Some Contributions of DRI to Sustainable Agriculture

Rick Lawford

Alberta Users Workshop

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Some early questions about the benefits of the DRI research to users (after R. Stewart)

- Drought indices are used to compare with **impacts** to determine the risks of drought
- Methodologies- improve the depiction of drought characteristics, **dynamics**, to improve monitoring and early warning systems
- Understanding of drought **migration** would help address questions such as: how quickly can droughts move or intensify/dissipate? What is the direction of movement?
- Estimates of possible impacts and **adaptations**
- Actions toward decreasing **vulnerabilities**

Sustainable Agriculture:

Agriculture is sustainable if it is able to continue on a consistent basis to provide financial and social support for those who participate in the agricultural sector and, as the sector, it provides support for the financial well-being country without degrading its potential support for future generations to achieve the same success.

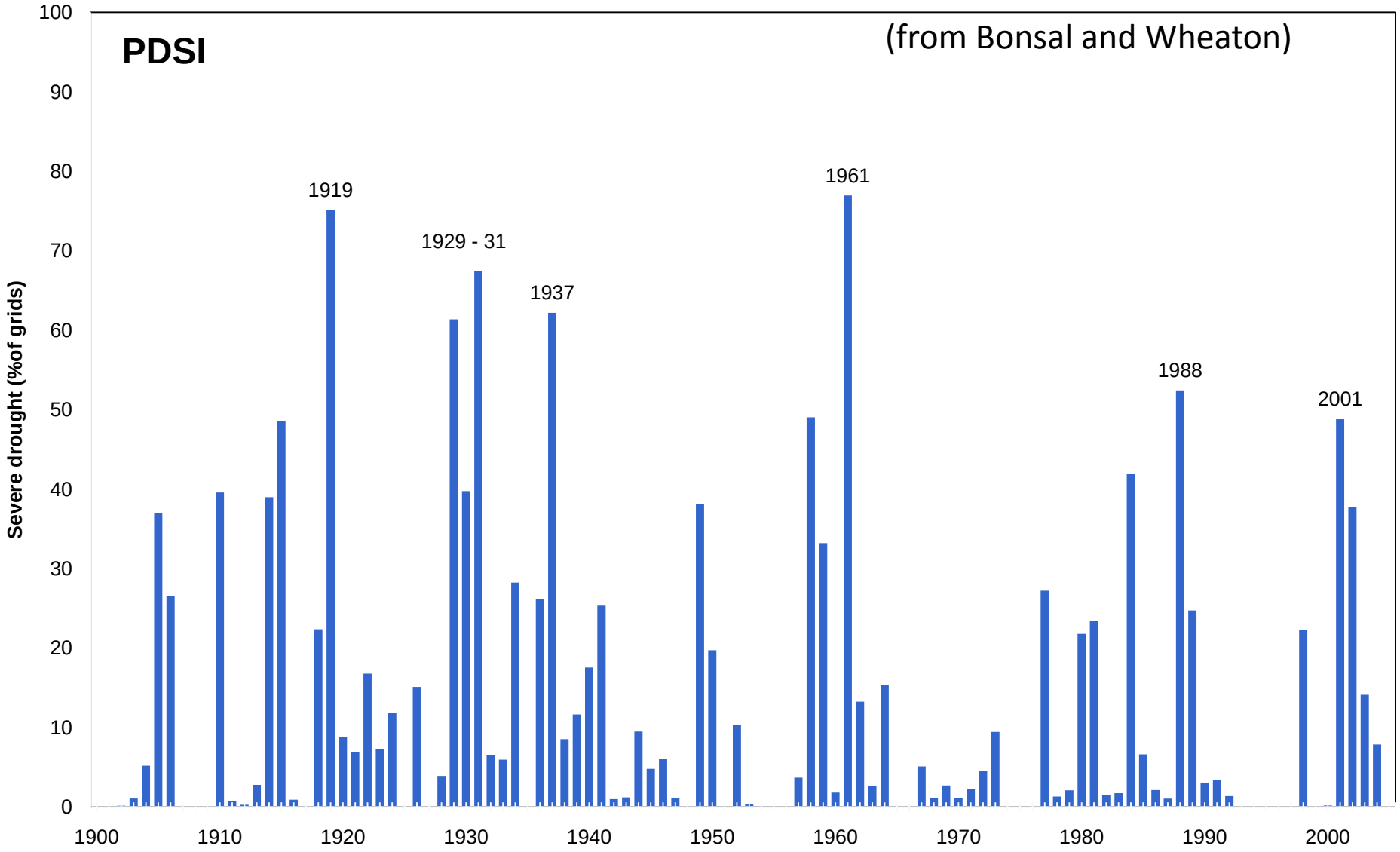
Some factors that work against sustainability:
- Overexploitation of the resource (soil degradation, water depletion)
- Stress from the climate (i.e., drought)
- Overuse of pesticides (water pollution)
- A poor economy (where inputs costs exceed the value of the product)

DRI studied the 1999-2004/5 drought. Socioeconomic Impacts of this drought in Canada were largest in 2001-2002

- Total Canadian agricultural production loss was ~$3.6B
- Gross Domestic Product fell ~$5.8B
- Employment losses > 41,000
- Worst year was 2002
- Alberta and Saskatchewan were hit hardest

Wheaton et al. 2008

Drought Frequency: study of severe drought PDSI girds shows that droughts have been frequent And intense in the past.



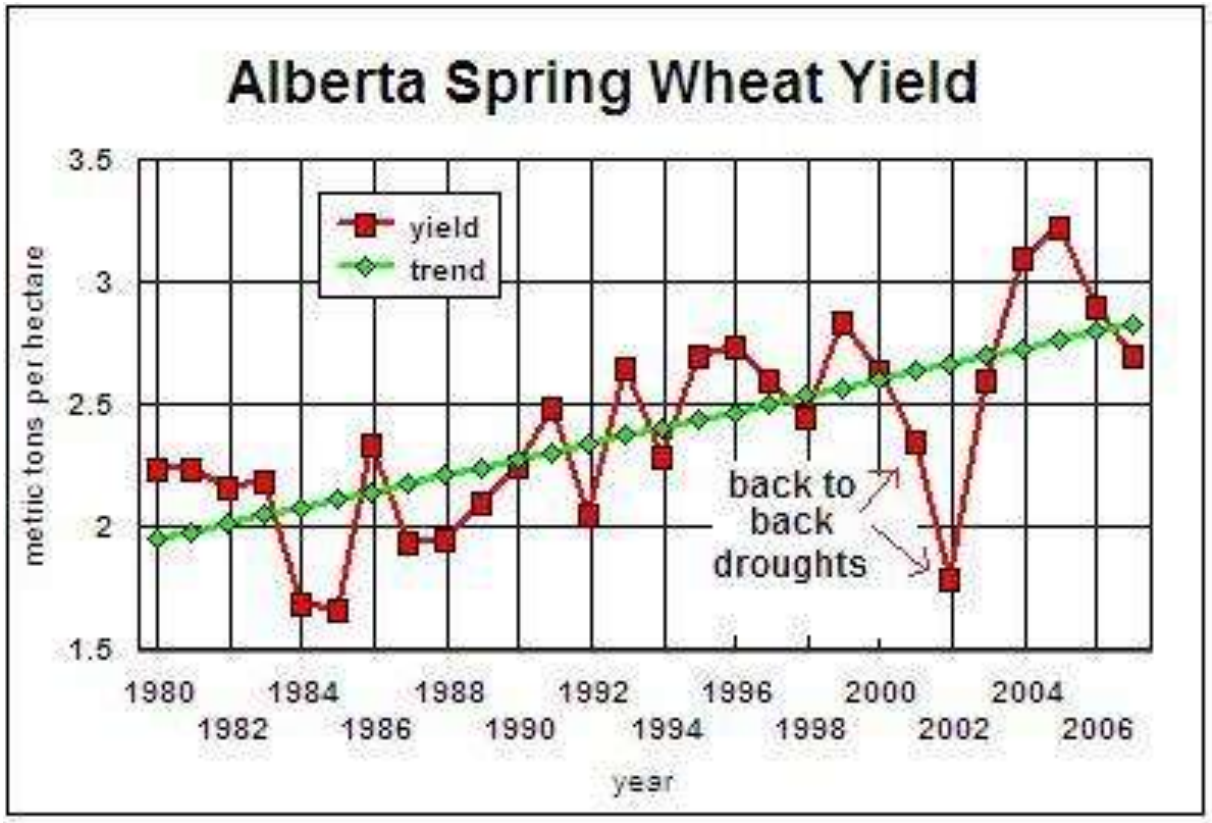
Looking back to the 1930's……

Change in the economic contribution of wheat farming on the three Canadian prairie provinces (from Ankli, 1977)

Years	Average value of wheat crop
1917-1920	$373.3 million
1921-1924	$178.1 million
1925-1928	**$432.5 million**
1931-1934	**$134.8 million**
1935-1939	$175.7 million

The worst grain yield occurred in Saskatchewan in 1937 with productivity at 2.6 bushels of wheat per seeded acre.

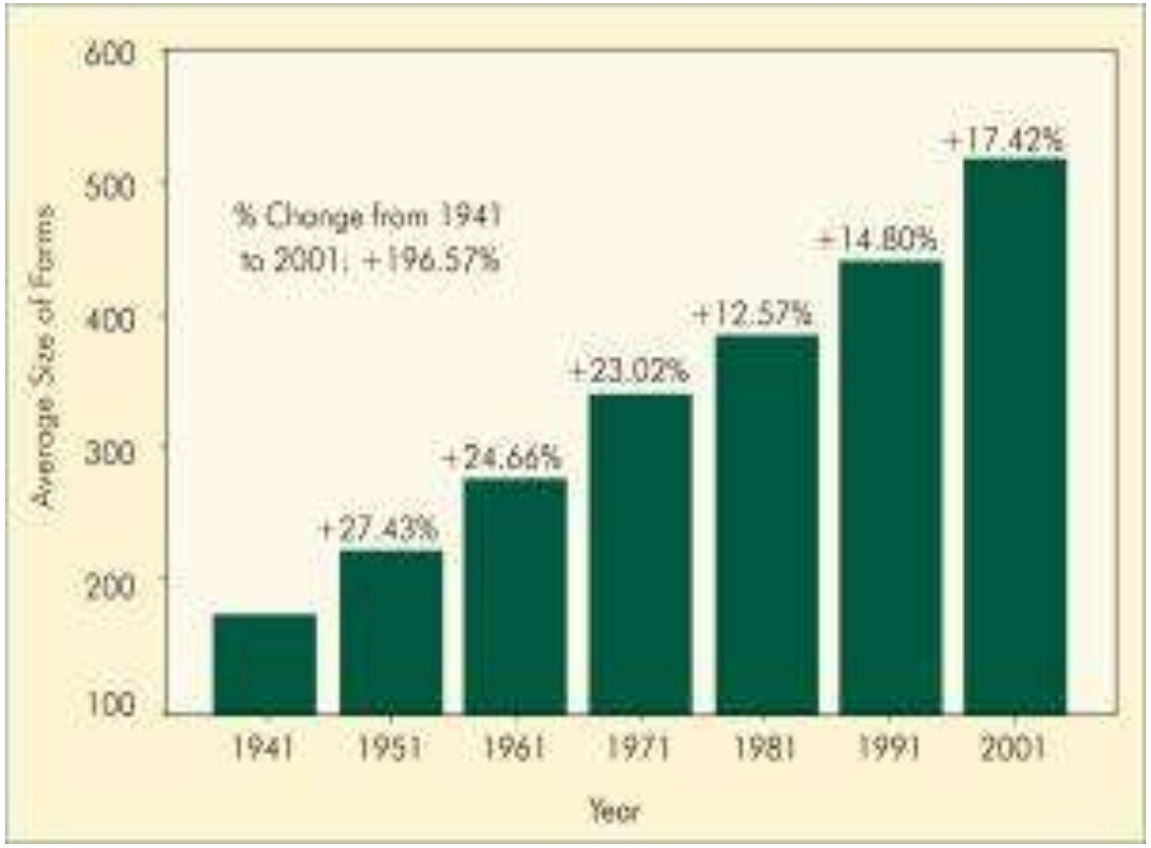
While technology has increased average yield and evened out its year-to-year variability drought still has a major impact on production.



(from Martell Crop Projections web site)

Some changes that may explain the shift in drought impact:

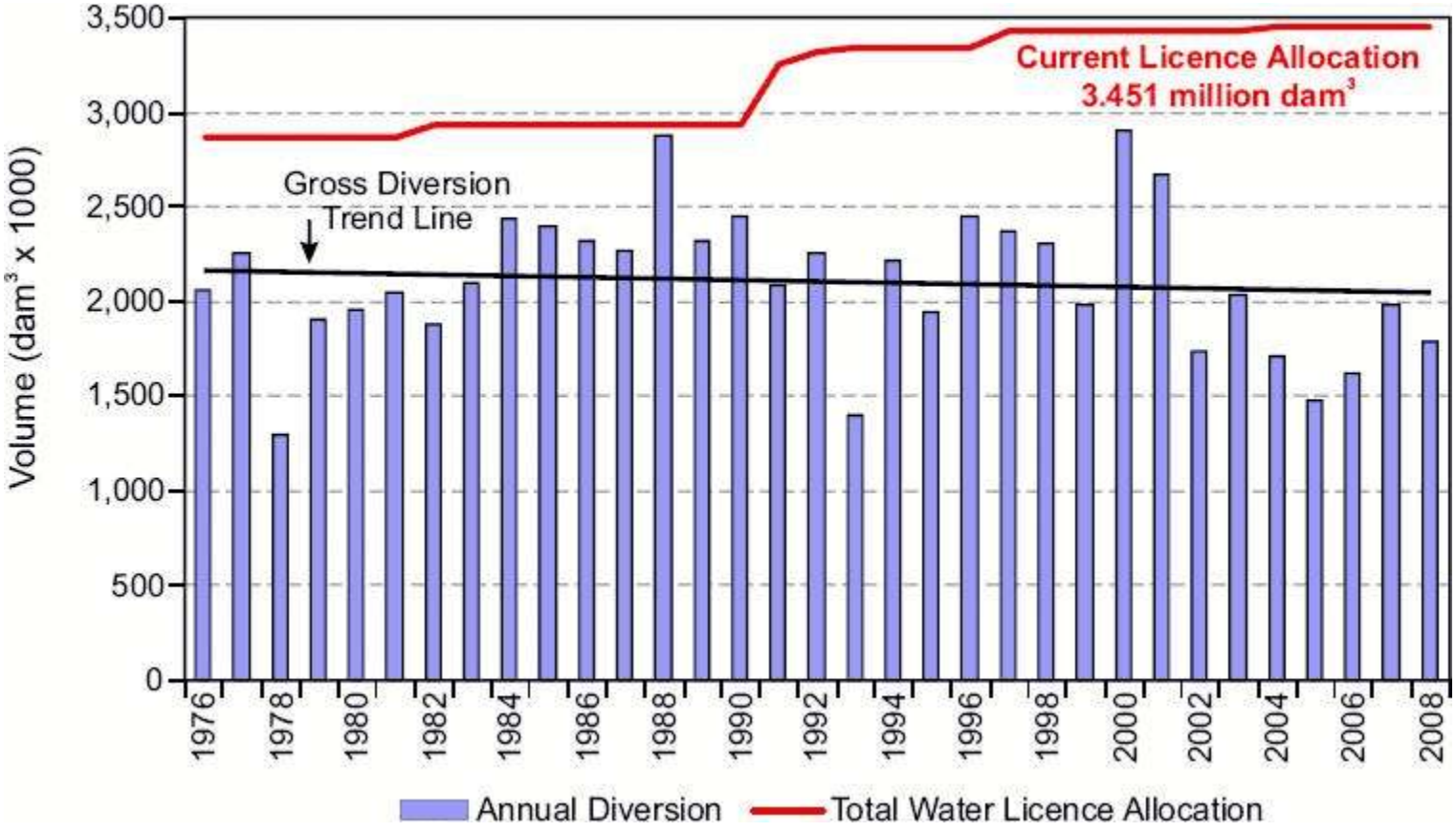
Larger farms have spread the risk of bad weather in one location. However the scale of intense drought is likely too large to enable farms escape the consequences of severe drought unless they are spread over large areas.



(Alberta government)

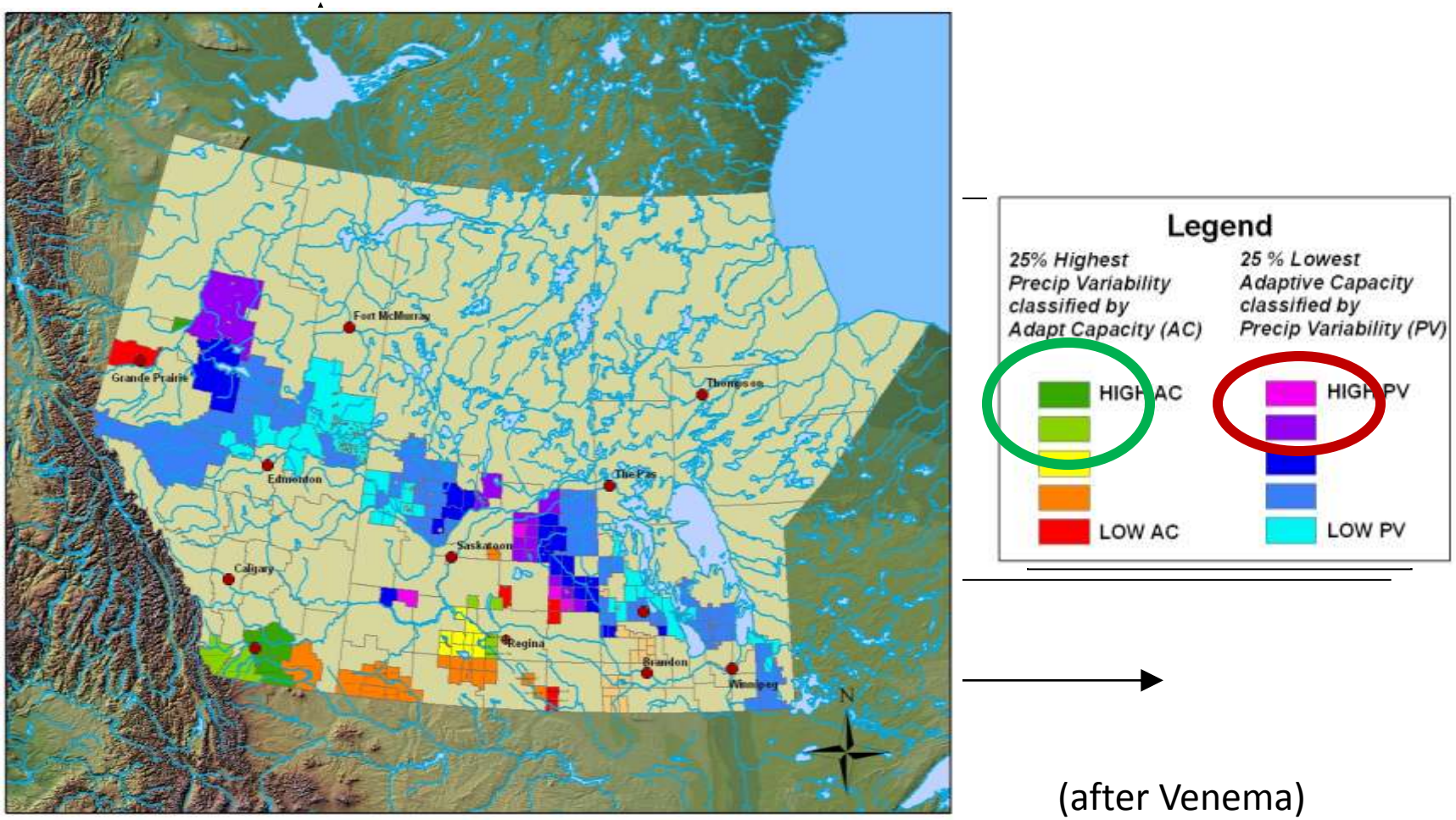
Irrigation in southern Alberta:

Water Allocations in southern Alberta increased to the late 1990's but water use has been trending downward (slightly)



(Alberta government)

Adaptive Capacity can be supported by individual farming strategies



(after Venema)

Decisions related to sustainable agriculture take place on a number of time scales.

Daily to weekly – Short-term decisions are based on weather forecasts and outlooks. These consist of decisions on when to spray, when to fertilize, when to irrigate, etc.

Seasonal to annual – There are many decisions taken throughout the agricultural, community that would benefit from more accurate seasonal forecasts.

Multiyear to decadal – Long term climate variability and climate change affect the statistics of variability and the frequency and intensity of extremes.

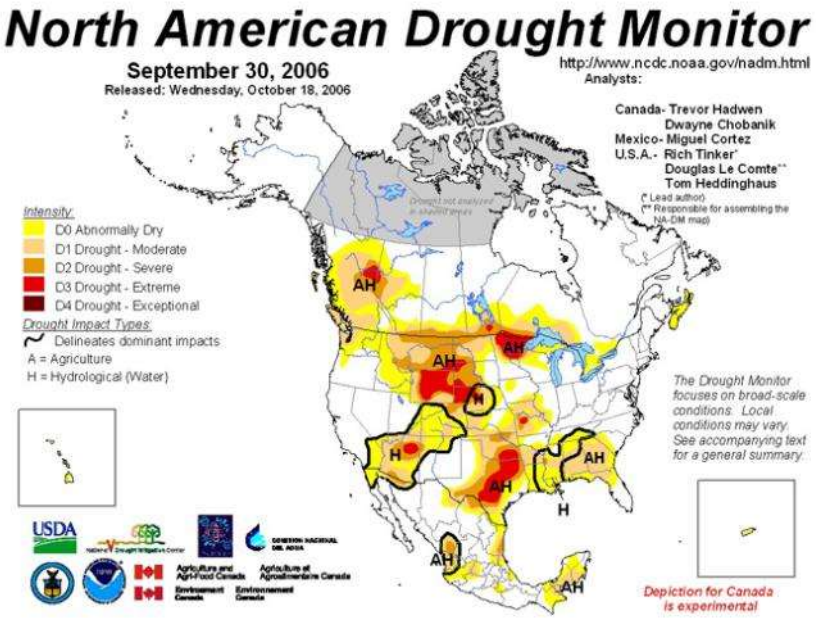
Daily to weekly – Short-term decisions are based on weather forecasts and Outlooks. These consist of decisions on when to spray, when to fertilize, when To irrigate, etc.

The adequacy of advice depends on:

1) the accuracy of the forecasts.
2) a knowledge of current conditions.

NADM Continental Drought Indicators

The NADM drought conditions in US, MX, CN are determined independently based on different data, indices, & analyses within each country



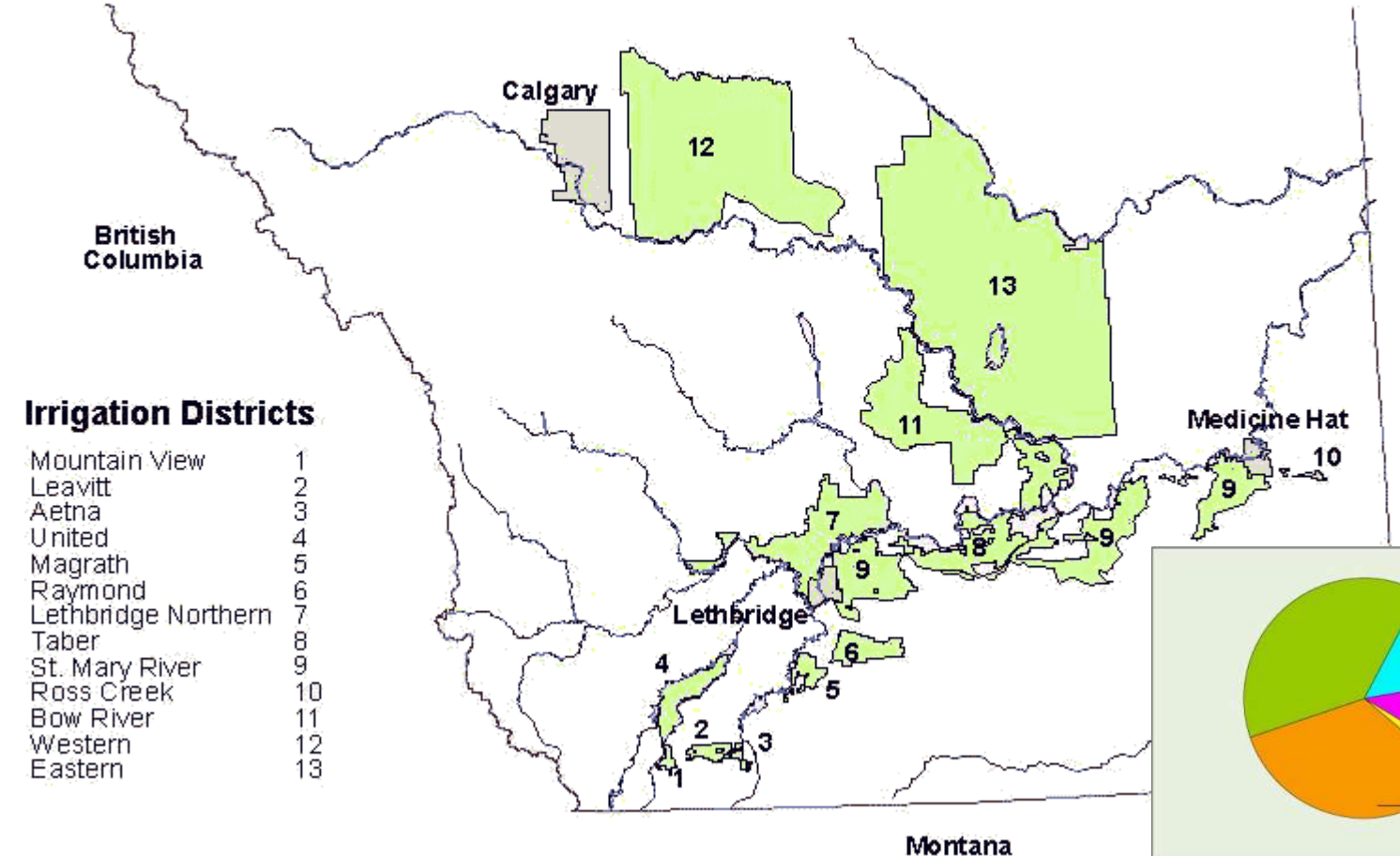
Drought indices covering entire country are needed

- Same indices, same analysis period, same methodologies
- This consistency needed for depiction across international boundaries

http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/index.html

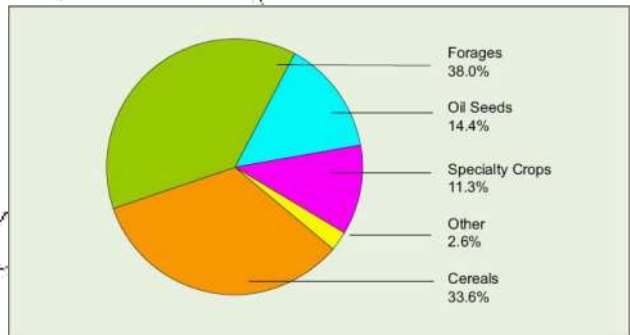


According to Agriculture Canada, the Oldman river region receives <u>400-450mm per year</u> of precipitation and has a net moisture <u>deficit</u> of about <u>350 mm of water per annum</u>.



Irrigation Districts

Mountain View	1
Leavitt	2
Aetna	3
United	4
Magrath	5
Raymond	6
Lethbridge Northern	7
Taber	8
St. Mary River	9
Ross Creek	10
Bow River	11
Western	12
Eastern	13



Potential for Water Saving Through Use of Low Cost Methods

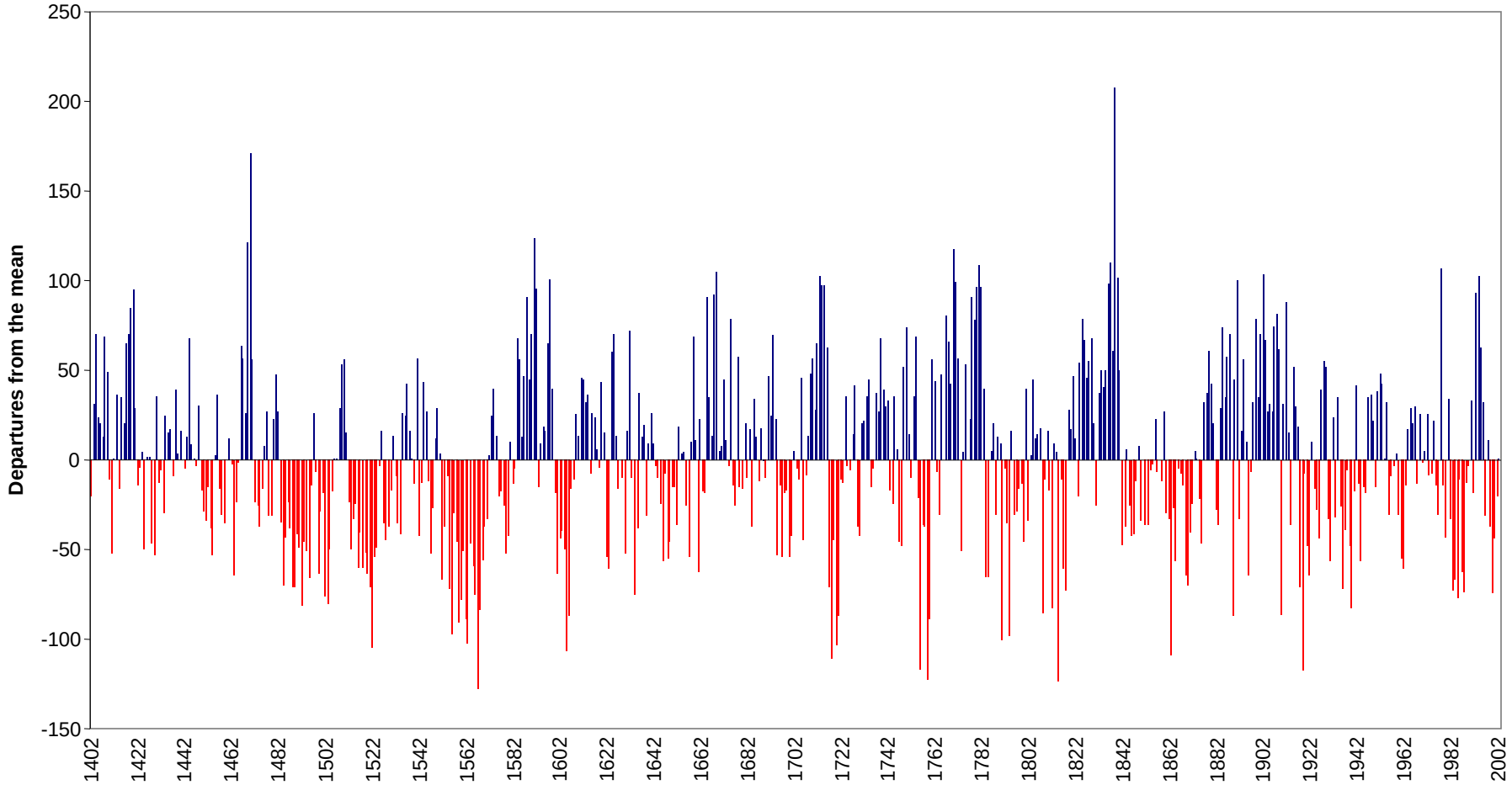
- CIMIS, operating since 1982, with more than 125 stations currently providing daily measurements of ETo. Survey conducted by USDA and UCB of 55 growers by using CIMIS in 1990s found use of **ETo information in irrigation scheduling led to an increase in annual yields of 8% and reduction in average water applied of 13%** (DWR, 1997).

- Collaborative project between NASA Ames and Mondavi applying aircraft data and the TOPS-VSIM model to optimize irrigation for wine grapes

- *irriGATEWAY* system operated by CSIRO in the Murrumbidgee Basin, Australia, **led to ~15-35% reduction in average water applied**

CIMIS ET_0, August 1, 2009

Multiyear to decadal – Long term climate variability and climate change affect the statistics of variability and frequency and intensity of extremes.



South Saskatchewan River at Medicine Hat, 1402-2004

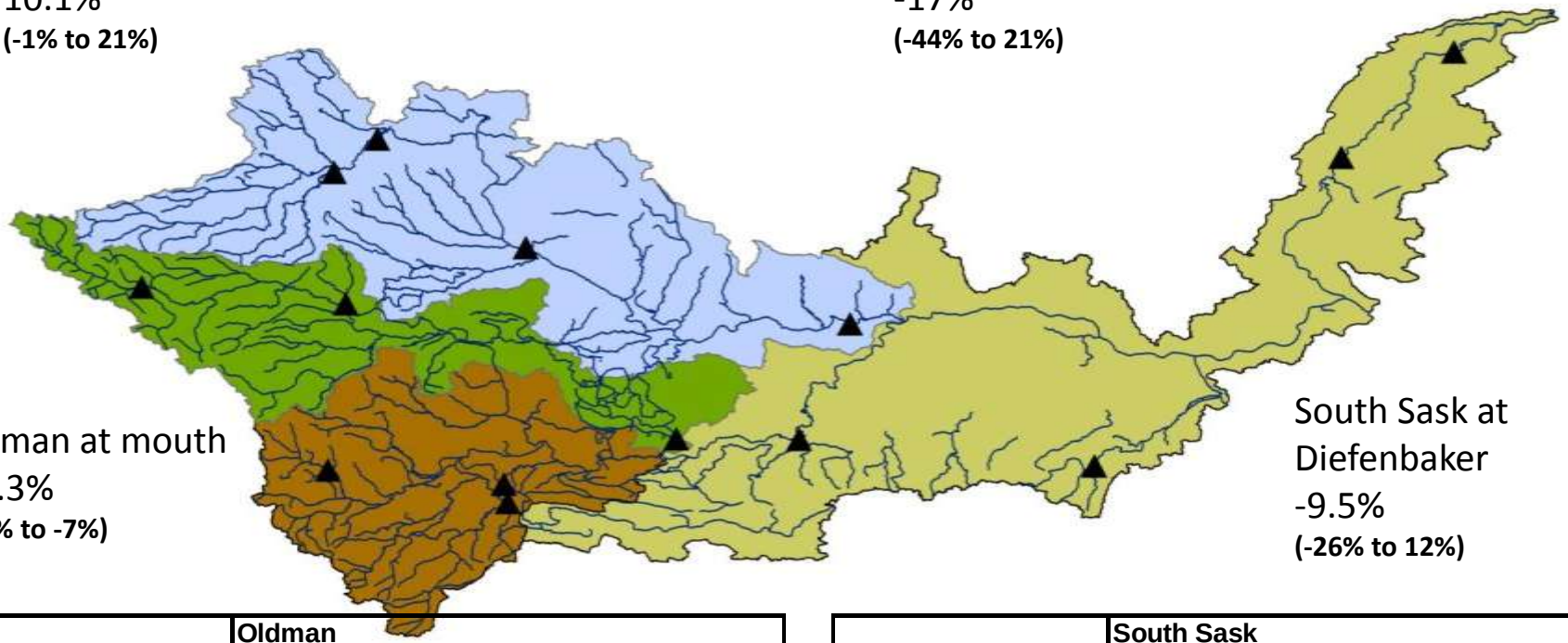
GCM scenario results 2039 – 2070
cumulative flows – Debits cumulatif

	Bow current	echa21	hada21	ncara21
Snow accum (mm)	120.8	105.0	134.5	111.0
Precip - ET (mm)	162.9	75.0	118.7	157.9
AET/PET	1.00	0.93	0.98	1.00

	Red Deer current	echa21	hada21	ncara21
Snow accum (mm)	12.4	5.4	9.4	6.5
Precip - ET (mm)	106.6	59.3	90.0	123.2
AET/PET	0.76	0.66	0.70	0.75

Bow River at mouth
10.1%
(-1% to 21%)

Red Deer at Bindloss
-17%
(-44% to 21%)



Oldman at mouth
-23.3%
(-37% to -7%)

South Sask at Diefenbaker
-9.5%
(-26% to 12%)

	Oldman current	echa21	hada21	ncara21
Snow accum (mm)	4.2	1.8	5.4	2.3
Precip - ET (mm)	74.8	52.6	73.0	79.1
AET/PET	0.52	0.45	0.48	0.52

	South Sask current	echa21	hada21	ncara21
Snow accum (mm)	16.7	5.9	15.7	10.2
Precip - ET (mm)	31.7	26.5	34.1	31.3
AET/PET	0.46	0.38	0.41	0.47

Climate Change will have an impact on water availability in the future and so will industrial expansion:

As of December 2005, 9,563,218 cubic decametres of water were allocated for various purposes. Of this allocation, 9,254,931 cubic decametres were for surface water and 308,287 cubic decametres were for groundwater.

Based on available water use information for 2005, it is estimated that, overall, 34.5% of water allocated was actually used in Alberta. This is equivalent to almost twice the amount of natural flow in the Red Deer River each year.

- The irrigation sector accounts for 43% of the total water allocations. The industrial sector accounts for 28% of allocations, followed by 11% for municipal use.

Water use in Alberta is predicted to increase to more than 3,998,600 cubic decametres by 2025 – a 21% increase from current use.

Seasonal to annual – There are many decisions taken throughout the agricultural, community that would benefit from more accurate seasonal forecasts.

There are many adaptive strategies that are currently used that would be improved by accurate seasonal precipitation forecasts.

Adaptive Strategies used for the Drought (Livestock Sector)

- Selling cattle
- Moving cattle
- Best management strategies
- Buying feed
- Trucking water
- Buying/renting land in non-drought locations to use for feed

Wittrock et al. 2008
Photo Source: PFRA

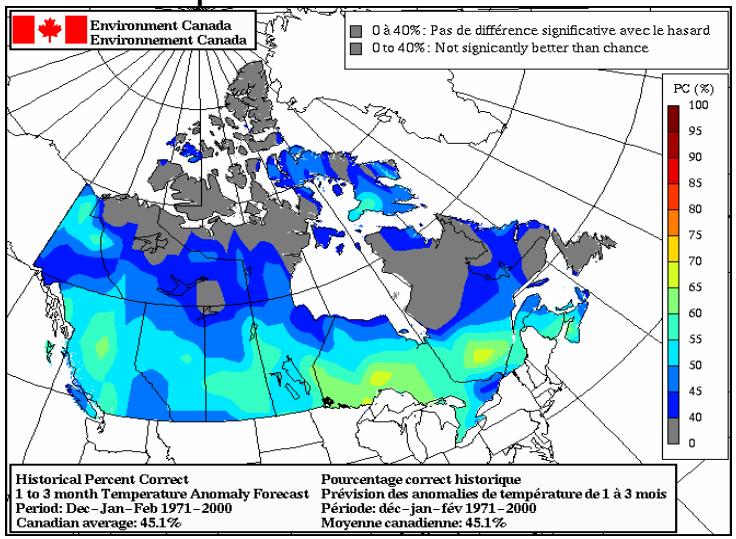
Adaptive Strategies for dealing with water scarcity (e.g. prairie communities)

- Imposed water restrictions
- Hauled water from alternative water sources
- Restricted use of drinking water
- Used grey water to water gardens
- Upgraded potable water infrastructure

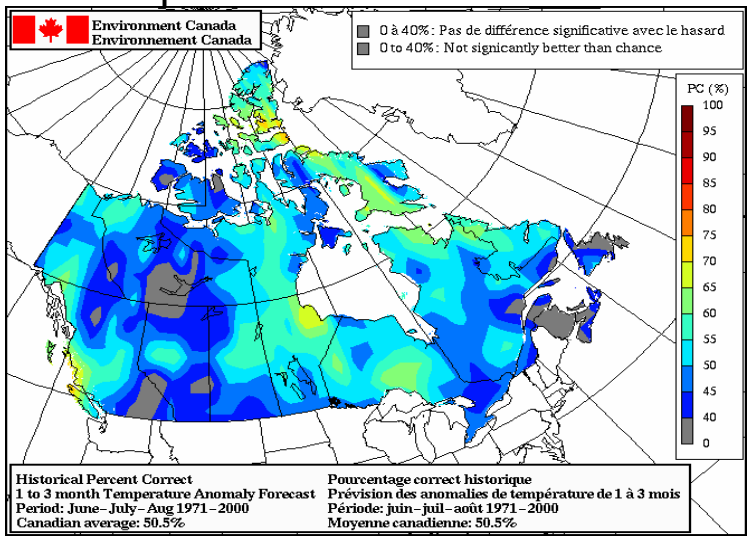
Wittrock et al. 2008
Photo: E. Wheaton 2005

Skill (% correct)

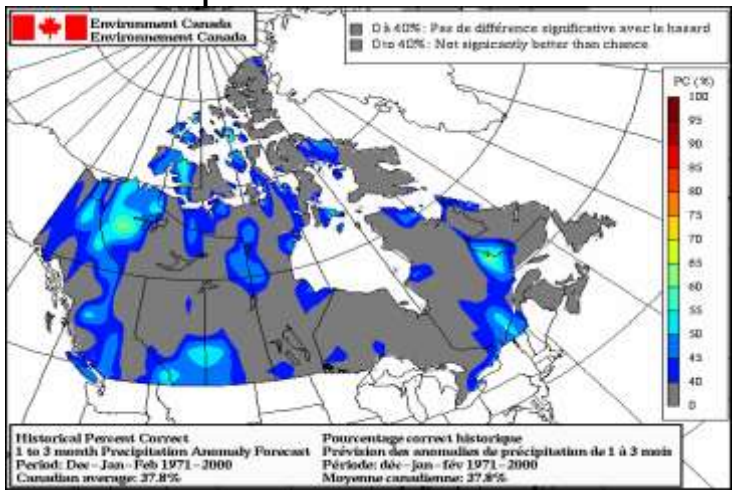
DJF Temperature



JJA Temperature



DJF Precipitation



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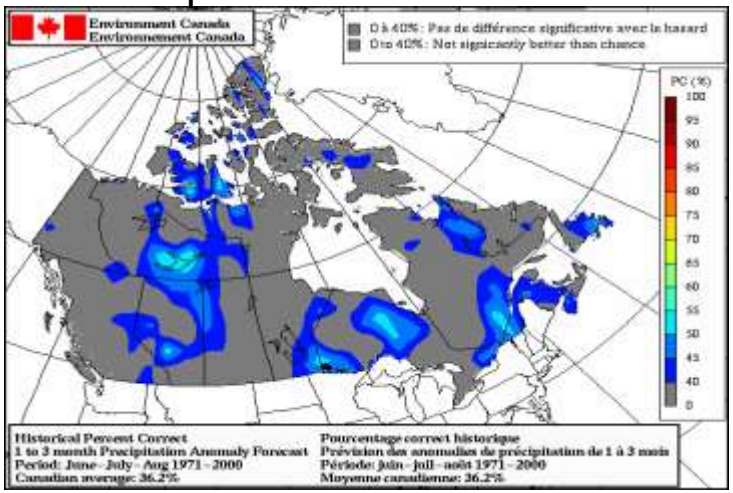

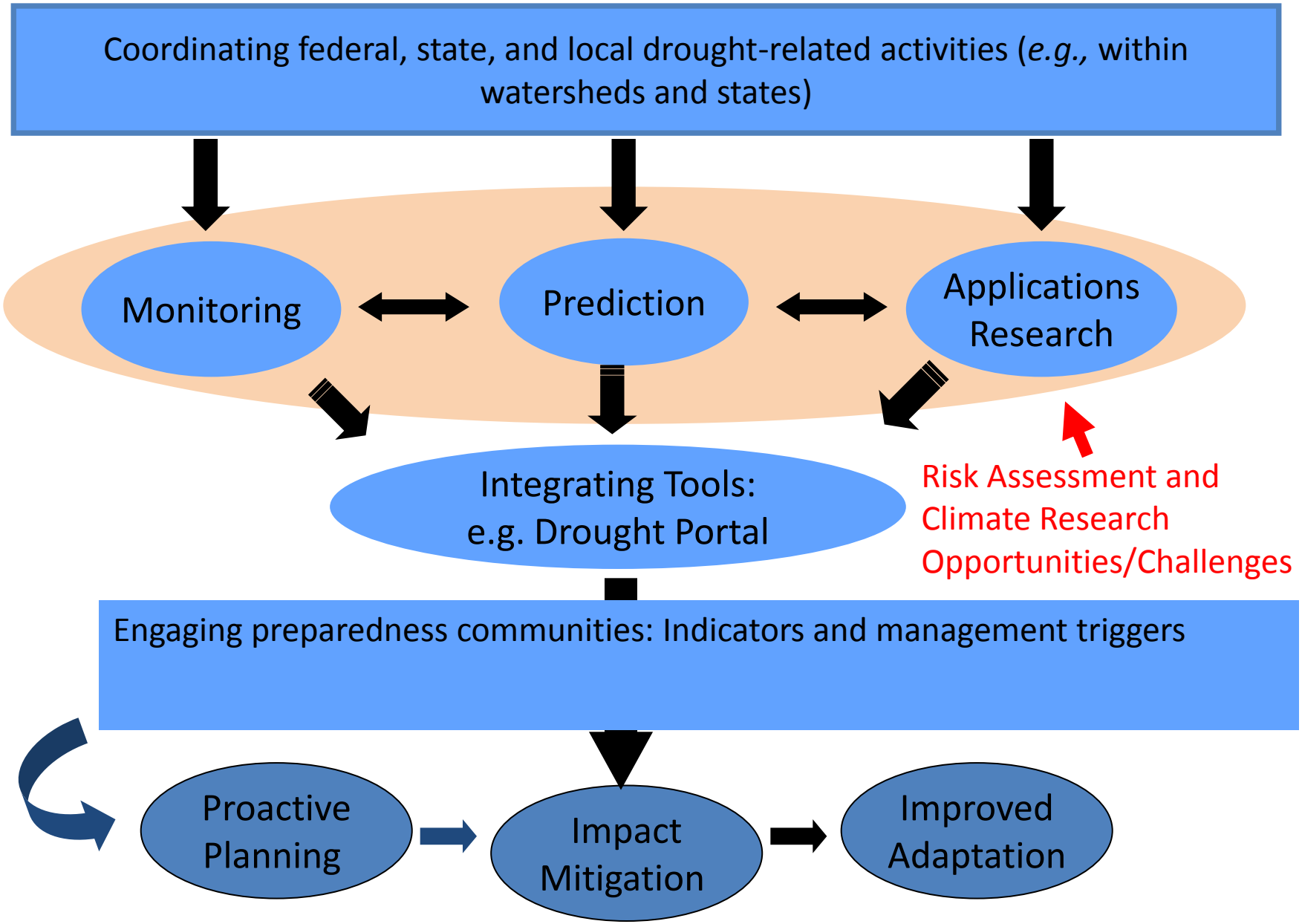
Coordinating federal, state, and local drought-related activities (*e.g.,* within watersheds and states)
Monitoring
Prediction
Applications Research
Integrating Tools: e.g. Drought Portal
Risk Assessment and Climate Research Opportunities/Challenges
Engaging preparedness communities: Indicators and management triggers
Proactive Planning
Impact Mitigation
Improved Adaptation

Summary:

DRI has made a number of contributions that could improve the Sustainability of Canadian agriculture on three primary time scales. However, the impact of these findings will depend on:

- the ability of modellers to incorporate this new understanding into models,
- The willingness of operators and producers to test and use these systems on an on-going basis.
- The willingness of governments to fund research to support the development of a prediction capability for drought at the seasonal to annual time scale.

So what will we do about the potential 2010 drought?