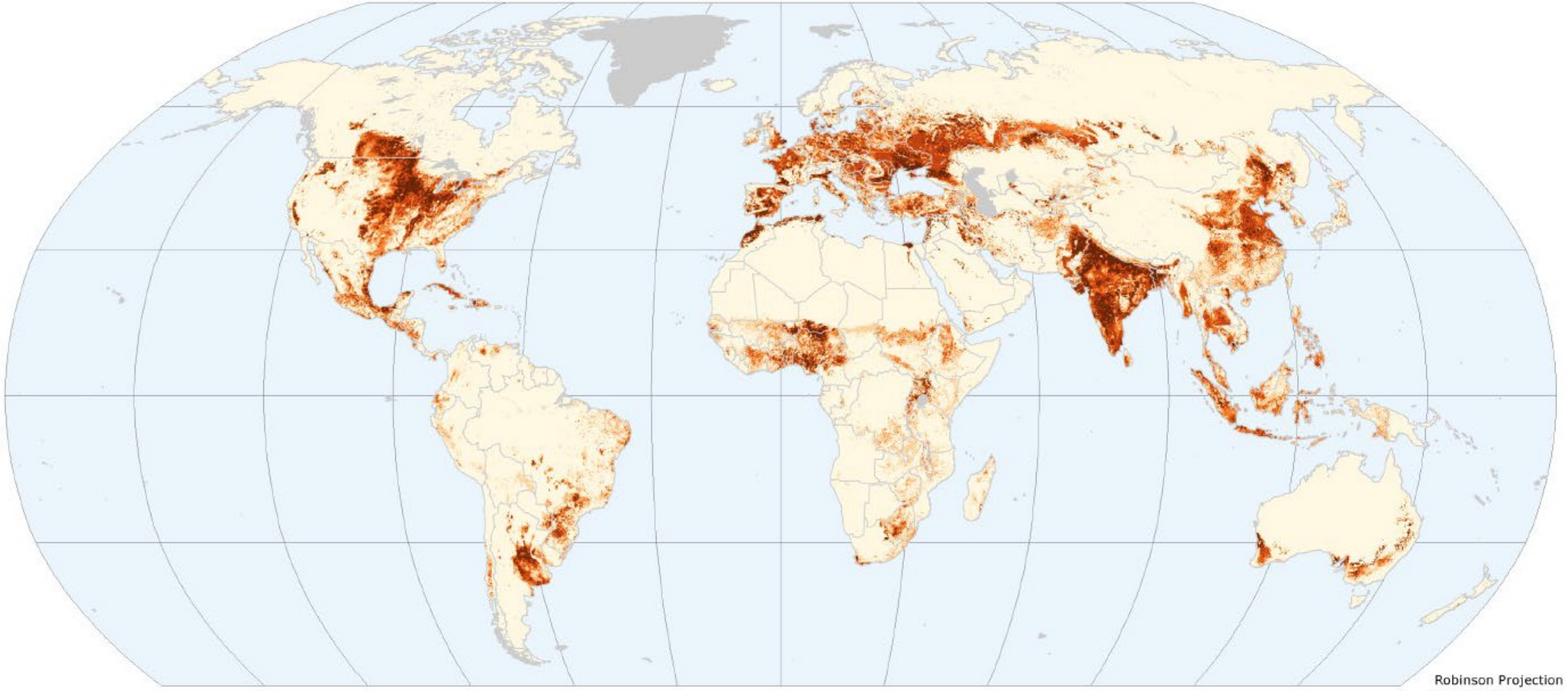
Adaptation Resilience Training

Agriculture: Climate Change Adaptation

David Sauchyn, PhD, PGeo
Director, Prairie Adaptation Research Collaborative

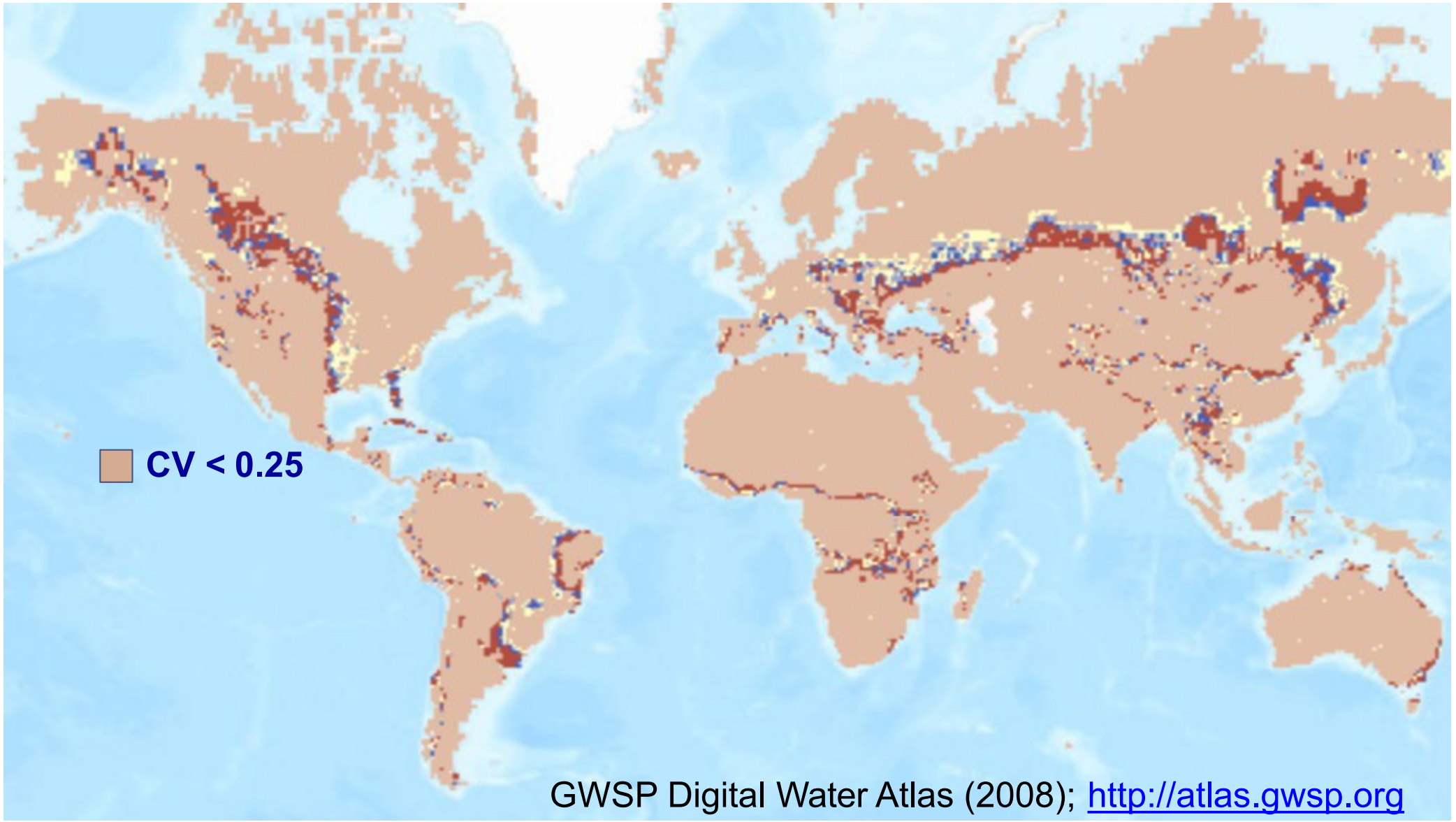
September 15, 2021

The World's Cropland



https://sedac.ciesin.columbia.edu/data/set/aglands-croplands-2000/maps

Inter-annual Variation in the Climate Moisture Index



Southern Alberta (Near Enchant)

The Death of the PFRA

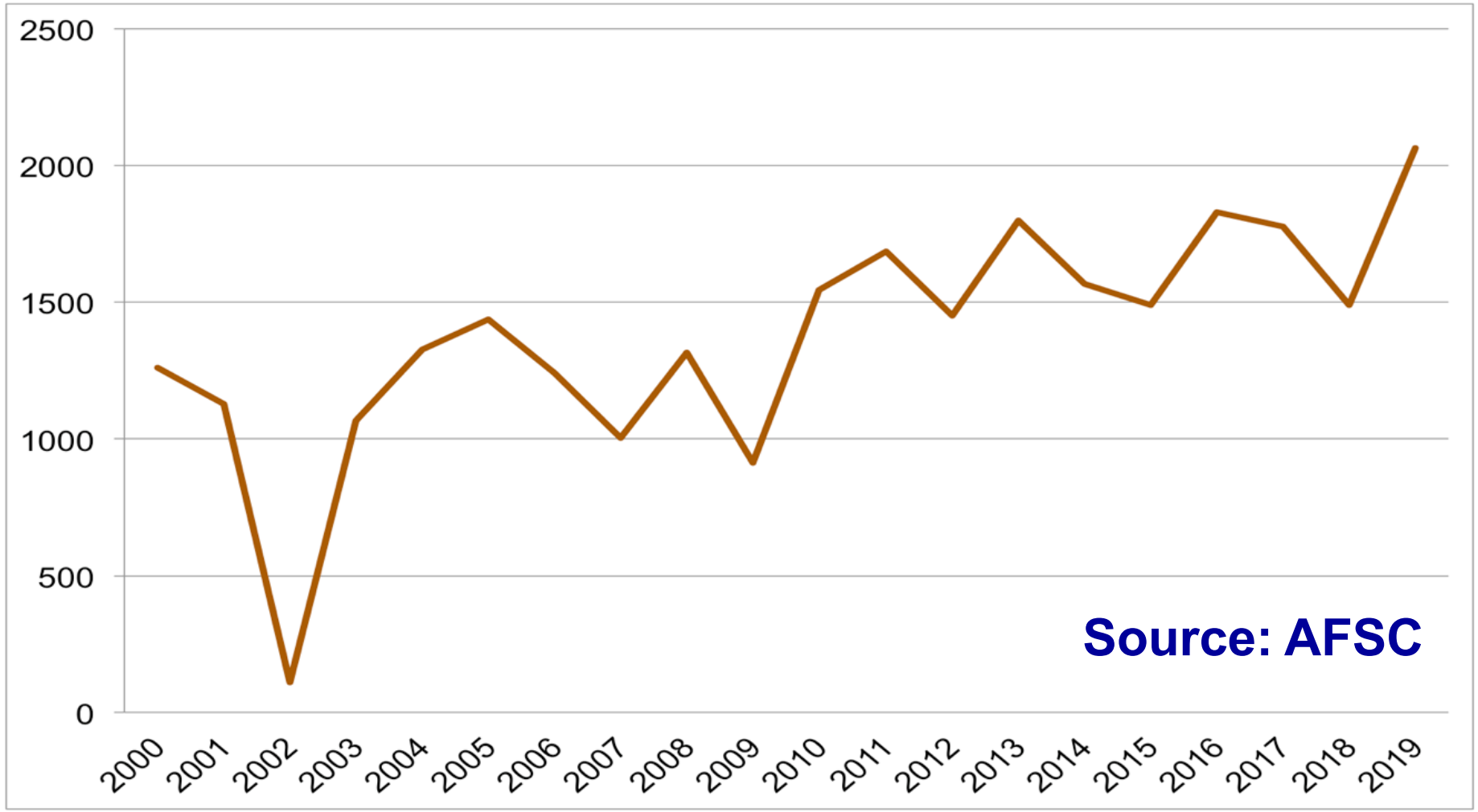
October 1, 2012

Canadian Cowboy Country MAGAZINE

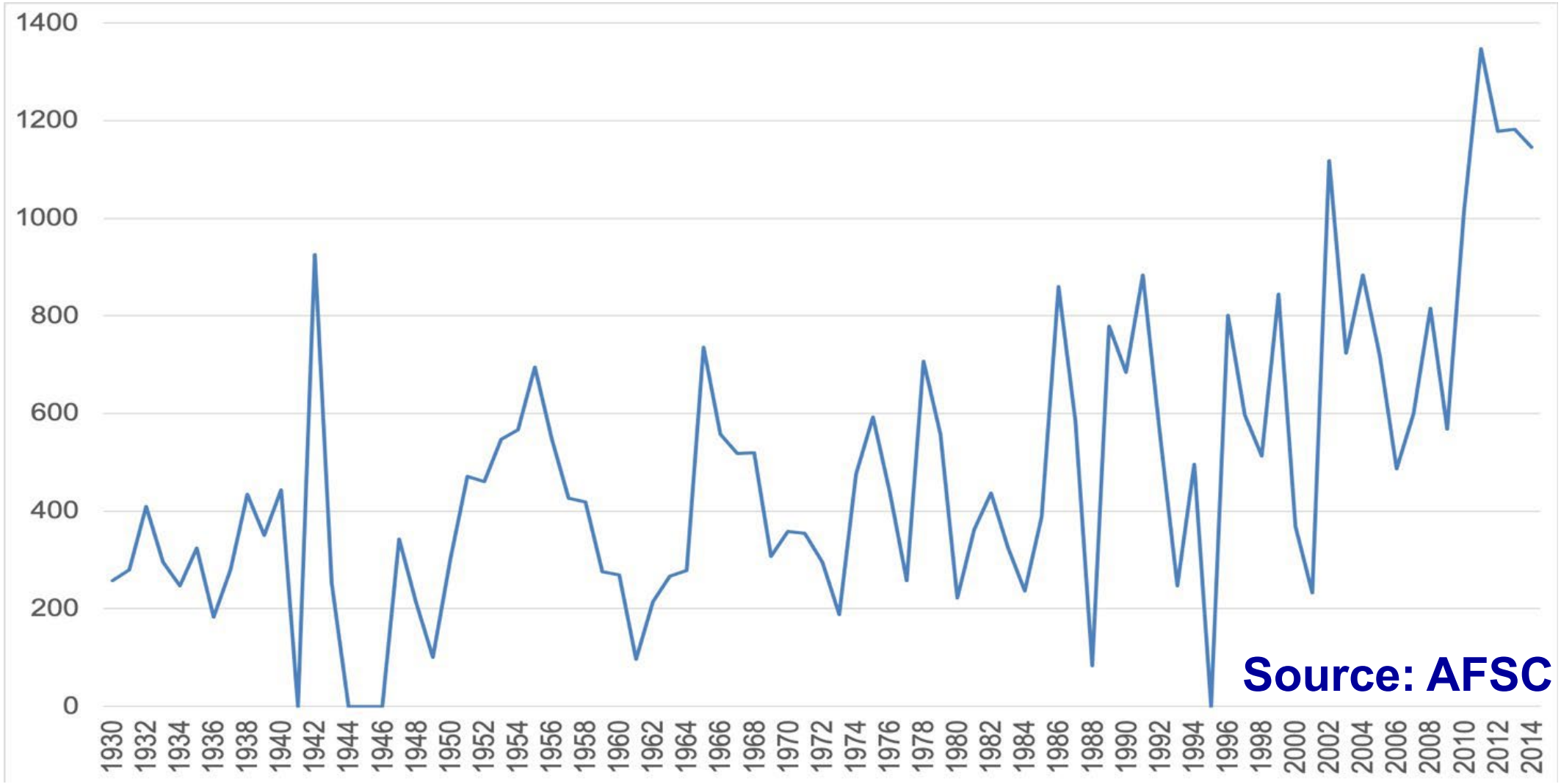
The level of agricultural adaptation effort already resident in the Prairie Farm Rehabilitation Administration (**PFRA**) made Regina the logical base for pursuing climate impacts and adaptation research. On March 24, 2000, in Regina, Minister Ralph Goodale (Natural Resources Canada) announced the establishment of the Prairie Adaptation Research Collaborative (**PARC**).

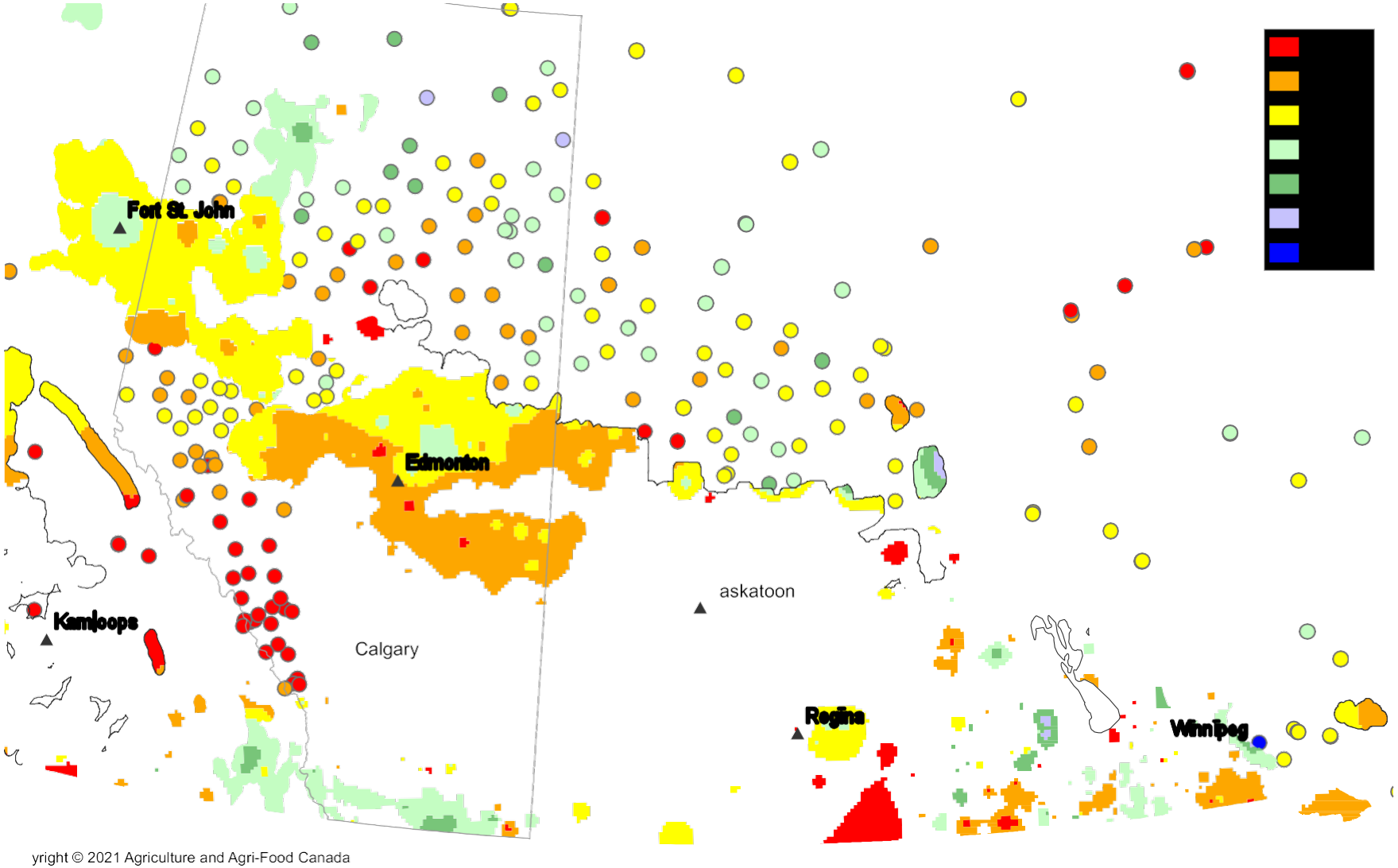

Raising cattle requires water, grass and shelter. I can replace only one of these.
– Rancher near Shaunavon, SK

Barley Yields (kg/acre) - County of Flagstaff, 2000-2019



Forage Yield (kg/ha) - Onefour, AB, 1930-2014





Alberta's Agriculture Drought and Excess Moisture Risk Management Plan

Response Toolbox: possible actions to respond to drought and excess moisture conditions; from mitigation during the early stages of soil moisture stress to financial stabilization during and following more severe moisture conditions

- Producers are aware of government response.
- Provide information on business risk management programs.
- Provide timely, relevant information
- Deliver the Water Pumping Program.
- Recommend tax deferral from sale of breeding stock
- Implement a drought or excess moisture recovery loan program.
- Implement other programs as appropriate: drought disaster loans, grazing on unallocated public land, emergency water hauling, etc.

Planned Adaptation to Climate Change

Key Principles:

- **Sustainable:** enhance the capacity of natural systems to boost resilience by buffering climate risks
- **Partnerships:** engage the local community and ensure they are well informed - *Community Developed*
- **Evidence-based:** decision-making is well-supported and informed - *Science Based*

Planned Adaptation to Climate Change

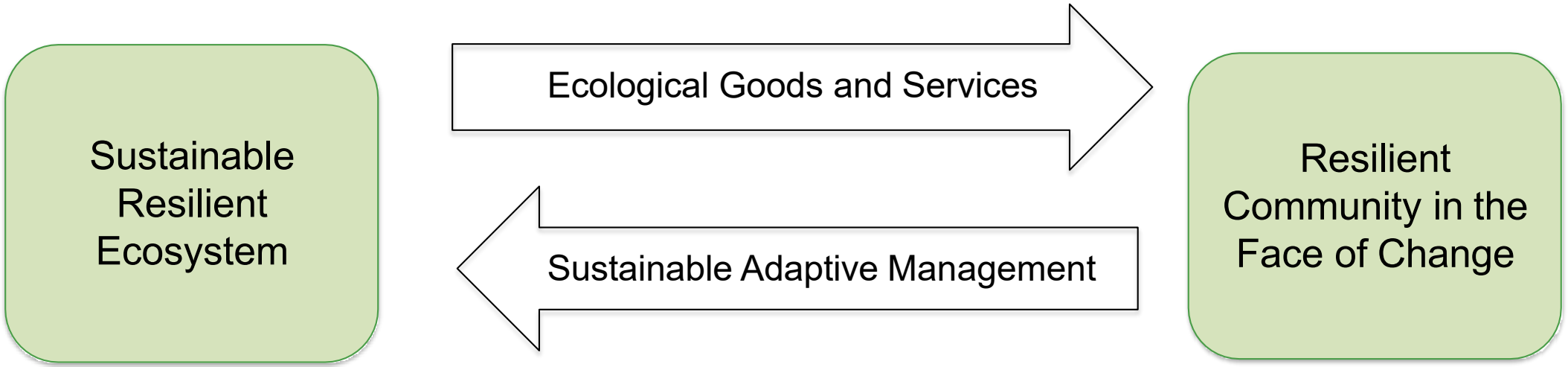
- **Balanced :** a holistic approach that includes managing both, climate and non-climate risks – *Integrated*
- **Prioritized** and **tailored:** target relevant scale and sectors most affected, long-term implications, high values - *Targeted*
- **Transparent -** communicate decisions – *Accountable*
- **Monitoring and review decisions –** *Accountable*

Sustainable Agriculture – For Example, ALUS

Principles:

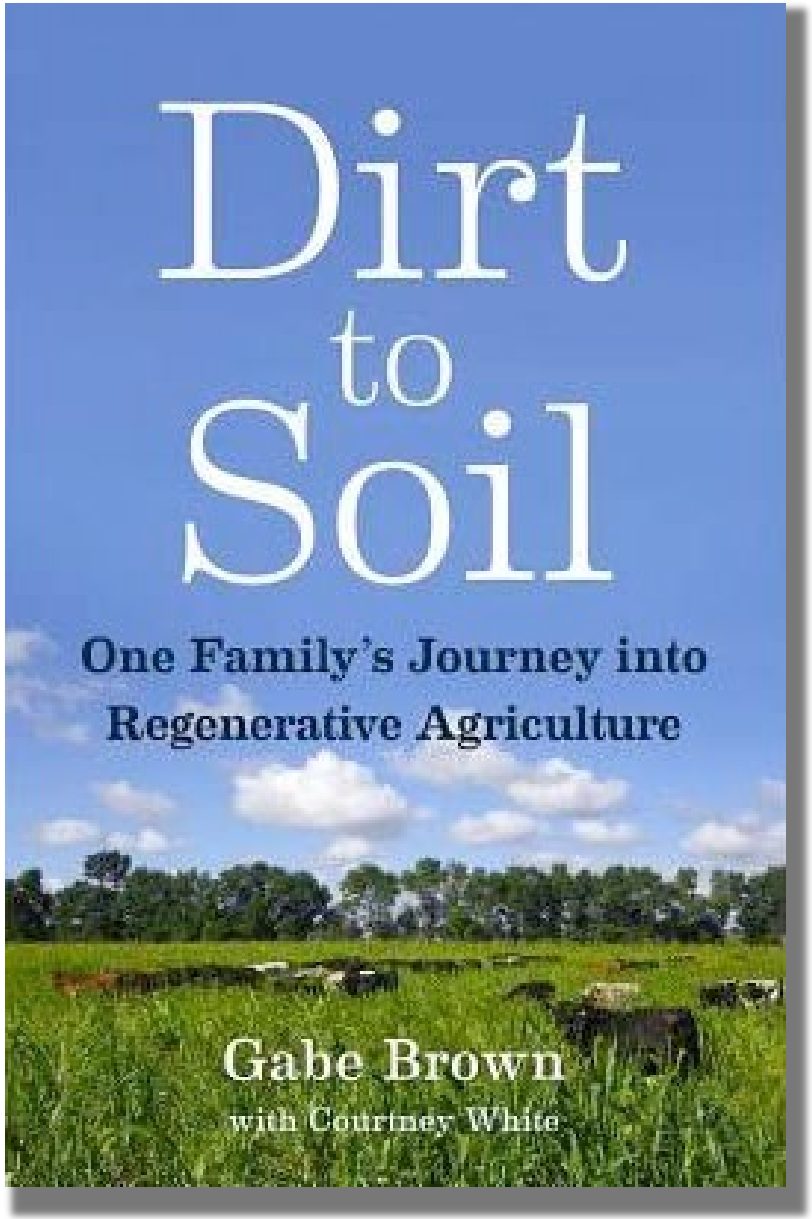
- Voluntary
- Integrated: complement existing programs
- Accountable
- Science-based
- Community-developed
- Targeted
- Market Driven (economic value)

Ecosystem-Based Adaptation



The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change

Convention on Biological Diversity (2009)



Gabe Brown's book **Dirt to Soil** is designed to be a guide for others. In it he shares in depth his five principles of soil health:

- no-till or minimal tillage,
- keeping the ground covered,
- diversity in plant and animal species,
- keeping living roots in the soil as much as possible, and
- the importance of integrating animals.

THE GLOBE AND MAIL PRESENTS | CANADA ' S FOOD SYSTEM: APPROACHES TO A SUSTAINABLE FUTURE

Regenerative Agriculture

Supporting sustainable food production

FREE VIRTUAL EVENT
WEDNESDAY, JUNE 9, 2021 | 1:30 - 2:30 PM. ET

PRESENTING SPONSOR

How regenerative farming could help Canada meet its new carbon emission targets

· CBC News · Posted: May 01, 2021

Unconventional techniques can sequester carbon while improving soil

Saskatchewan BRACE Projects: Agricultural Water Management

Introductory Qualified Persons Training

“Building a network of professionals to support Saskatchewan agricultural producers in building a resilient agricultural industry by designing projects that both meet the requirements of approval and are adaptive to the impacts of a changing climate”.

Since September 2015, the Water Security Agency has been implementing the Agricultural Water Management Strategy. New regulations, legislation and policies have been implemented to promote responsible drainage in Saskatchewan while supporting resilient watersheds and thriving communities.

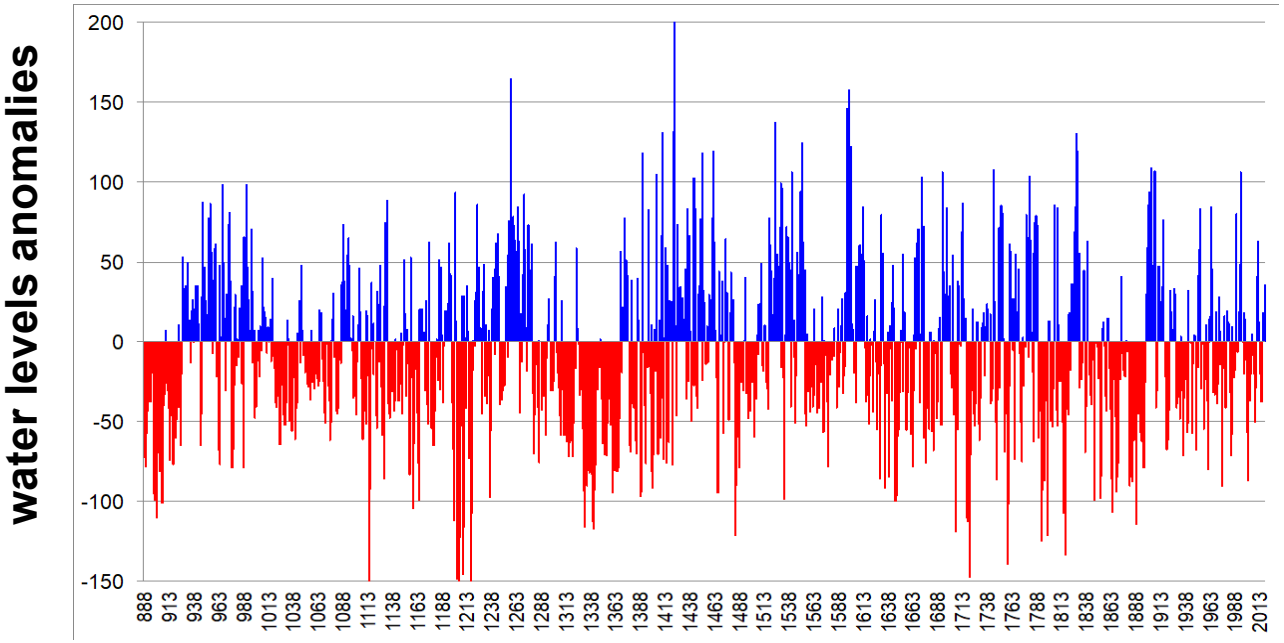
Southeast College

PARC

Water Security Agency

Saskatchewan BRACE Projects: Building Capacity for Community Hydrologic Drought Response

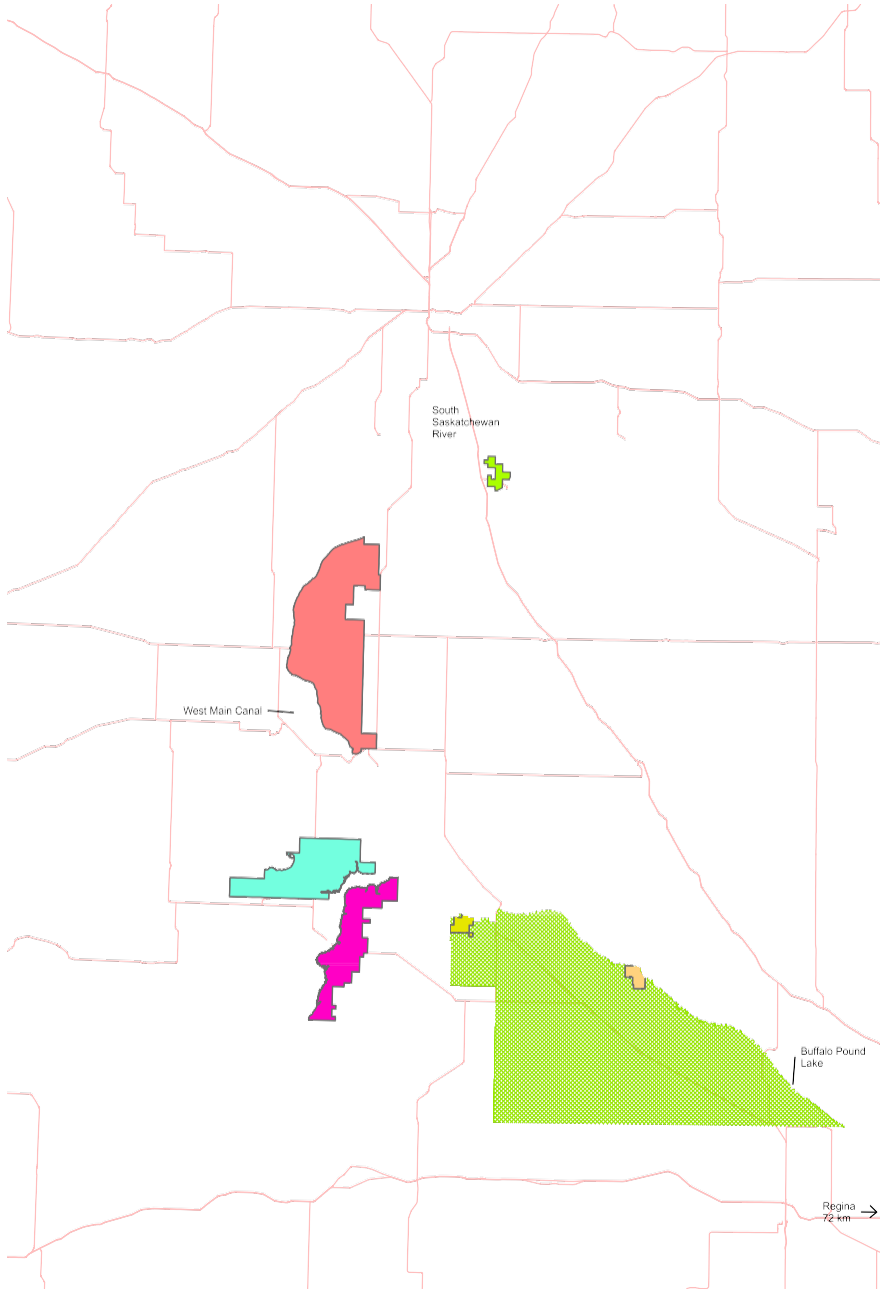
Building the capacity of municipalities in Saskatchewan to manage hydrologic drought in the context of a changing climate, including impacts on water supply and quality.



SRC SASKATCHEWAN RESEARCH COUNCIL

Water Security Agency

PARC



Saskatchewan Announces $4 Billion Irrigation Project At Lake Diefenbaker

July 02, 2020

‘Historic’ $815M irrigation investment announced for southern Alberta agriculture

October 9, 2020

Shifting Agricultural Crop Suitability in a Changing Climate

This project **investigated new opportunities for annual crop production** by analyzing output from the Agriculture Crop Adaptation Atlas and Database (AgCAAD), a crop suitability model that was developed by Alberta Agriculture and Forestry (AAF) to assess the potential for introducing new crops where they previously have not been grown. Prior this project, the AgCAAD model relied solely on historical climate conditions. Therefore, the **objective** was to **apply a range of future climate scenarios** to the AgCAAD model, and thereby **compare crop suitability under current and projected agro-climatic conditions**.

PARC

Alberta
Agriculture
and Forestry

The factors, components and parameters used by the AgCAAD model to assess land suitability

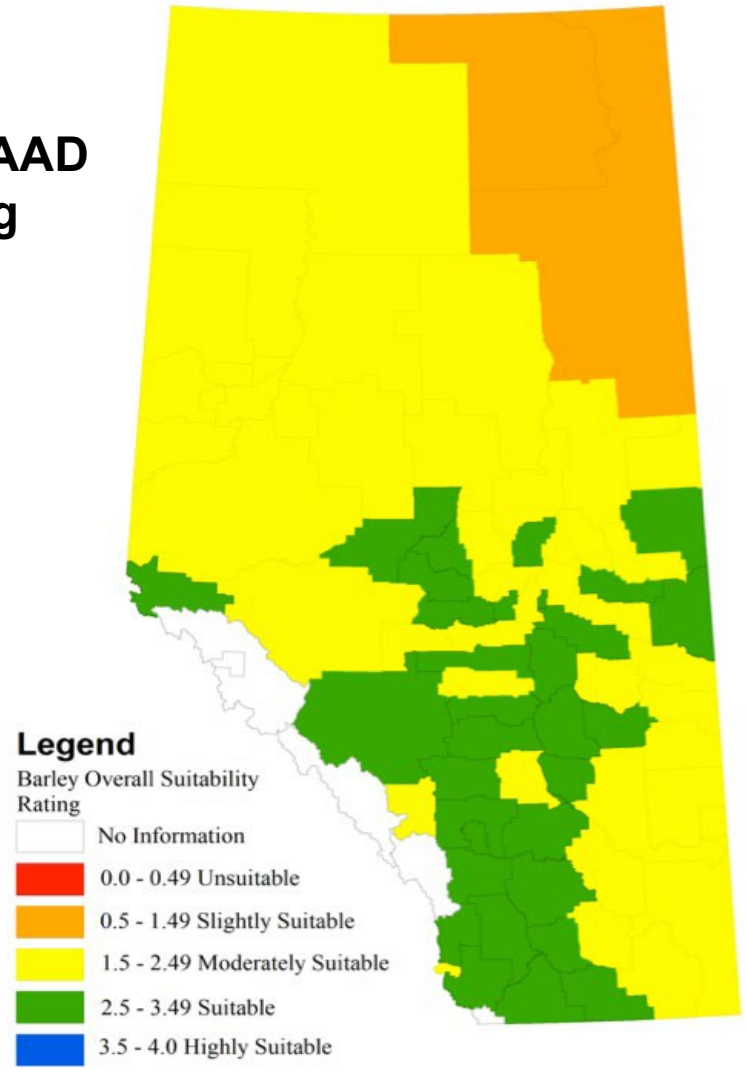
FACTOR	Component	Measurable Parameter
Climate	Heat (energy) supply	Growing degree days; growing season length; minimum winter temperature; frost-free period; maximum and minimum diurnal temperature thresholds, and optimum diurnal temperature range, for photosynthesis
	Moisture supply	Annual precipitation
Soils	Physical conditions	Soil texture
	Chemical conditions	pH, salinity
	Drainage	Drainage class

Assumptions / Limitations

- The rating is only a potential of the soil and climate to produce crops. Soil and water management are not considered. There are many social and economic factors that determine where crops are produced.
- The historical climate data and future projections are of shifts in average temperature and precipitation. Crop yield can depend very much on short-term variability and extreme weather.
- Crop suitability is a rating per township while recorded crop yield is in bushels per municipality
- The rating is only for rain fed/dryland agriculture; irrigation is not considered

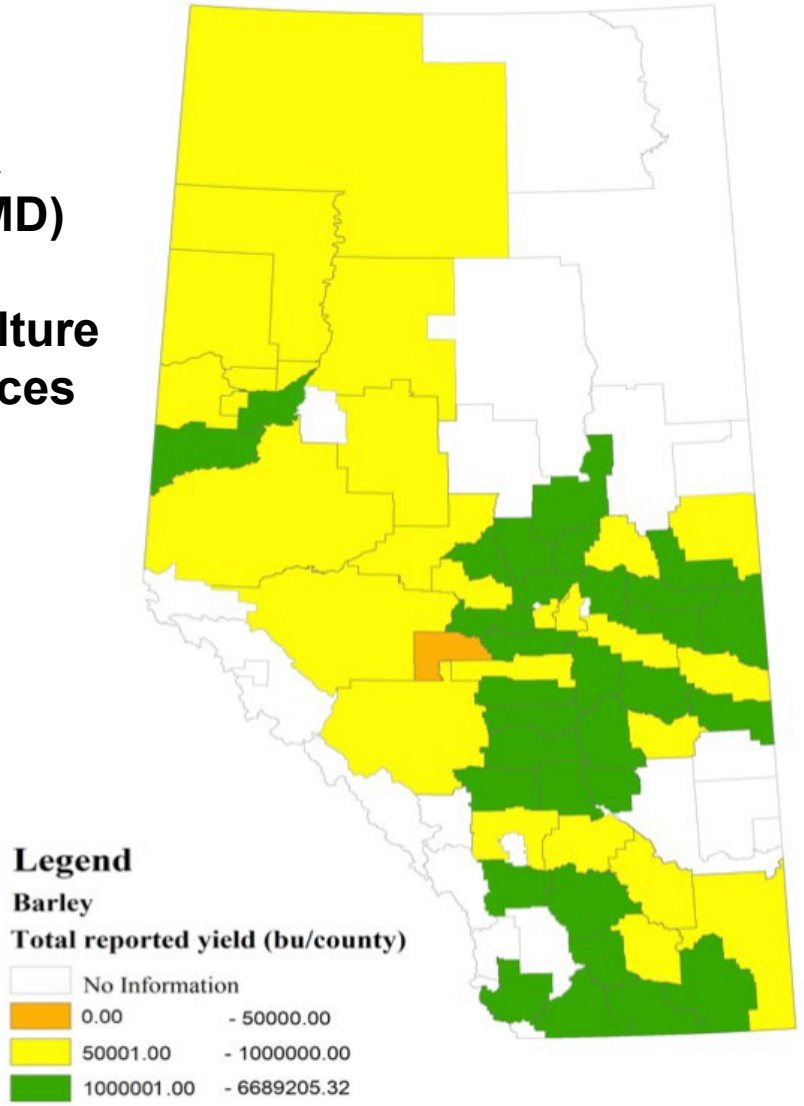
Verifying the Historical (2000-2019) Modeling of Crop Suitability

AgCAAD rating



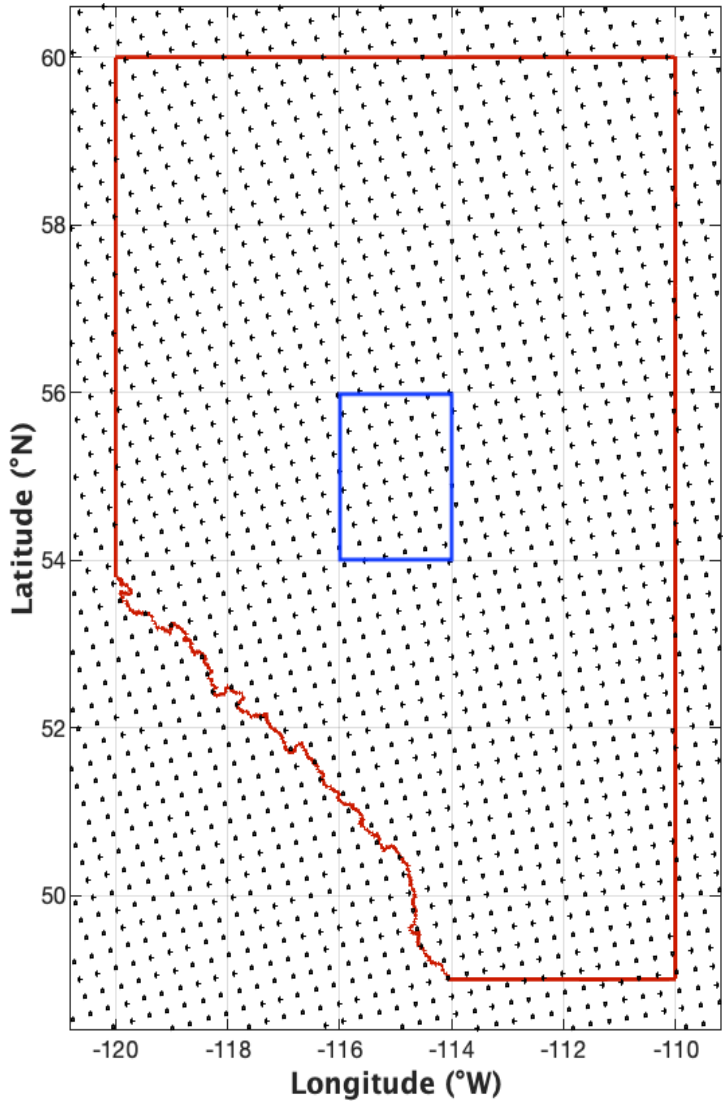
Crop yield data (bu/county or MD)

Source: Agriculture Financial Services Corporation

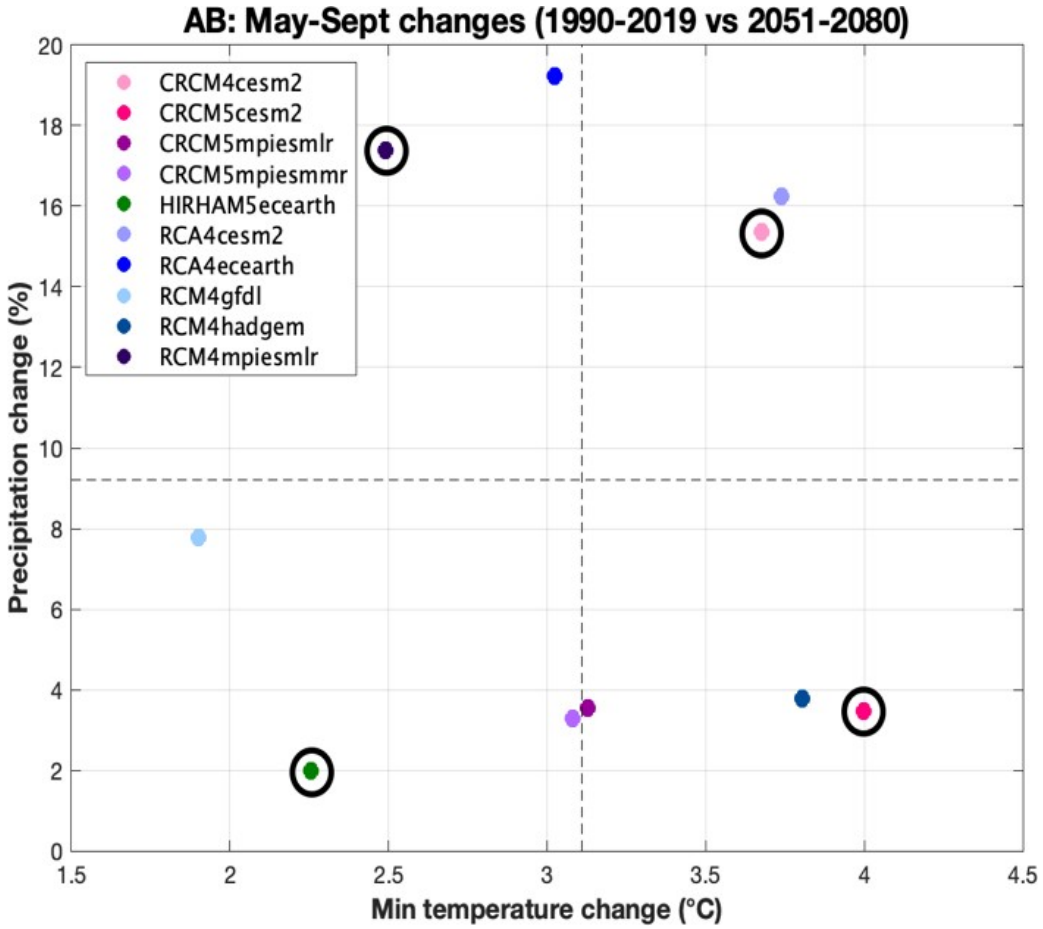


Climate Projections

GCM cell RCM grid

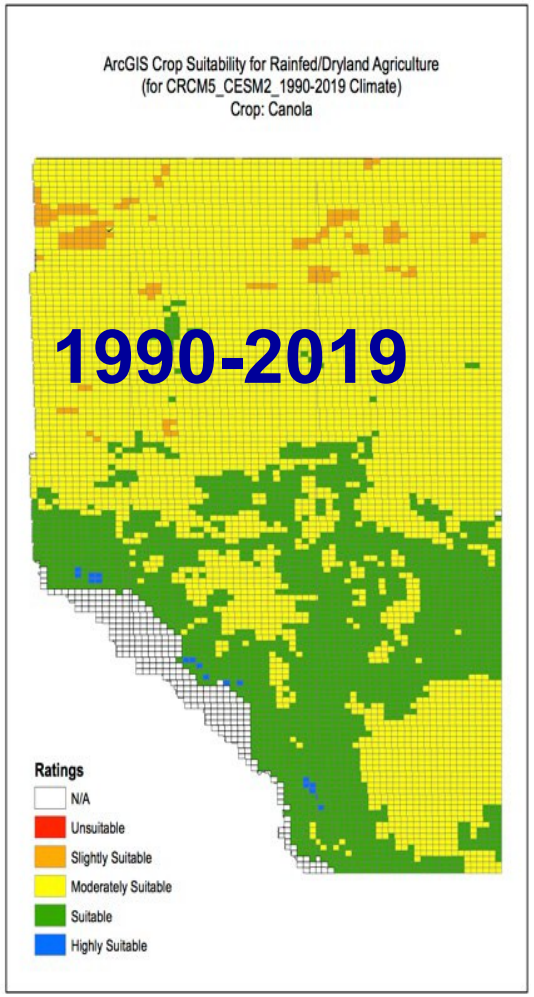


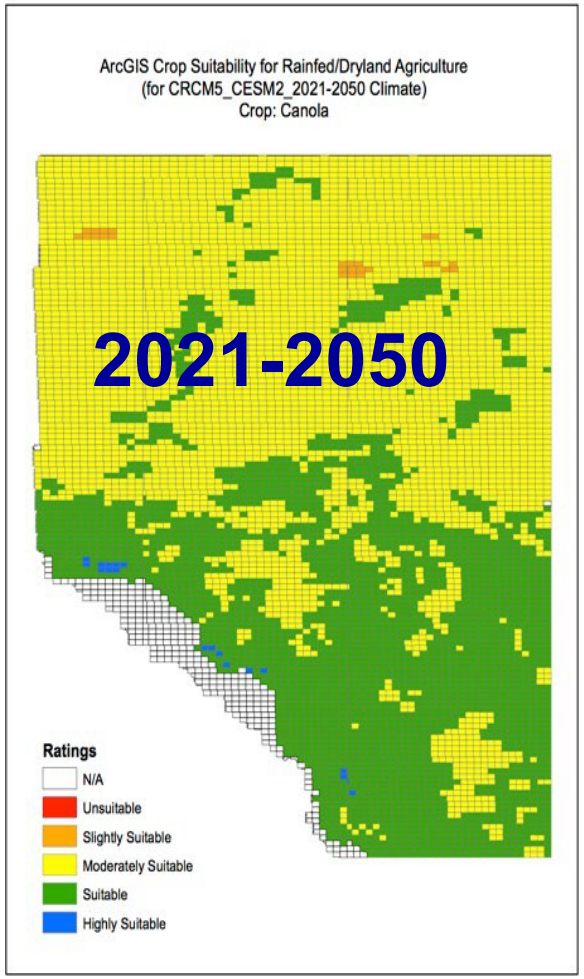
Climate of 2051 – 2080 versus
1990 – 2019 from 10 RCMs

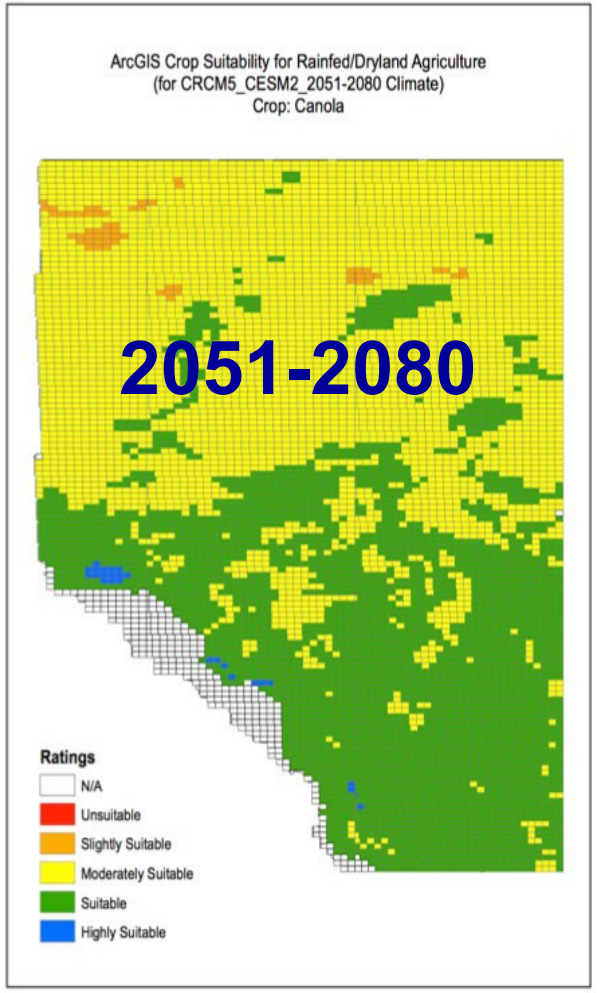


Crop Suitability Analysis

72 suitability maps: 6 crops, 4 climate projections and 3 time periods, for example:







Conclusions

- Under simulated conditions, the number of townships with **suitable growing conditions increases**, with **a few exceptions:**
  - Under the two warmer climate change scenarios, the area suitable for the production of peas and wheat increases in the near future (2021-2050) but then decreases in the far future (2051-2080).
- Otherwise, **climate change favours annual crop production** in Alberta.

Conclusions

- These results should assist the agriculture sector in Alberta by **informing decision making** related to crop selection, cropping system diversification, and the best use of available land and water resources.

- While focused exclusively on changes in crop suitability in Alberta, the outcomes of **our analysis will be transferable** to adaptation planning across the Prairie region.

Questions?

Next: A bit about the Economics of Climate Change from an on-farm perspective

By Sven Anders, Professor, Dept. of REES, University of Alberta

UNIVERSITY OF ALBERTA

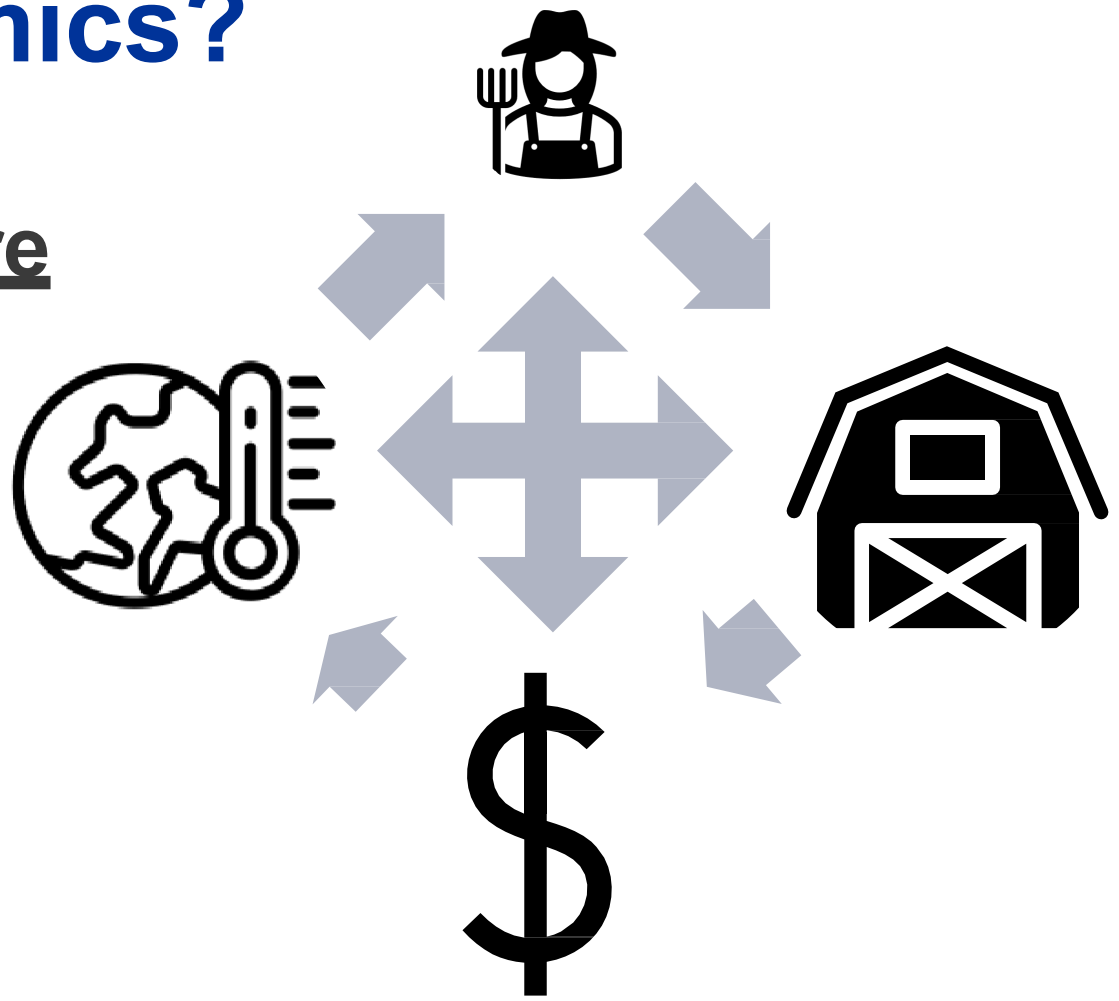
Economics of Climate Change in Agriculture … But don't call it Climate Change

Sven Anders, Professor, Department of Resource Economics and Environmental Sociology

September 15, 2021

Why worry about economics?

The CC Challenge in Agriculture



1. **Global Societal Issue vs Small Family Farms**

2. **How incentivize famers to mitigate CC? Who should pay for it all?**

What we know to date

- The Science – Agronomic adaptation & adoption strategies
- "How to protect the status quo of "business as usual" – *AFSC's* crop Insurance, etc.
- Private crop insurance on the rise in Canada (e.g., inputs)
- *Alberta Emission Offset System* (complex & complicated!)

What we don't know…

- What do producers think about CC mitigation?
- What do they want ?

Economics of Climate Change on Farm

Thinking about CC effects on agriculture actually straight forward

Climate Change is a complex, hidden & uncertain risk factor for farm operators

CC Risk Factors	Management
On-farm production	Control
Market prices & input costs	Mitigate
Supply-chain & Trade	Hope

Economic effects of CC on farm

CC affects production & management decisions -> impacts short & long-term profitability of operations:

$$\Pi = P * Q - W * X$$

P = Increased volatility in commodity prices & future markets

Q = Harvest & market forecast become less predictable

W = Prices of major inputs climb

X = Supply-chain bottle necks create shortages

What to do about it?

$$\pi = P * Q - W * X$$

Producer decision-making needs to actively incorporate CC risks

P*Q: Re-evaluate commodity hedging & forward contracting practices -> minimize contractual obligation risks

Adopt CC resilient production practices & technology -> crop & seed choices, livestock stocking numbers, sustainable rotations, active BMP adoption

W*X: Can you improve productivity more extensively?

Re-evaluate integrated pest mgmt., soil fertility, tillage practices. Production system review?

What to do about it?

$$\pi = PP * QQ - WW * XX$$

Farmer decision-making needs to actively incorporate CC risks

Problem:

- CC risks on agriculture are highly variable & uncertain
- Farmers can manage some risks **BUT** are often at mercy of others

Why is CC still such a hard sell in Agriculture?

Just don’t call it climate change – A UofA Study

- AB farmers/ranchers remain by and large climate skeptic
- **WE** want producers to take CC seriously, dump busines as usual, and adapt pro-active CC on-farm decision-making

Research question:

What is the role of “the farmer” in on-farm CC mitigation?

Just don't call it climate change: climate-skeptic farmer adoption of climate-mitigative practices

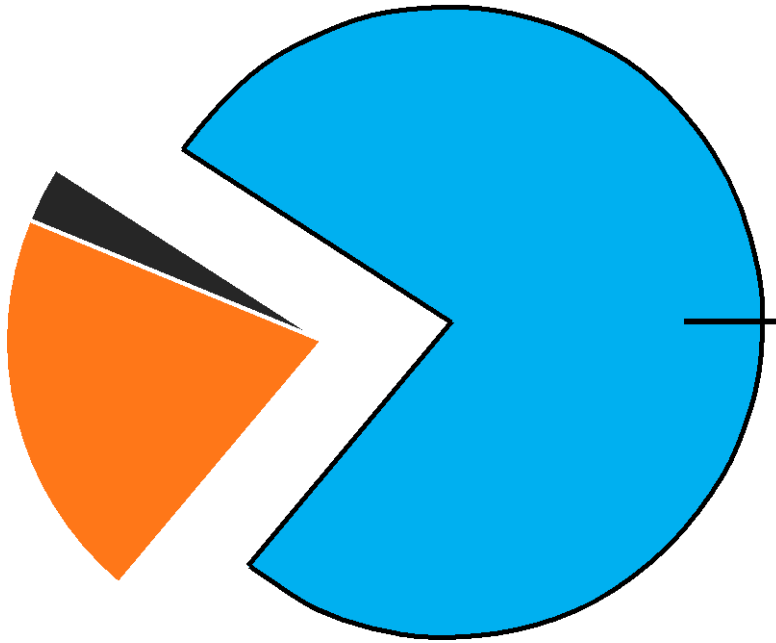
Debra J Davidson[1], Curtis Rollins[1], Lianne Lefsrud[2], Sven Anders[1] and Andreas Hamann[3]

Published 15 March 2019 • © 2019 The Author(s). Published by IOP Publishing Ltd

Environmental Research Letters, Volume 14, Number 3

Just don’t call it climate change

Is climate change occurring?

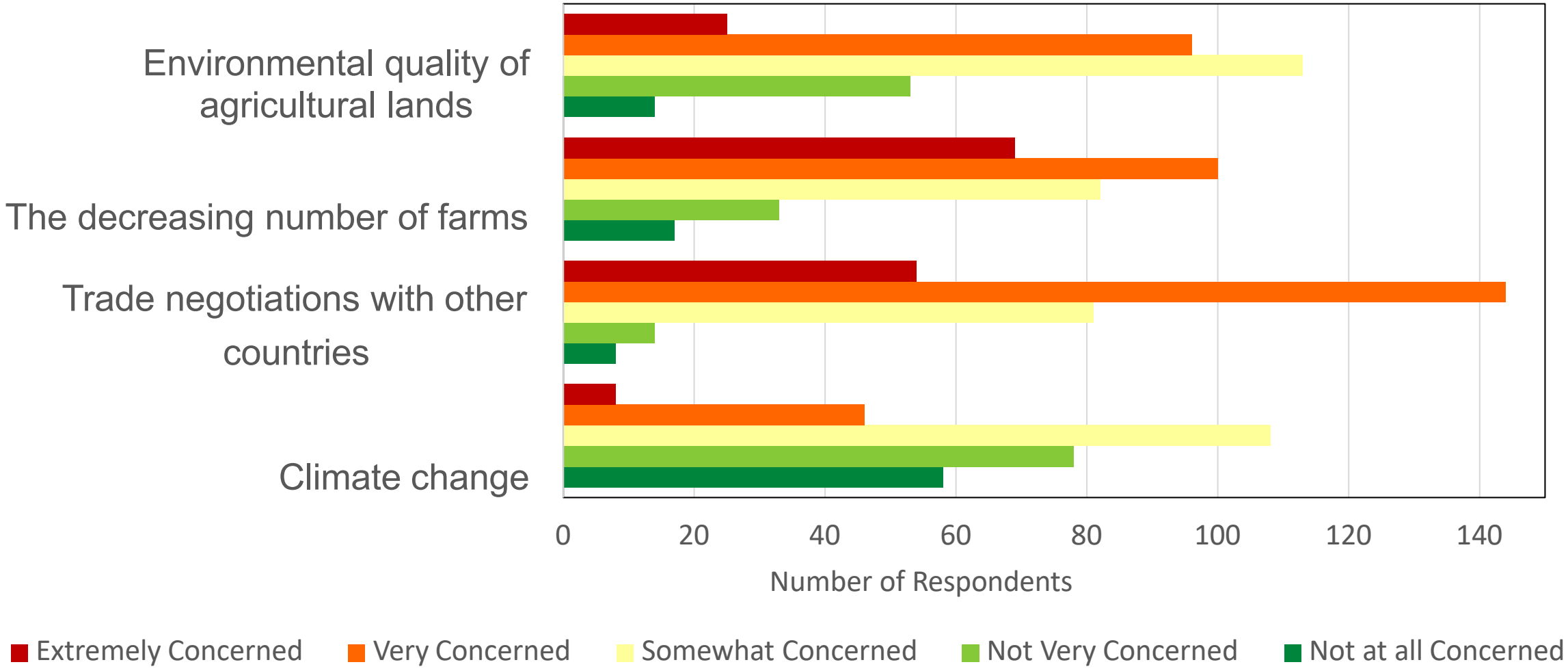


- No
- Insufficient evidence to judge
- Yes

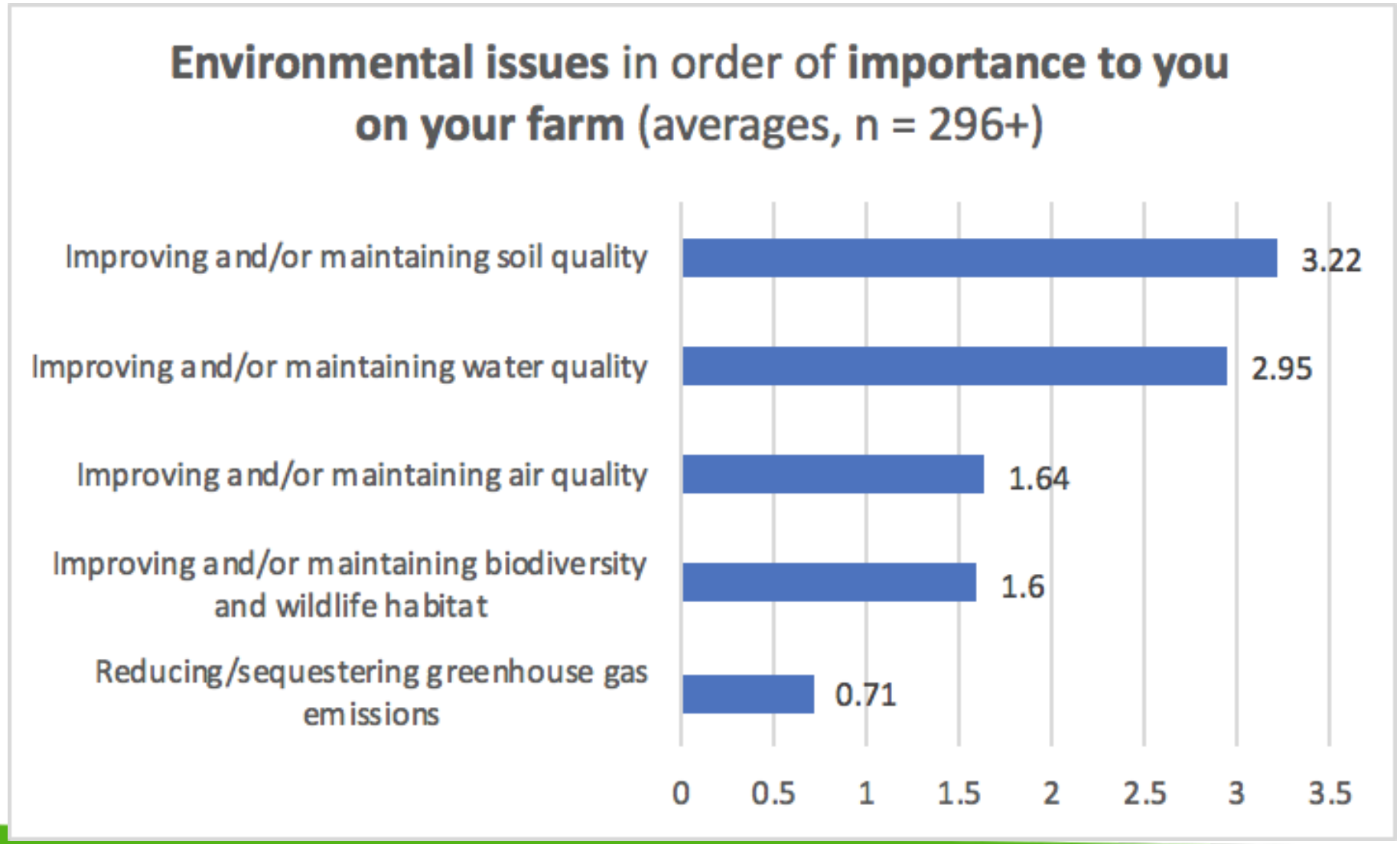
If so, what is causing climate change?

- Equally caused by humans & natural enviro. change
- Caused by natural environmental change
- Caused by humans

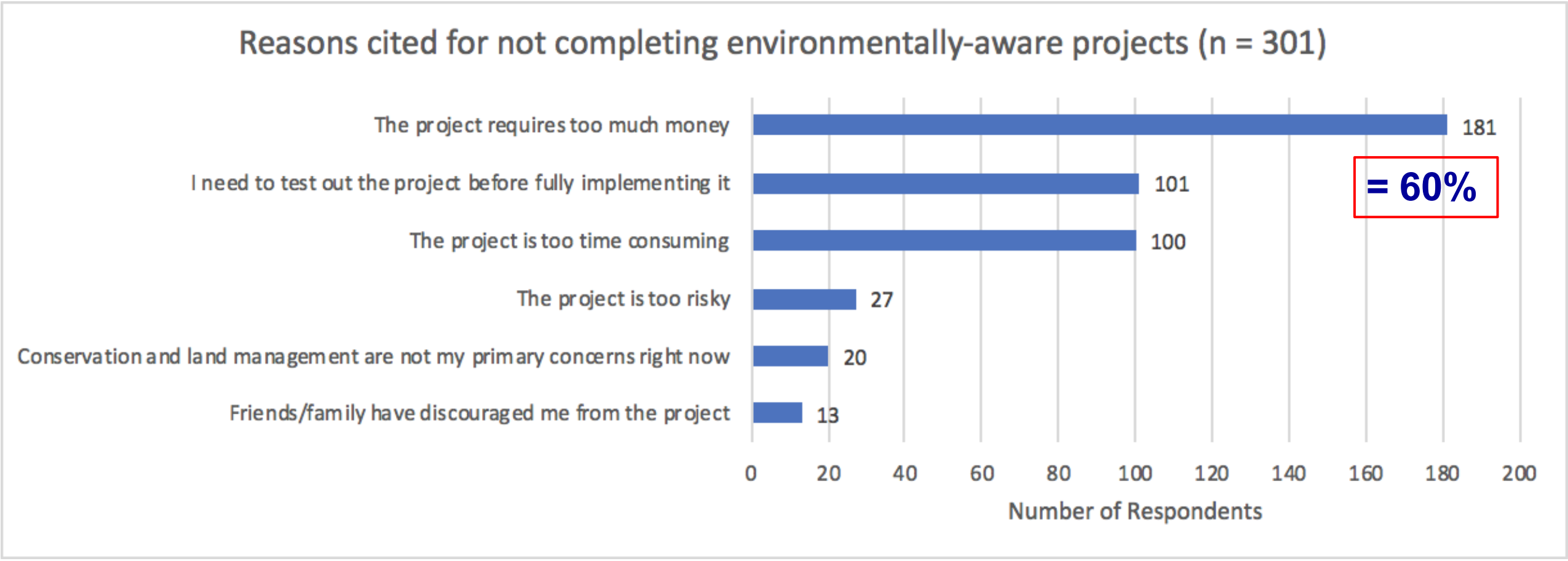
How concerned are you about the following issues affecting the future of Canadian agriculture?



Please rank the following environmental issues in order of importance to you on your farm (most important = 5)



For which of the following reasons have you been unable to complete environmental projects?



So, what do AB farmers & ranchers do about CC mitigative practices on-farm?

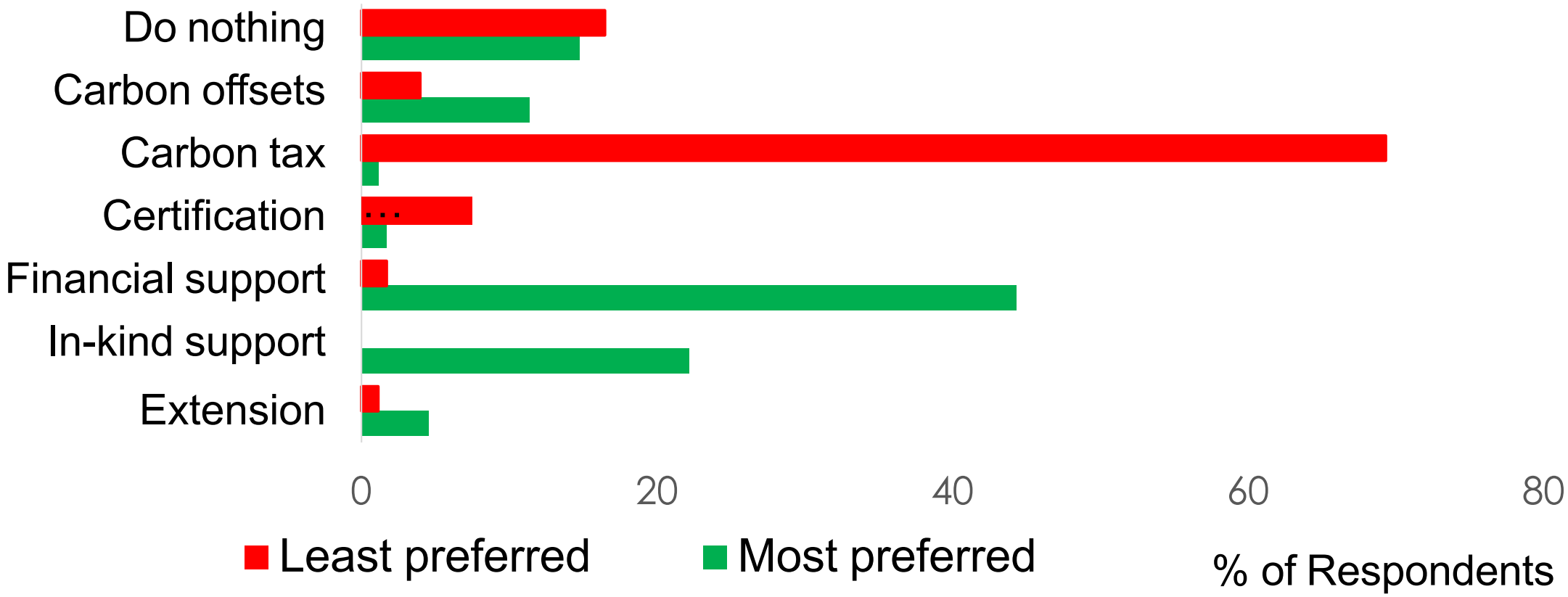
Table = 21 proven CC mitigative on-farm practices (Best Mgmt. Practices, BMP)

1) Producer already adopted practice
2) Would consider adoption in the future
3) “Not in my farm/ranch!

Practice	Adopted	Would Consider	No Adopt.	N
Leave/spread crop residue in fields after harvest	**97**	2	1	260
Zero-tillage	82	12	6	252
Use GPS, precision agriculture, variable rate fertilizer technology	81	16	3	250
Installed LED lights	**80**	19	1	299
Manure composting	79	19	2	148
Make animal breeding decisions to improve feed efficiency	79	15	5	156
Include perennial, forage, and/or legume crops in rotations	71	23	6	231
Improved the energy efficiency of buildings	68	30	2	289
Introduce legumes, other nitrogen fixers into grazing lands	67	29	3	147
Maintain wetlands	62	23	14	222
Fenced off riparian areas & sensitive ecosystems against livestock	60	27	12	139
Planted tree belts or lots	58	26	16	267
Converted cropland to pasture or other vegetation	52	24	24	250
Planted permanent/perennial vegetation on marginal lands & fields	51	33	16	250
Supplement feed with ionophores, lipids, oil seed, bacterial suppl.	39	39	21	132
Reduce slaughtering age of cattle by 2+ months	39	49	12	116
Plant cover crops	36	46	18	192
Restored wetlands	33	42	25	209
Installed solar panels	19	**67**	14	276
Production of bioenergy	10	**61**	29	165

My last slide – What can be done in Alberta?

Which type of policy or program aimed at CC mitigation would you be **most supportive of**? Which program or policy would you be **least supportive of**?



Take home messages

- CC is a complex, hidden & uncertain risk factor
- Cost of adaptation & adoption are well understood and born by producers
- Benefits of adaptation & adoption are for society
- Working with producers on CC requires understanding of specific barriers, facilitators, and individual views
- Financial (other) support (compensation) needed to incentivize change

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UNIVERSITY OF ALBERTA
DEPARTMENT OF RESOURCE ECONOMICS AND ENVIRONMENTAL SOCIOLOGY

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Thank you!

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Summary – Key Message

Adaptation Success

- Collaboration = farmers + associations + researchers + govt
- Programs, tools and resources, information sharing that is:

evidence based

sustainable

funded



Adaptation Resilience Training: Agriculture

Let's Have a Conversation

Crystal Mackay, Loft 32

September 15, 2021

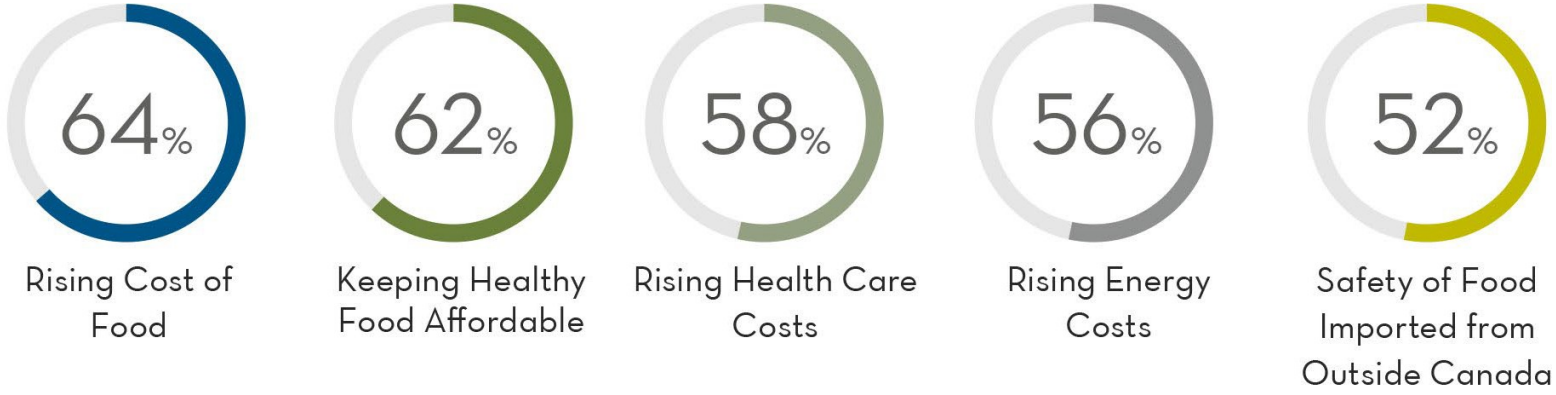
From farms to tables

The age of „post-truth” and “truthiness”

Oxford Dictionaries declared “post-truth” international word of the year in 2017.

An adjective “relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief.”

Life Concerns for Canadians 2020
Canadian Centre for Food Integrity foodintegrity.ca



MORE CANADIAN FOOD SYSTEM CONCERNS

Let’s talk about people.

POINTS OF VIEW SPECTRUM

Sub in issues here…

The power of storytelling

Connect with shared values first.

Shared values is the base for building trust.

Shared values are 3-5x more impactful than facts for earning trust.

Canadian Centre for Food Integrity
www.foodintegrity.ca

Let’s talk tough topics.

- Why it’s difficult
- About people – you and them
- Tips and actions

Why is it a difficult topic?

- Morals, ethics
- Feelings, reactions
- Surprise
- Outside your expertise
- Impacts, repercussions and fallout

Think about topics you aren't comfortable with

- What do you dread being asked about?
- Name it and research it
- Increase confidence
- Practice

It’s about them.

- Ask some questions.
- What is their real concern?
- What will help address the concern?
- How do you connect with them?

Give perspective and context

- Encourage critical thinking.
- Put extreme examples into perspective.
- Shape a new narrative with your experience.

Let’s have a conversation

Effectively correct misinformation

- Concerns can be based on old information, extreme examples or not relevant in Canada.

“I can’t afford climate change improvements.”

1. **Ask them some questions.**

2.Connect with shared values.
“Ok I get that…”
“I feel strong about…too.”

Time and Map Technique

Map: Globally, US, Canada, Ontario, Guelph, a farm I visited

Time: In the past, today, in the future

Note: Time technique is very powerful for tough topics that have legitimate problems.

Farmers just focus on farming.

Time technique
In the past, today, in the future

Your goal:
Give perspective and context

- Encourage critical thinking
- Put extreme examples into perspective
- Shape a new narrative with your experience


What's
Your
Story?

Now it’s your turn

1. The asker
2. The answerer
3. The listener

Topic: “I don’t think climate change related work is a priority.”

“But here’s the thing about evidence. It changes nothing. Evidence belongs to the Thinking Brain, whereas values belong to the Feeling Brain.

You cannot verify values. They are by definition **subjective and arbitrary.”**

And values cannot be changed by reason, only through **experience**.”
Mark Manson

WRAP UP


Do the best you can until you know better. Then when you know better, do better.
Maya Angelou
quotefancy

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DISCLAIMER

THANK YOU!

If you have any questions, please contact info@climatewest.ca

To download this presentation and additional resources please visit: climatewest.ca

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