Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA)

Water Management: We are all part of the solution
2015 SAW Conference,April 15, Melfort, SK

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Vulnerabilidad y Adaptación a los Extremos Climáticos en las Américas

Principal Investigators:

Los investigadores principales

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IDRC CRDI

NSERC CRSNG

Social Sciences and Humanities Research Council of Canada

www.parc.ca/vacea/

International Research Initiative on Adaptation to Climate Change

IDRC CRDI

1 Coastal Cities at Risk
University of Western Ontario

2 Protecting Water Resources in West Africa and Canada
Institut National de la Recherche Scientifique, Montreal

3 Partnership for Canada-Caribbean Community Climate Change Adaptation
University of Waterloo

4 Indigenous Health Adaptation to Climate Change
McGill University, Montreal

5 Vulnerability and Adaptation to Climate Extremes in the Americas
University of Regina

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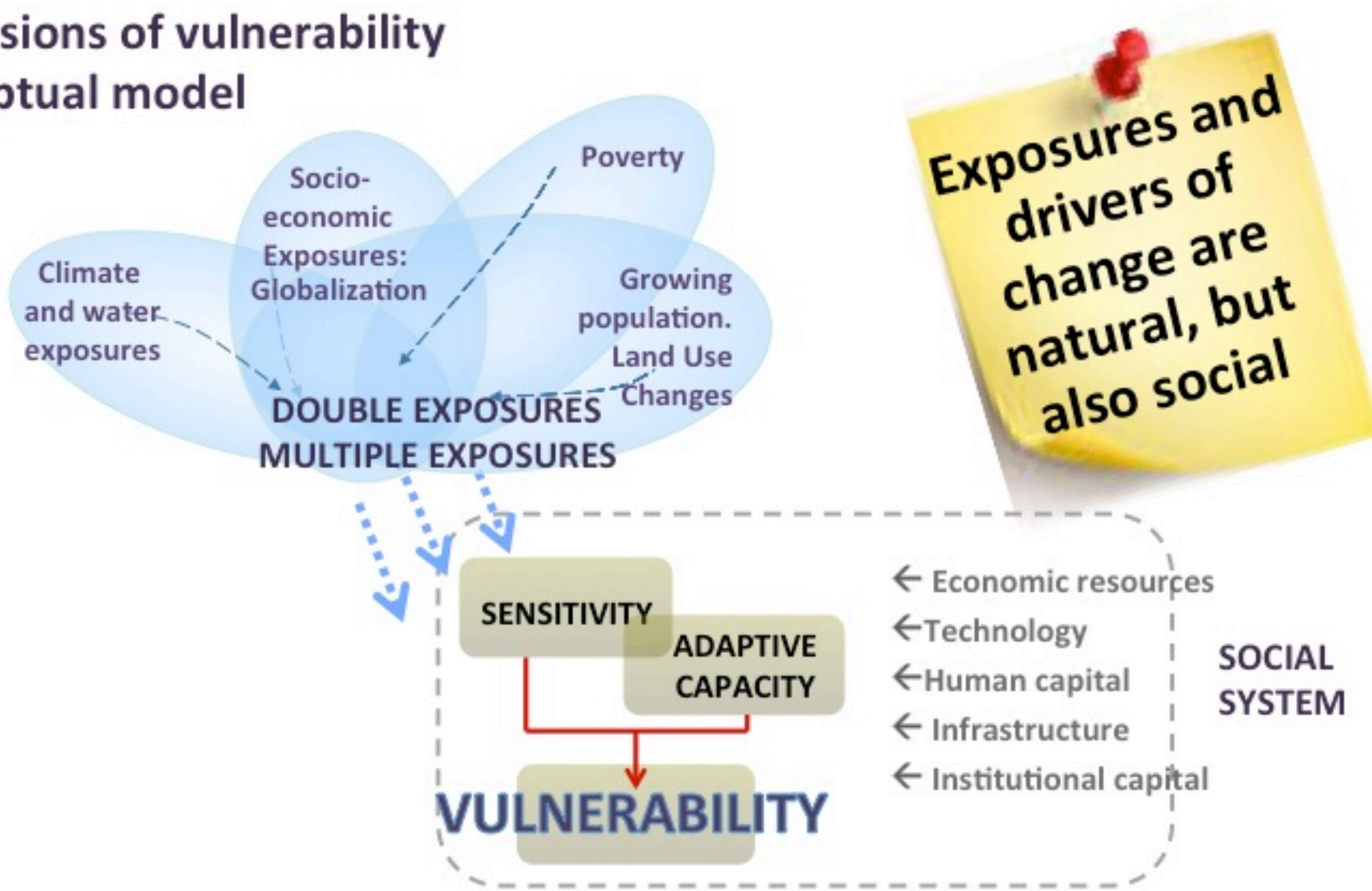
SK Assoc of Watersheds	Deanna Trowsdale-Mutafov
SK Environment	Kim Graybiel
SWA	Wayne Dybvig
Swift Current Creek Watershed Stewards	**Arlene Unvoas**

VACEA - Objective

The overall objective is to improve the understanding of the vulnerability of rural agricultural and indigenous communities to **shifts in climate variability and to the frequency and intensity of extreme climate events**, and to engage governance institutions in Canada, Argentina, Brazil, Chile and Colombia in enhancing their adaptive capacity to **reduce rural community vulnerability**.

Dimensions of vulnerability
Conceptual model



Montaña, E y Díaz, H. 2012

Relating climate extremes to climate change

“The main way **climate change is perceived** is **through** changes in **extremes** because those are outside the bounds of **previous** weather.

…

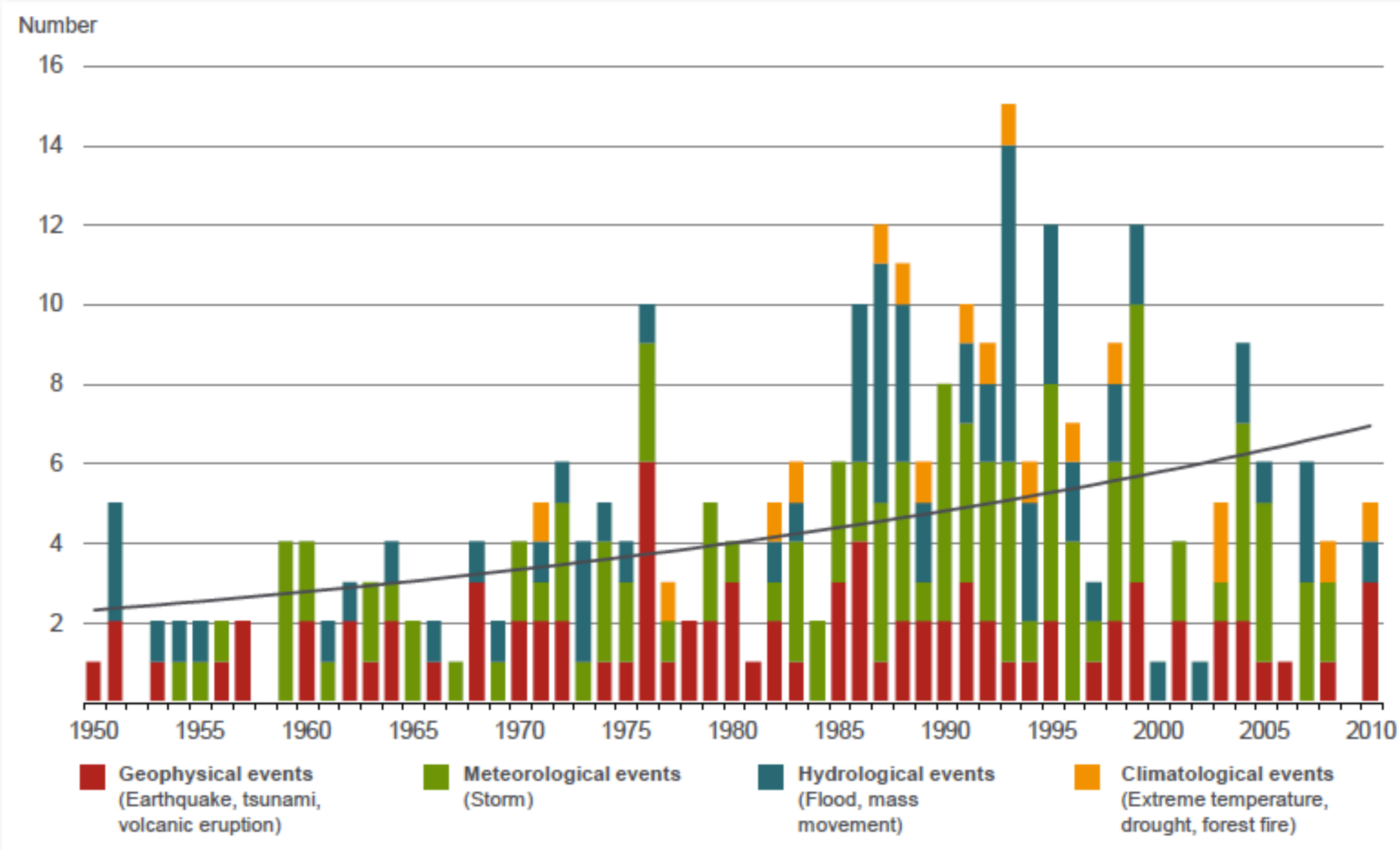
The answer to the oft-asked question of **whether an event is caused by climate change** is that it is the **wrong question**. All weather events are affected by climate change because the environment in which they occur is warmer and moister than it used to be.”

Trenberth, Kevin (2012) Climatic Change.

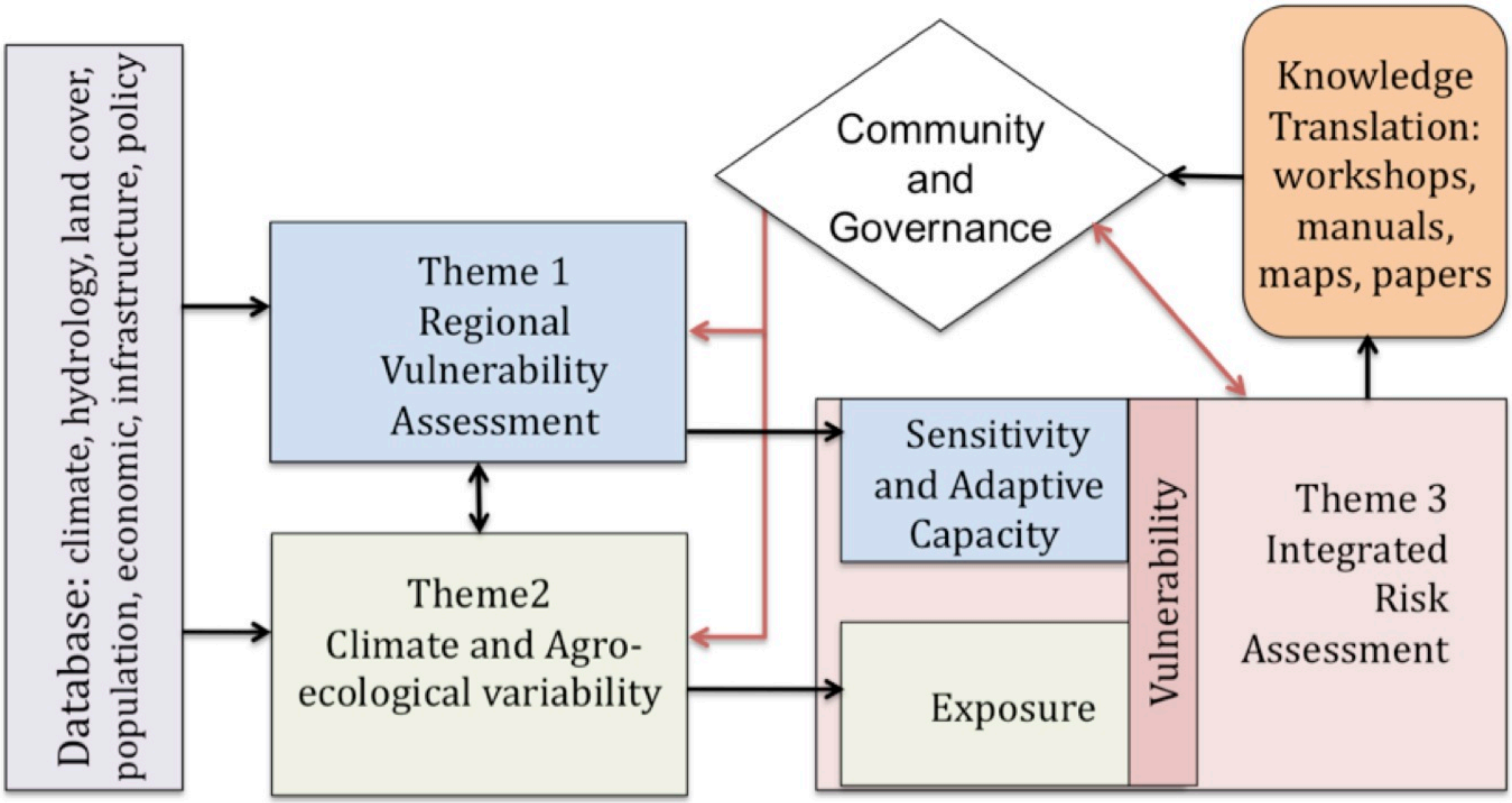
NatCatSERVICE

Great natural catastrophes worldwide 1950 – 2010

Number of events with trend



VACEA Methodological Framework



Research Sites (Watersheds)

	River basin	Location	Size (km^2)	Extreme climate events	Agricultural production
Brazil	Ararangua	southern Brazil	3,020	hurricanes, hail and tornadoes, heat stress	rice, fruits, vegetables, cattle
Colombia	Chinchiná	central Andes	1,135	droughts, floods, storms, avalanches	coffee, sorghum, maize, rice, cattle
Argentina	Mendoza	eastern Andes	17,821	droughts, hailstorms, heat stress	fruits, horticulture, goats
Chile	Choapa	northern Chile	8,124	droughts, floods, mudslides, frost, heat	fruits, horticulture, flowers, goats
Canada	Oldman	southern Alberta	26,700	droughts , floods,	grains, pulses, forage, vegetables, cattle
	Swift Current	southern Saskatchewan	5,592	droughts , floods	grains, pulses, forage, , cattle

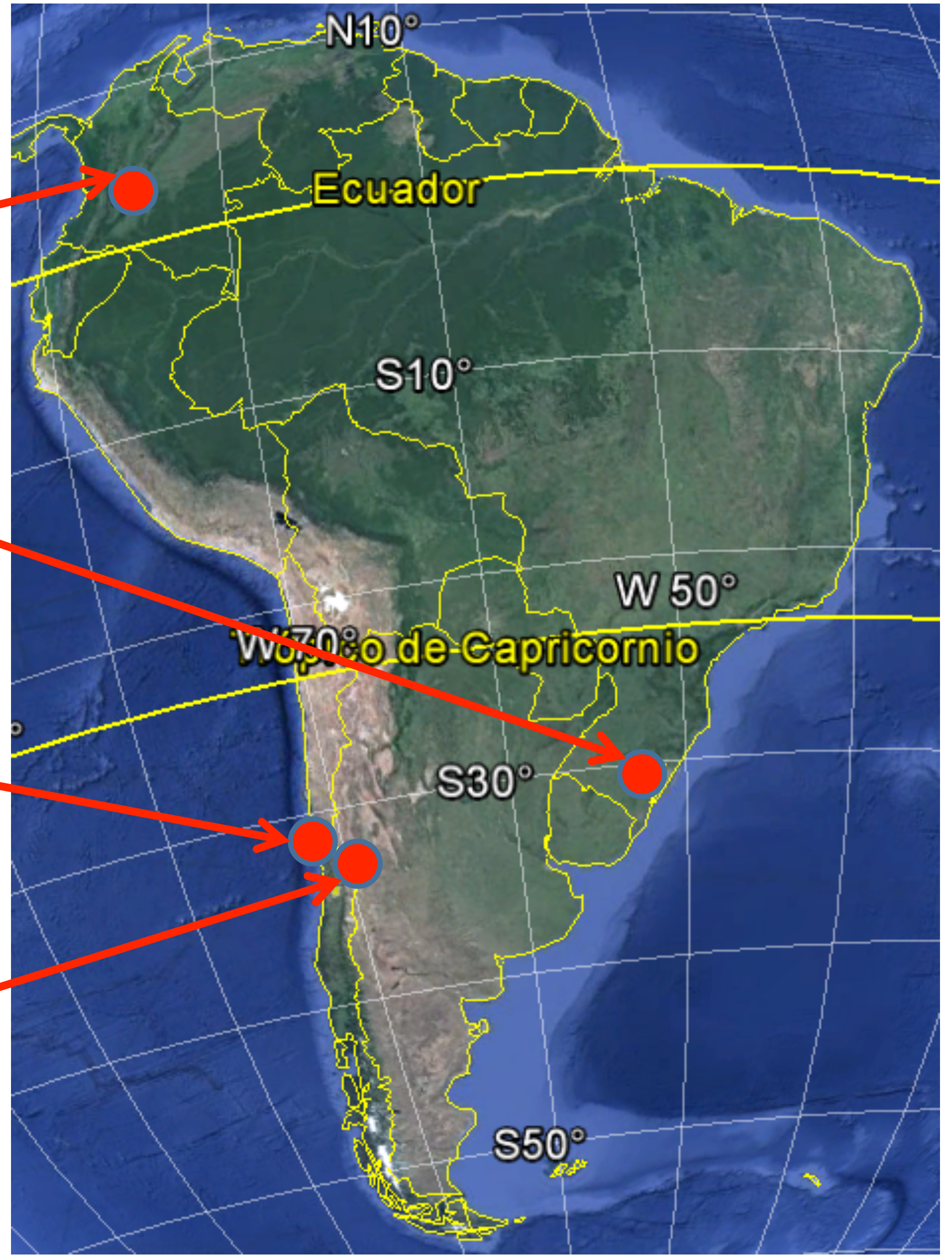
The VACEA pilot areas

COLOMBIA
Manizales-Caldas Region
The Chinchina River Valley

BRASIL
Santa Catarina

CHILE
Choapa Valley

ARGENTINA
Mendoza River Basin



Choapa River Valley: The dynamic border of the Atacama desert in north central **Chile**

The source of rivers, and water for communites and ecosystems, is impacted by decreasing snowfall, reduction of glacier volume and rising elevation of isotherms.

Farming communities are the first source of **information on threats posed by climate change, and adaptations**.

Chinchina River Valley: The heart of the coffee region of **Colombia**

Glaciers are quickly retreating, reducing water availability.

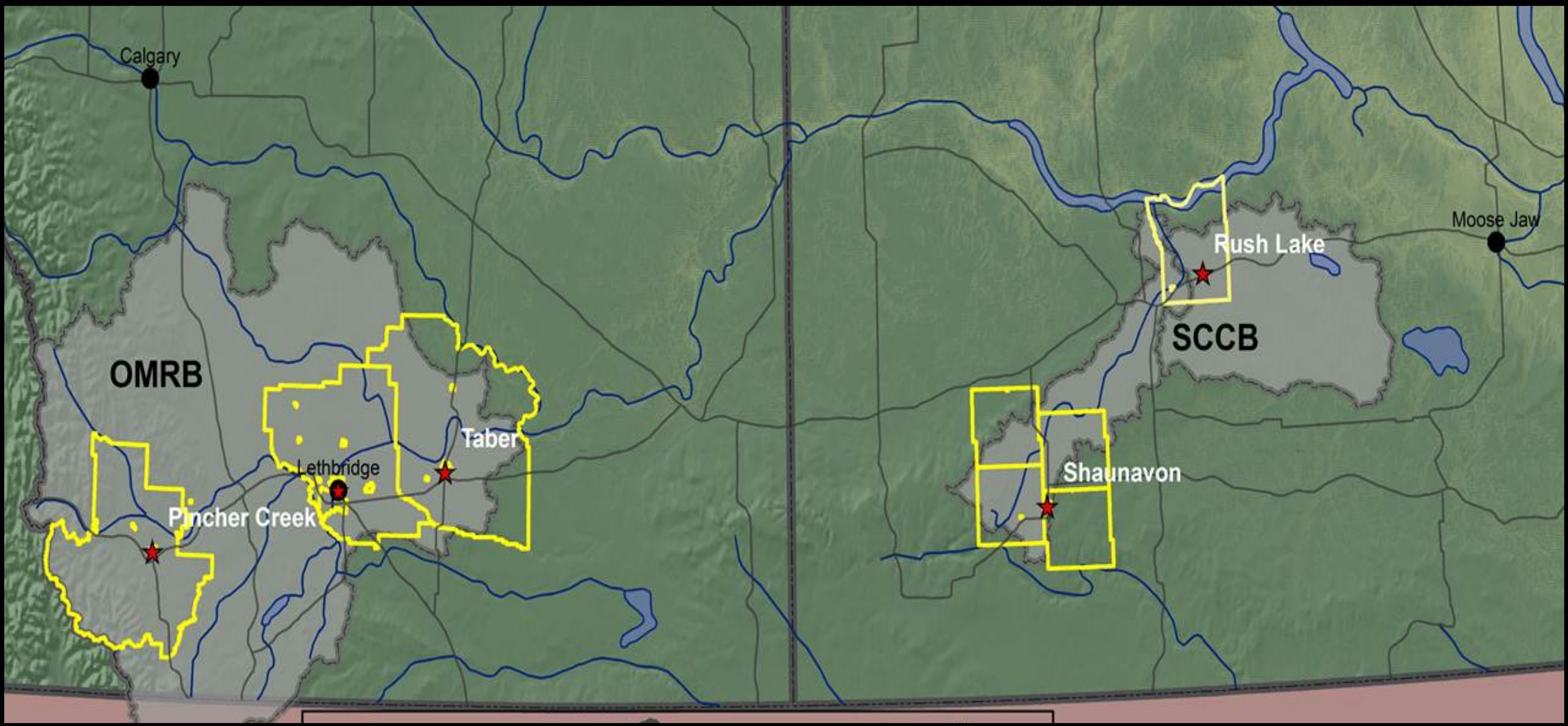
Santa Catarina River Valley, Brazil: The bio-diverse Temperate South

Farmers in the VACEA network actively participating in **adaptation initiatives**.

Mendoza River Basin: The Oasis of the central Andes of **Argentina**

VACEA team gathering the local perceptions about the effects of **climate change** and best **adaptation strategies**.

Study "Communities"



Assessments of Community Vulnerability and Governance

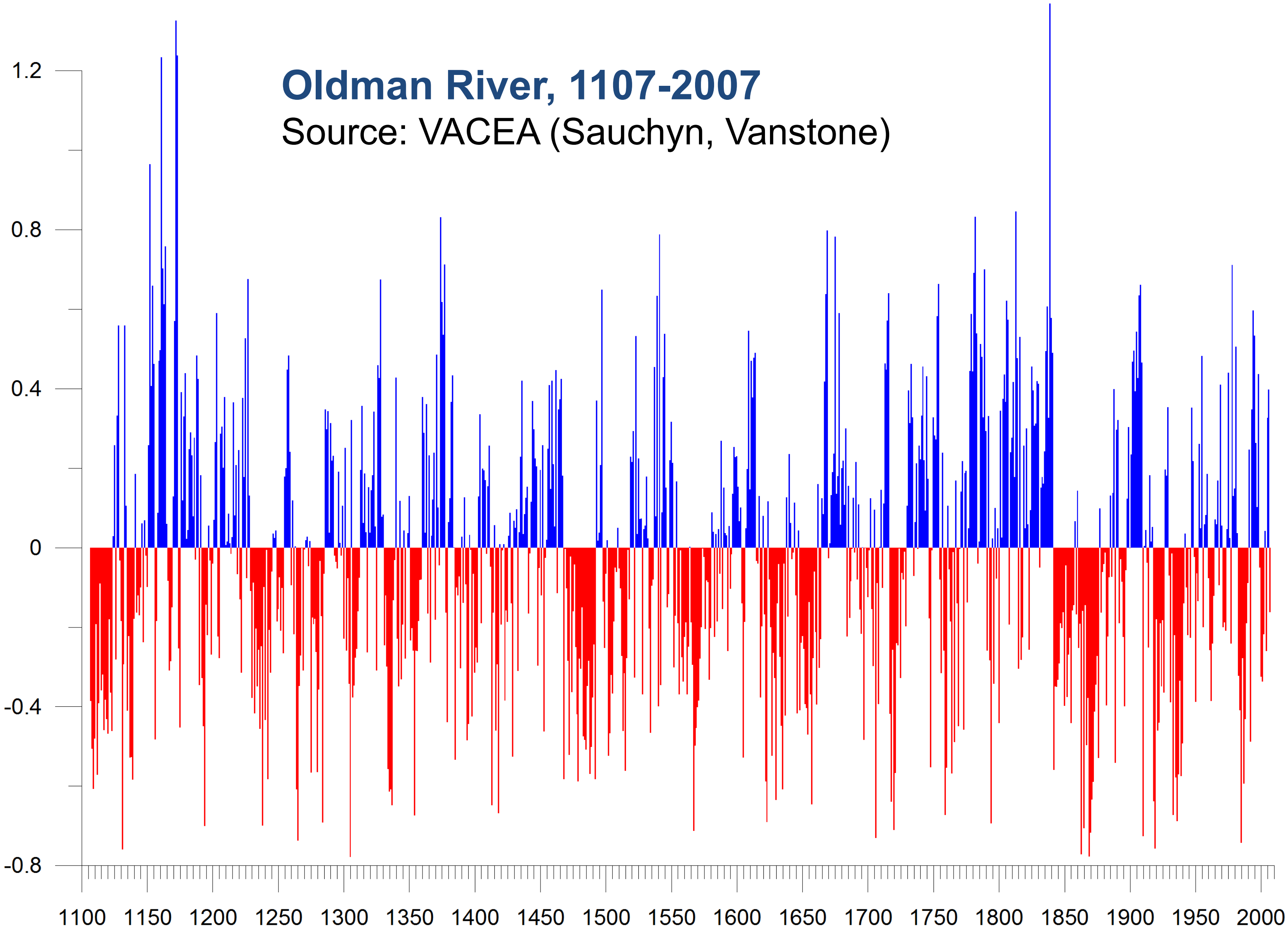
VACEA Social Survey

Community (Study Area)	Community Vulnerability Assessment (CVA) Interviews	Governance Assessment Interviews
Rush Lake	17	6
Shaunavon	34	18
Pincher Creek	33	20
Taber	16	26
Total	**100**	**70**

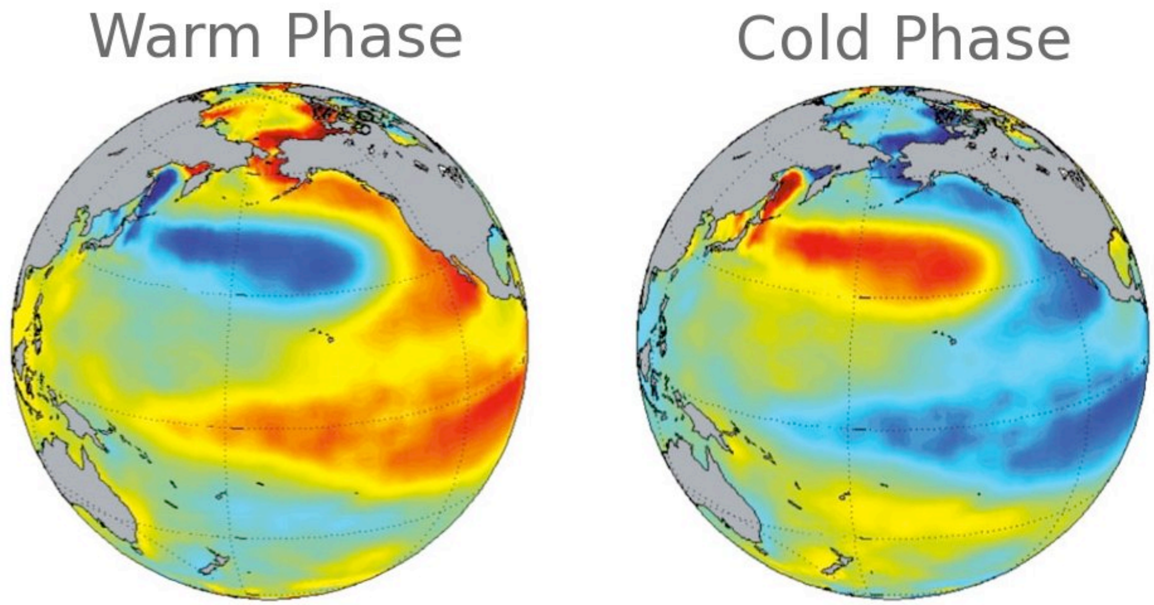
Exposure	Impacts	Sensitivities	Adaptation
SHAUNAVON - DROUGHT			
• Shaunavon and the surrounding area have historically experienced drought as an ongoing stressor.	• The main impacts of drought is crop damage resulting from a lack of soil moisture. • Ranchers are affected by reduction in hay yields and lack of water for livestock. Crop producers are affected by declining crop yields/quality. • Surface water quality is affected by drought conditions and changes in the quantity of surface water. • From a governance perspective, drought can be more difficult to identify and therefore institutional response is slow. In contrast, flooding is a marked and identifiable event, which facilitates governmental response.	• Unlike the other study sites Shaunavon does not have developed irrigation making the area more sensitive to drought. • Financial instability, particularly a high level of debt, is a major sensitivity that exacerbates vulnerability to drought. Increasing farm size (an adaptive strategy to the growing cost-price squeeze) often increases debt and therefore financial sensitivity. • Some older farmers reflected that the movement away from mixed farms and toward single-commodity farms may cause additional sensitivity, since crop and cattle prices tend to operate conversely.	• The area has a history of utilizing adaptive practices to adjust and adapt to dry conditions. Historically, these include: ○ Rotational grazing ○ Crop rotation ○ Contour tillage ○ Zero-till farming (more recently) ○ Crop selection (e.g., lentils for drought-resistance; yellow peas for shorter growing seasons) • Resource management, for example, stockpiling hay in non-drought years, bringing in hay from other areas, hauling water and diversifying water sources using mixed water sources (having more than one well, using dugouts and wells) and rainwater conservation. The most extreme response selling or even culling cattle. • Off-farm income helps to supplement farm income. While some farm family members routinely work off-farm, such employment is also used as a coping response during drought years.

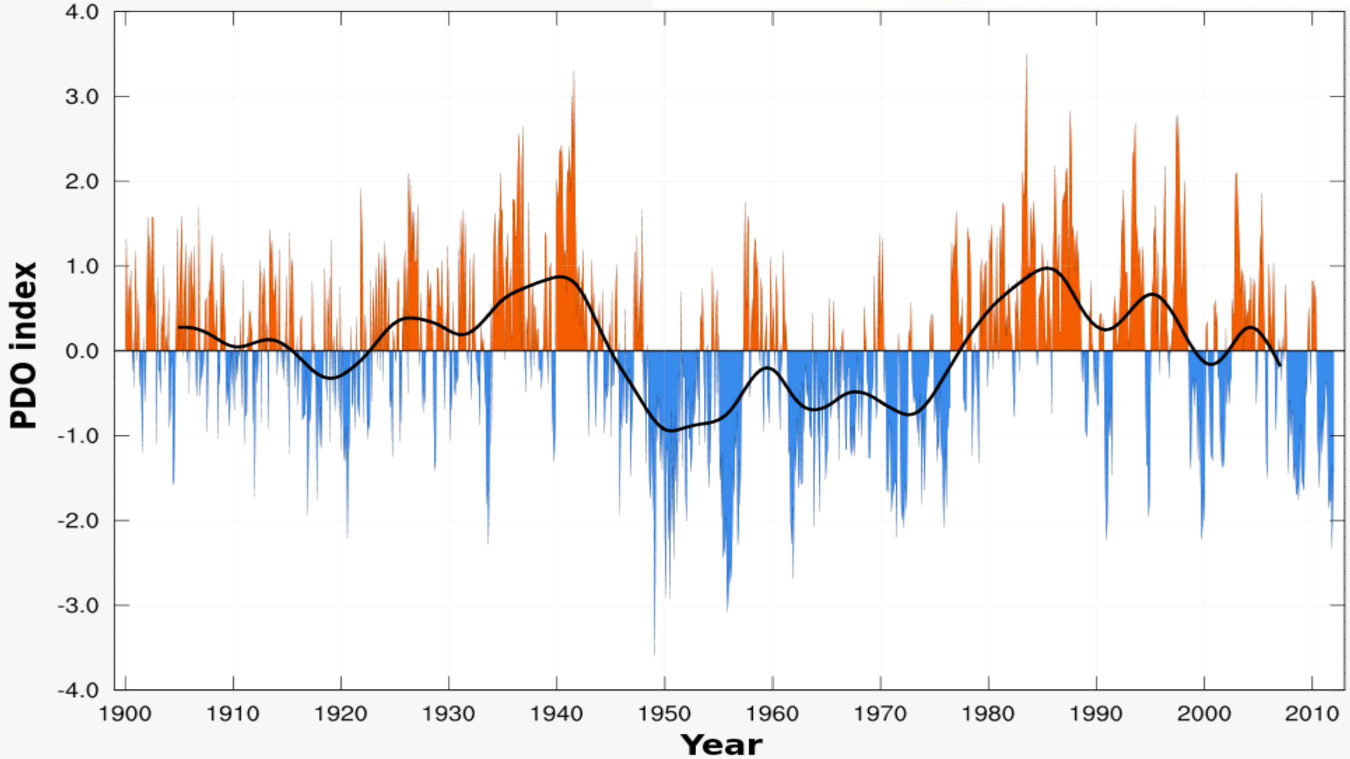
Climatic and Agro-Ecological Variability

The climate of past centuries: no obvious signal of global warming; dominated by variability at interannual and decadal scales.

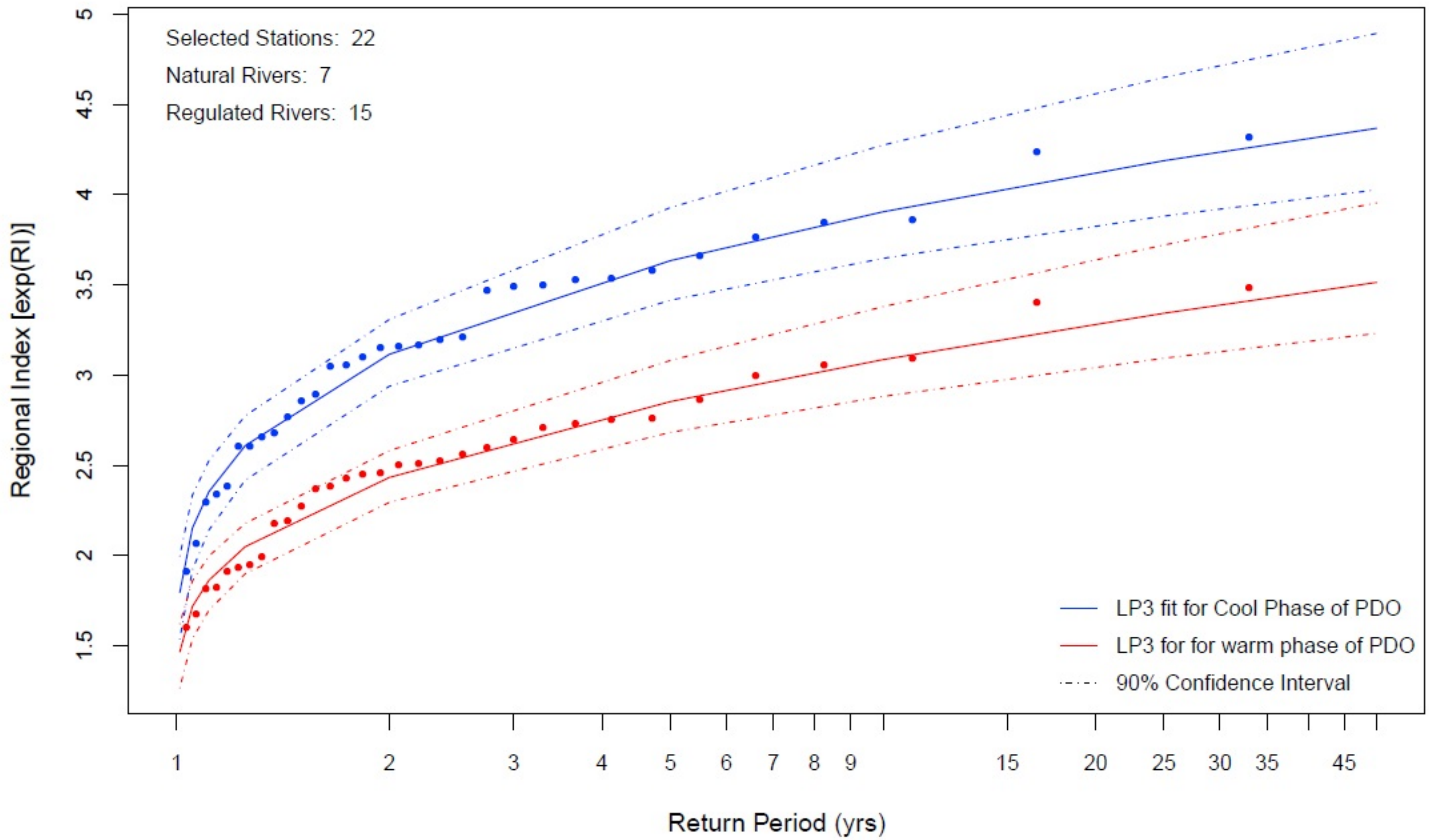


Pacific Decadal Oscillation





Annual peak flow by PDO phase for 22 gauging stations



Gurrapu et al. 2014

Features of Climate Extremes in Two Key Watersheds in the Canadian Prairies - the Swift Current Creek and Oldman River Watersheds: A VACEA Fact Sheet

Top five droughts (using SPEI)

1961, 1936, 1984, 1937, 1988 are the strongest droughts in the growing season (May to August) for the SCC. The more recent drought of 2001, although falling short of the top five, is also among the top ten most severe droughts.

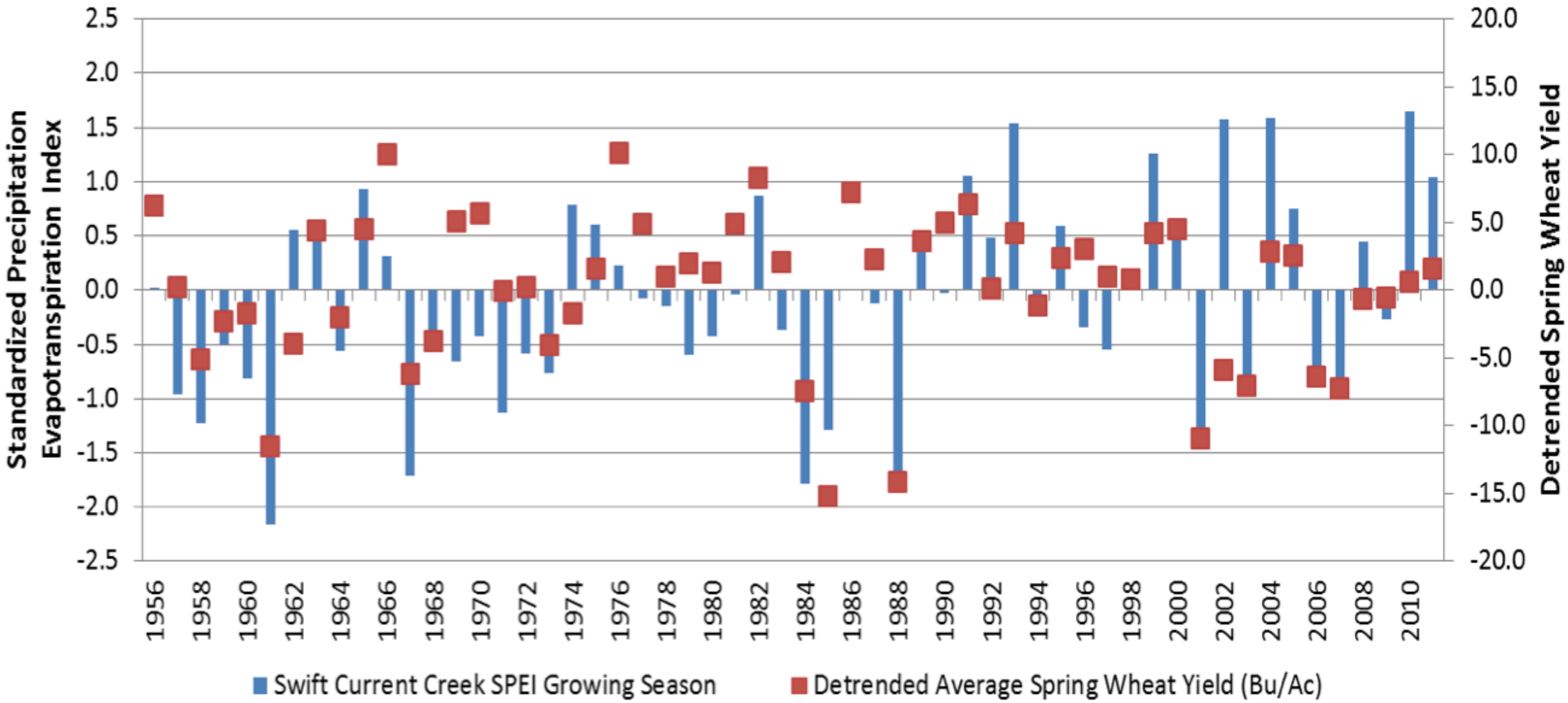
Top five wet periods (using SPEI)

1927, 2010, 1909, 2004, 1954 are the wettest single-year wet growing seasons for the SCC**.** Another recent year, 2002, ranks sixth.

- more than a third of the variation in spring wheat yields is associated with variations in climatic conditions (represented by SPEI). The rest is related to other factors, including soils and agricultural management
- consecutive drought and wet years that affect large areas often cause the greatest challenge for adaptation and require the most improved adaptation measures and planning

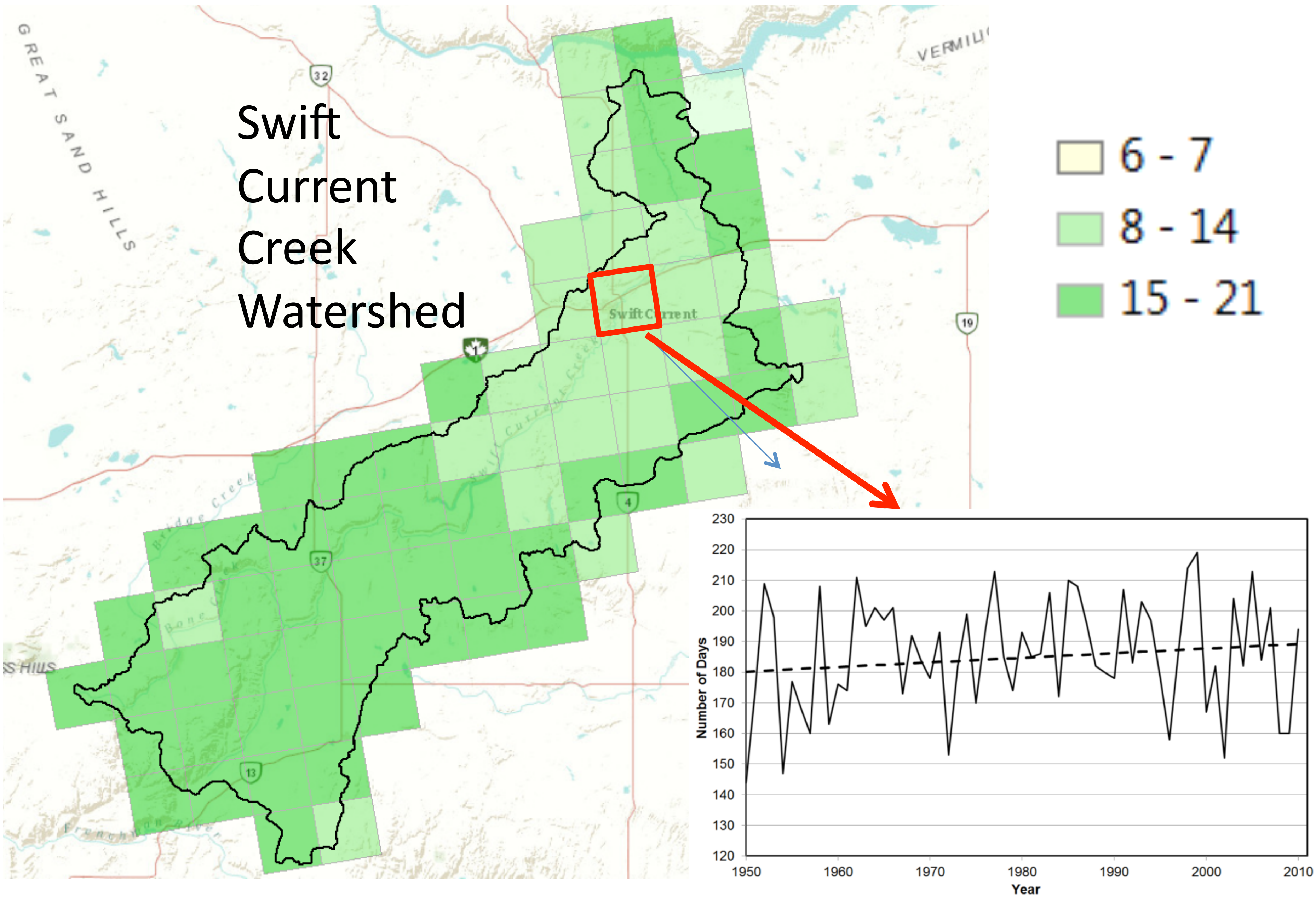
Growing season SPEI and detrended spring wheat yields
Swift Current Creek watershed

Source: VACEA (Wheaton, Wittrock, Bonsal)

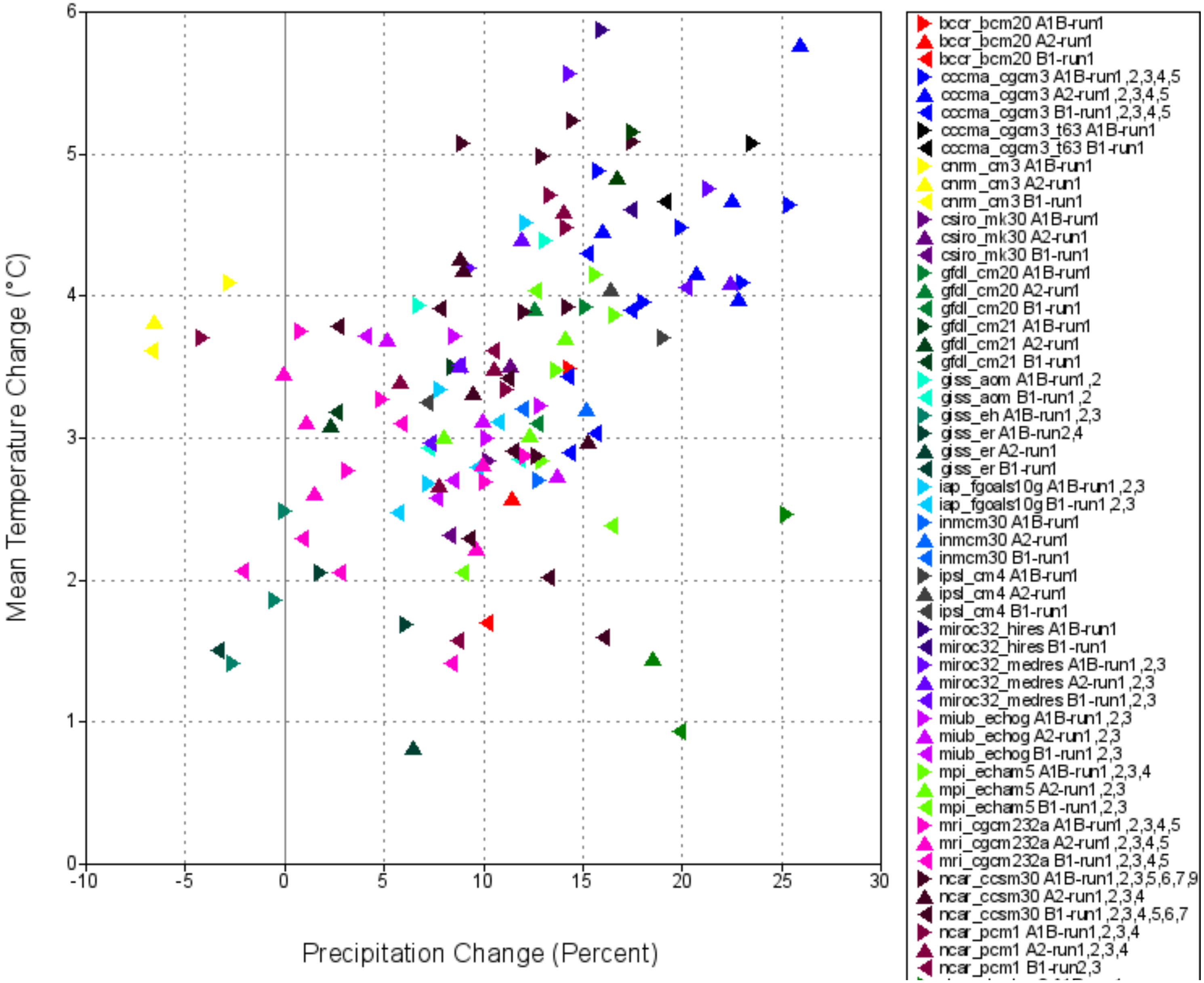


Climate Extreme Index
Maximum temperature
Minimum temperature
Number of frost days
Number of days without frost
Growing degree days
Intra-annual extreme temperature range
Growing season length
Heat wave duration
Cold wave duration
Lightest rain day amounts
Heaviest rain day amounts
Maximum number of consecutive dry days
Maximum number of consecutive wet days
Mean wet-day persistence
Mean dry-day persistence
Greatest 3-day rainfall total
Greatest 5-day rainfall total
Greatest 10-day rainfall total
Simple daily intensity (rain per rain day)
Total rainfall from events > long-term 90^{th} percentile
Number of events > long-term 90^{th} percentile

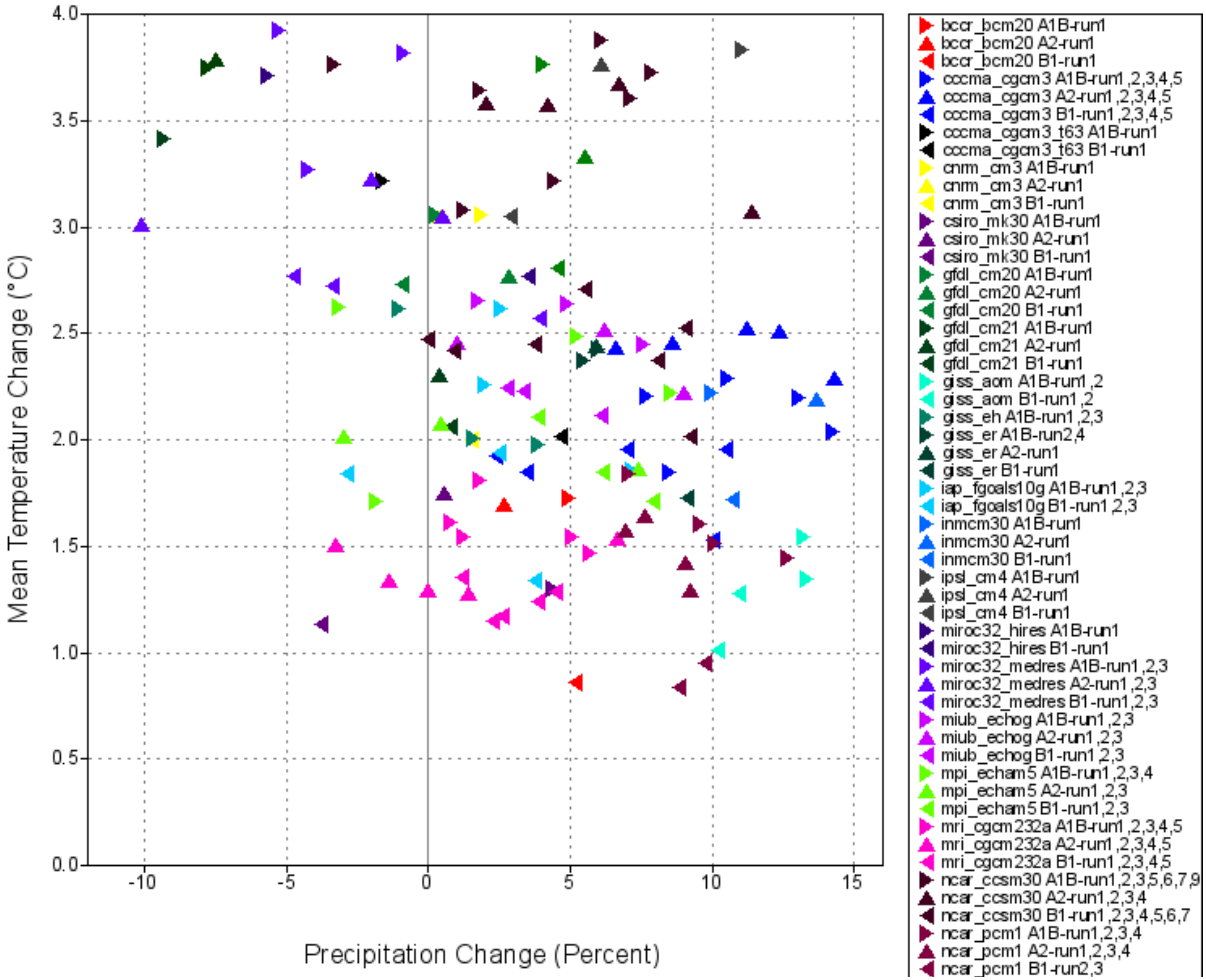
Change in Growing Season Length: 1950 – 2010 (in days)



Projected Changes in Winter Temperature and Precipitation, 2040-69 vs 1971-2000



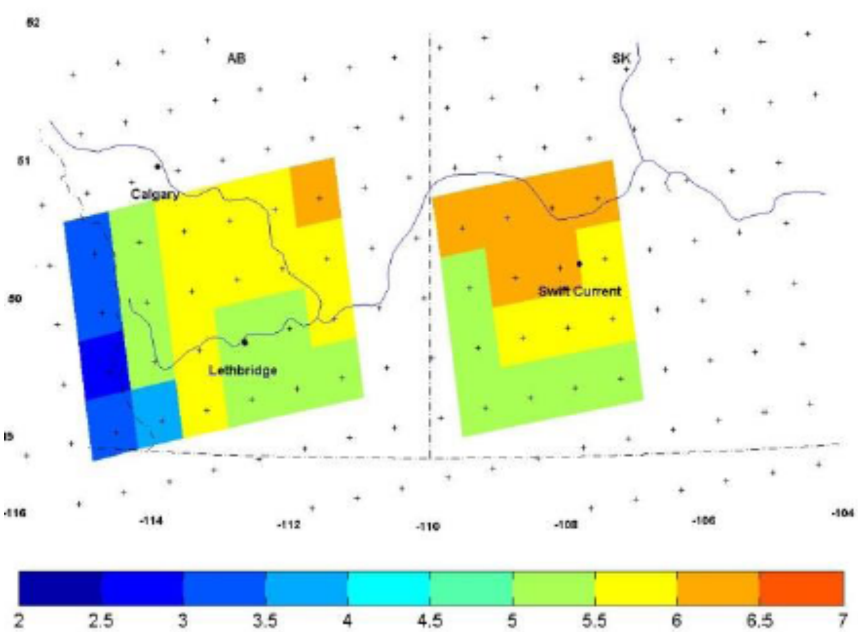
Projected Changes in Summer Temperature and Precipitation, 2040-69 vs 1971-2000



Change in Minimum Temperatures, 2041-70 versus 1971-2000

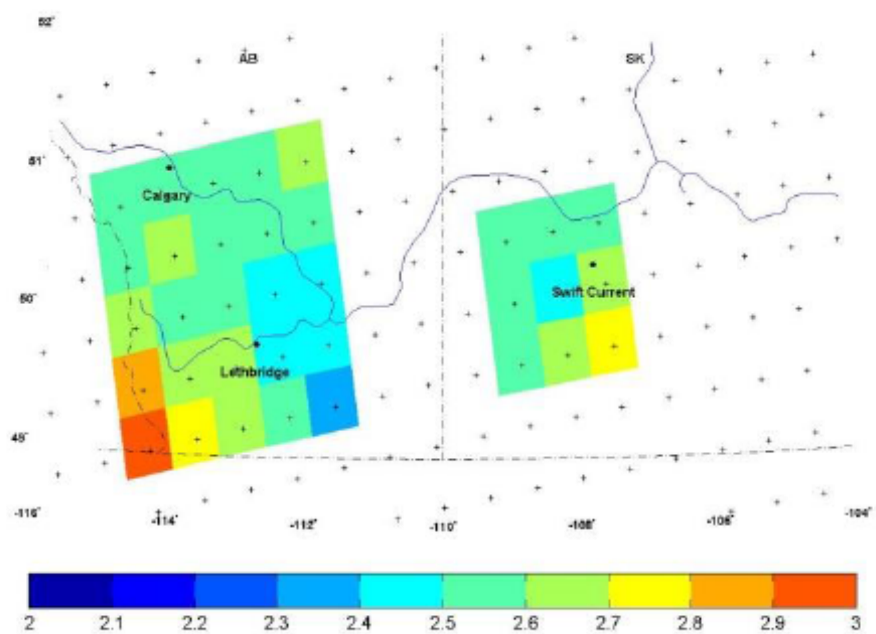
Winter

Corrected: HRM3 GFDL Δ=5.34°C

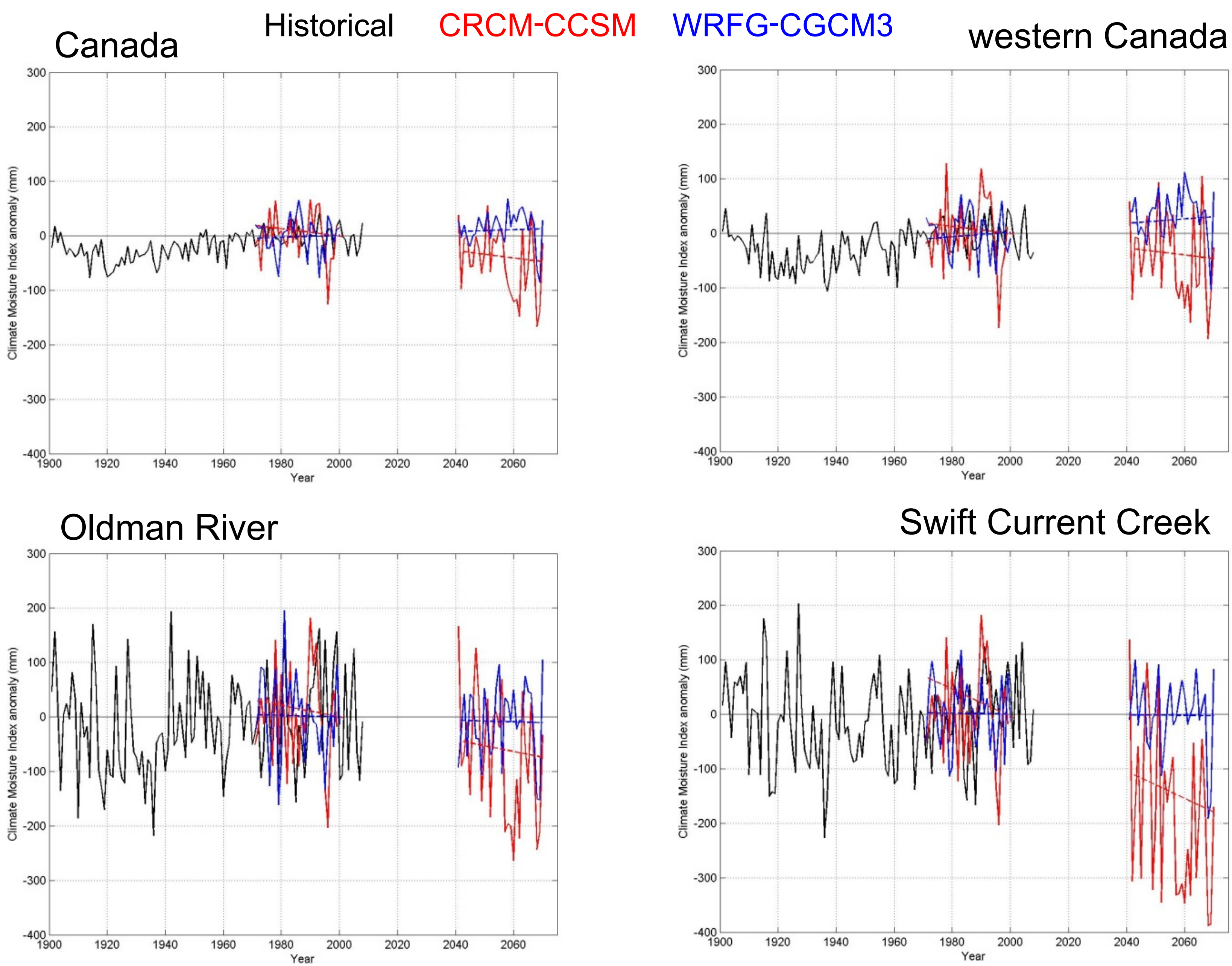


Summer

Corrected: RCM3 CGCM3 Δ=2.57°C



May-June-July Climate Moisture Index Anomaly (mm) (relative to 1971-2000)



Rural Adaptability to Climate Extremes (RACE) index

Indicator	Purpose	Levels of Analysis			
		Five VACEA Countries	Sub-national Jurisdictions	Watersheds	Study Areas
ENVIRONMENTAL EXPOSURE INDICATORS					
A) Future Climate Variability: 2050s (2041-2070)					
Percentage change in crop yield	Indicates economic vulnerability to future climate conditions	N/A	Coarse crop model analysis	Finer model: 10 km x 10 km	High resolution model: 1 km grid
Water supply: percentage change in mean annual runoff	Indicates future exposure to water shortage or excess	N/A	N/A	Hydrological model ($10km^2$)	Inference from hydrological model
Drought: SPEI – monthly, 3- and 6-month and annual	Indicates future exposure to drought	N/A	N/A	Projections form climate models	Downscaled projections
B) Baseline Climate Variability: 1971-2000					
Extreme high and low streamflows: 100 year return period of high and low flow	Indicates past frequency of extreme events	N/A	N/A	Network of stream gauge records	Individual stream gauge records
Length of Growing Season: # of days between the first 5 consecutive days with a mean daily temperature > 5 C and first consecutive days < 5 C	Indicates past growing season conditions (determinant of current adaptive practices)	N/A	N/A	Network of weather station records	Individual weather station records
Biomass: percentage change in kg/hectare	Indicates economic vulnerability and/or adaptation	N/A	N/A	Crop yield statistics and remote sensing of productivity	Available by interpolation from watershed scale

Rural Adaptability to Climate Extremes (RACE) index

Indicator	Purpose	Levels of Analysis			
		Five VACEA Countries	**Sub-national Jurisdictions**	**Watersheds**	**Study Areas**
SENSITIVITY (HUMAN/SOCIAL SYSTEMS) INDICATORS					
Relative level of income	Lower incomes can indicate vulnerability to a climate extreme.	Gross domestic income (GDI) or product (GDP) per capita,	Average regional income compared to national average	N/A	Information from participants or municipal data
Land tenure pattern: area owned vs. rented	Insecure land tenure indicates economic sensitivity to climate extremes.	N/A	National or regional government statistics	Not available	From participants or municipality level.
Access to Agricultural Water (based on agricultural context)		N/A	N/A	Access to regional reservoir systems (canals, dykes, pipelines)	Access to irrigation/drainage and/or producers' own validation of sufficiency of agricultural water.
ADAPTIVE CAPACITY INDICATORS					
Membership in agricultural organization or other network	Indicates social capital.	N/A	N/A	N/A	Information from participant surveys
Infrastructure for resilience to climate-induced water stress	Indicates the existence of infrastructure to adapt to climate extremes.	N/A	N/A	Municipal data on capacity and quality of infrastructure (range of	On-farm technology identified from participant surveys
Level of education	Indicator of human capital.	Could use UNDP educational index.	Census data.	N/A	Available from participant surveys.

Adaptation: adjustments in practices, processes, policies and structures to projected or actual changes of climate