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Exploring the Surface Characteristics of the 1999-2005 Drought in the Canadian Prairies

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Overview



Ê Objectives

Ê Drought indices- types, comments

Ê Drought characteristics- spatial and temporal

Ê Next steps: research and user needs

Objectives of the Research

(Theme 1 with links to other themes)



- Ê Use drought indices to examine the spatial, temporal patterns, and intensity of the droughts
- Ê Compare different methodologies to calculate the drought indices
- Ê Relate drought patterns to agricultural and hydrological impacts
- Ê Develop methods to document the dynamics of drought migrations

How Best to Characterize this Drought?

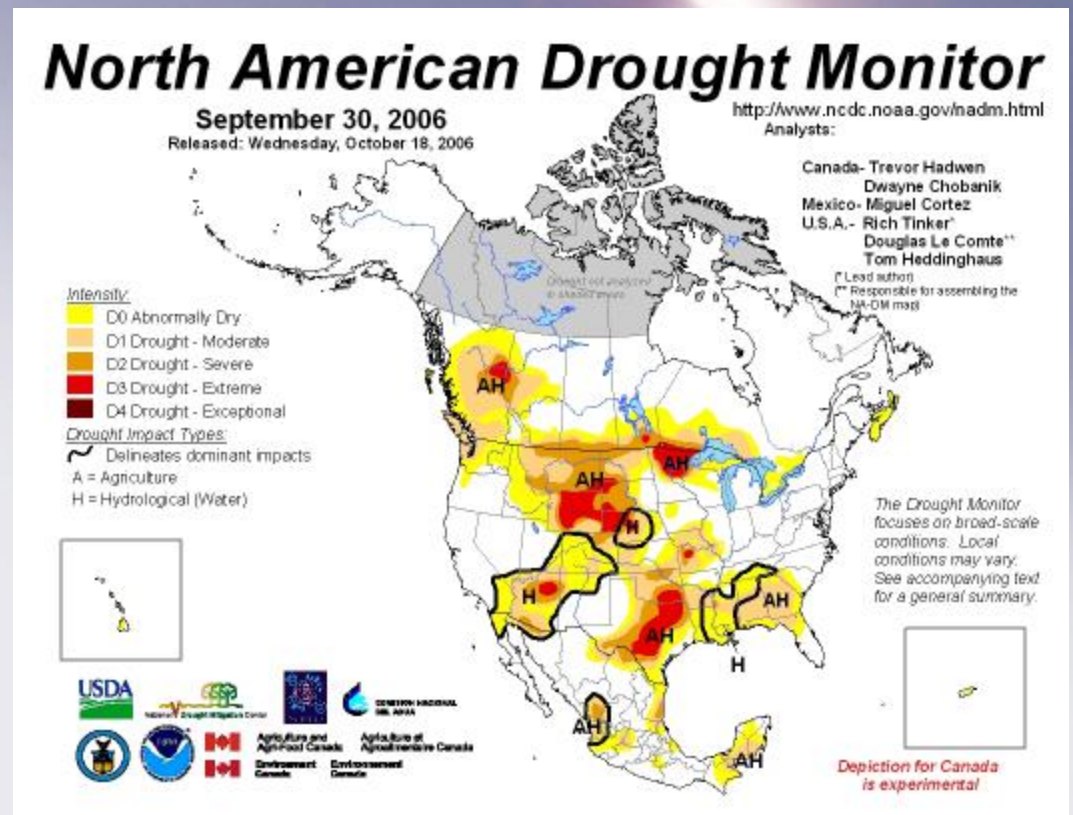


- Ê What was the maximum **intensity** of drought?
- Ê What was the **area** of intense drought? Where?
- Ê What was the **timing and duration**?
- Ê What **impacts** resulted, and how did they relate to the intensity, timing and duration of the drought?
- Ê How do droughts begin, **migrate**, intensify and dissipate?
- Ê What are the implications for **monitoring** and early warnings for impacts and solutions?

Drought Monitoring



- Percent of Normal (Rainfall)
- Deciles (Rainfall)
- Standardized Precipitation Index (Precipitation)
- Palmer Drought Severity Index (Soil Moisture)
- Crop Moisture Index (Temperature, Rainfall)
- Surface Water Supply Index (snowpack, streamflow, precipitation, reservoir storage)
- Reclamation Drought Index (above plus temperature)
- Aridity 1 Index (Soil Moisture)
- Aridity 2 Index (Actual versus Potential ET)



Drought Indices



- Ê Other types include wheat yield drought, aridity index (P/PET), fire weather indices (e.g. SSR, Keetch-Byram) ...
- Ê Could also use normalized drought vegetation index (NDVI), enhanced vegetation index (EVI), dry-day spells,...

Drought Indices: comments



- Ê Use of several is recommended
- Ê Each has advantages and disadvantages for certain applications
- Ê Various types are available, from simple to complex approaches
- Ê Use depends on the application: climate research, or impacts on agriculture, water, forest, economic, social systems

CRB Datasets 1: MSC Passive Microwave SWE Dataset



Per pixel SWE:

$$SWE = F_D SWE_D + F_C SWE_C + F_S SWE_S + F_O SWE_O$$

D - deciduous; C - conifer; S – sparse forest;
O - open land cover classes

$SWE_i = A + B(37V-19V)$ for SSM/I (1987-present)

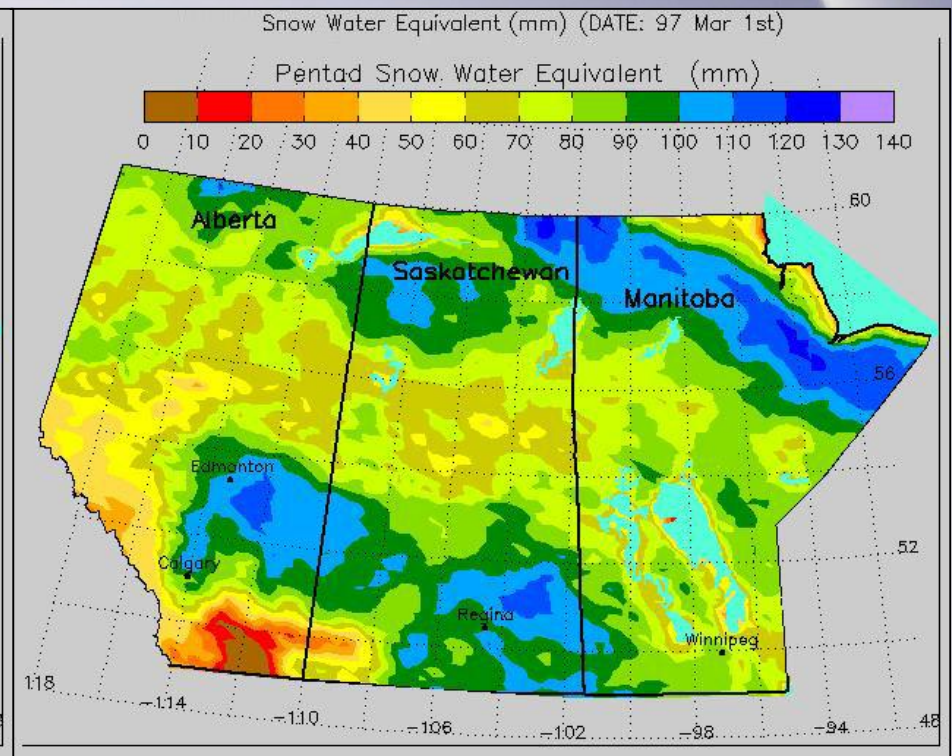
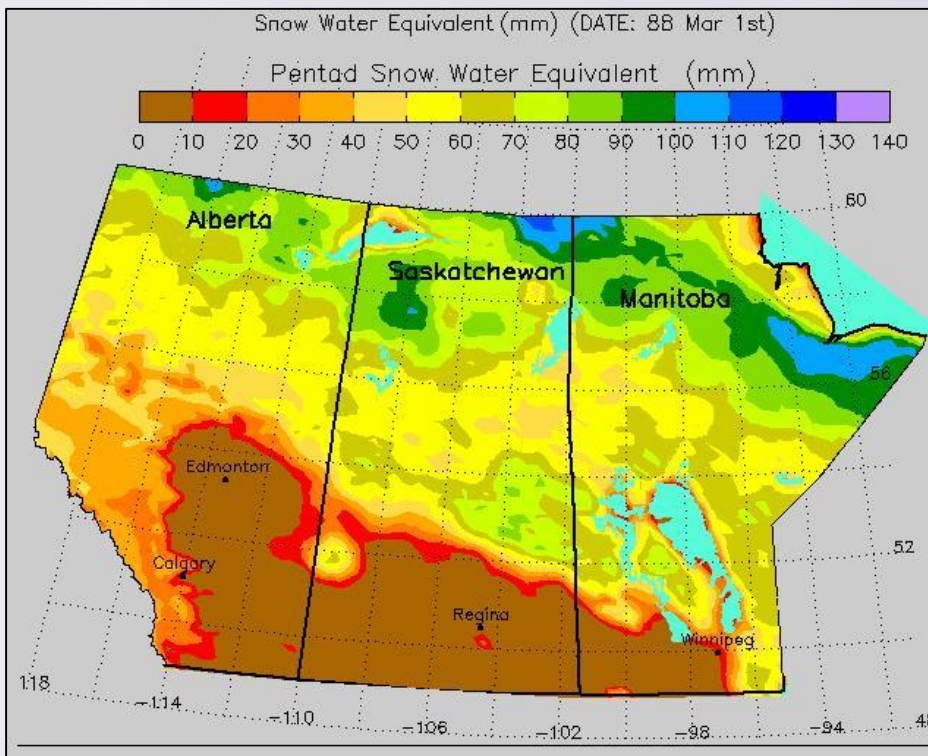
$SWE_i = A + B(37V-18V)$ for SMMR (1978-1987)

F_i = Land cover fraction per EASE-Grid pixel

Ø Land cover fraction derived from IGBP AVHRR global land cover dataset.

Ø 17 IGBP land cover classes aggregated into the four algorithm categories (D, C, S, or O)

Ø Time series extends from 1978 through the present, using the brightness temperature standardization of Derksen and Walker (2003).

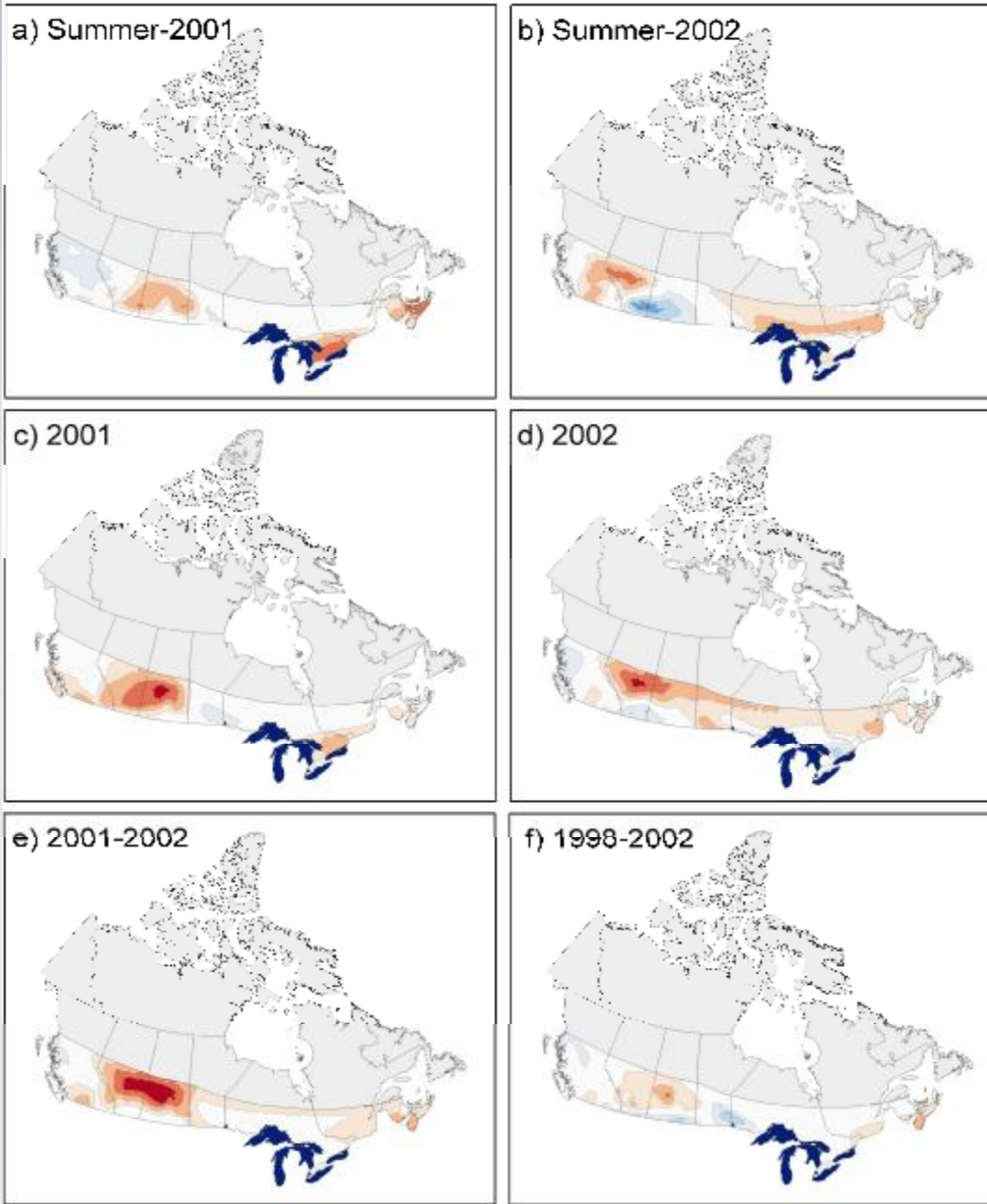


Growing Season Precipitation Totals: area of coverage of < 60% of 1961-1990



(Wheaton et al. 2005; data source AAFC)



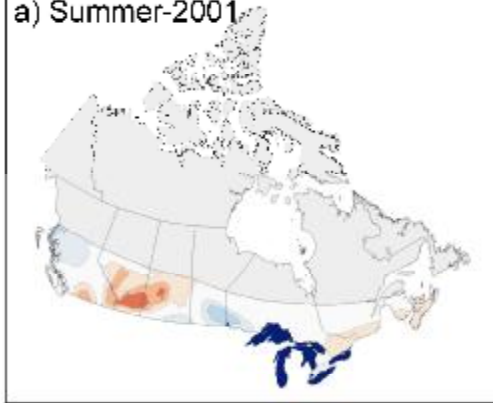


2001/2002 SPI Drought Patterns

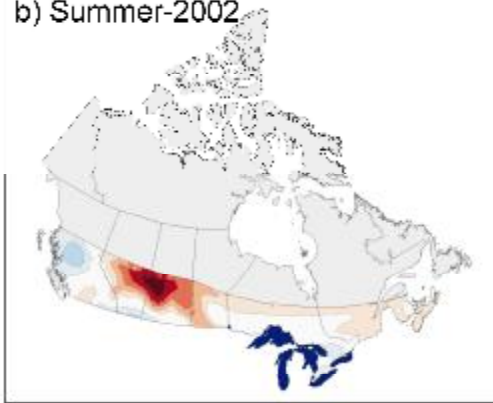
(Bonsal and Regier 2006)

Areas of greatest intensity
 Extensive west to east area
 Effect of the June 2002 rainfall in Prairies- gradient
 Areas of persistence

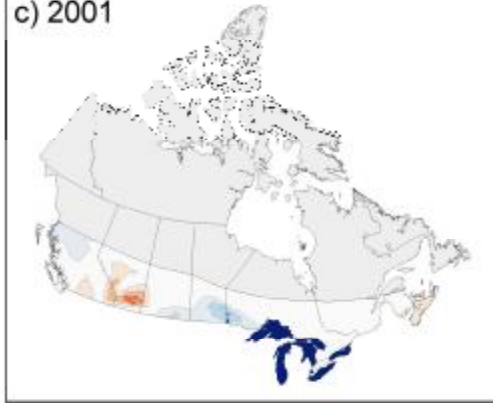
a) Summer-2001



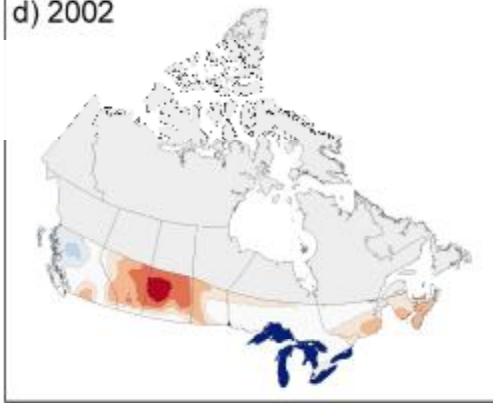
b) Summer-2002



c) 2001



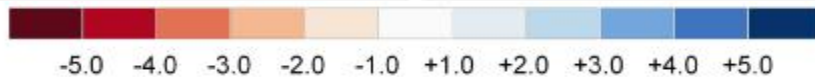
d) 2002



e) 2001-2002



f) 1998-2002

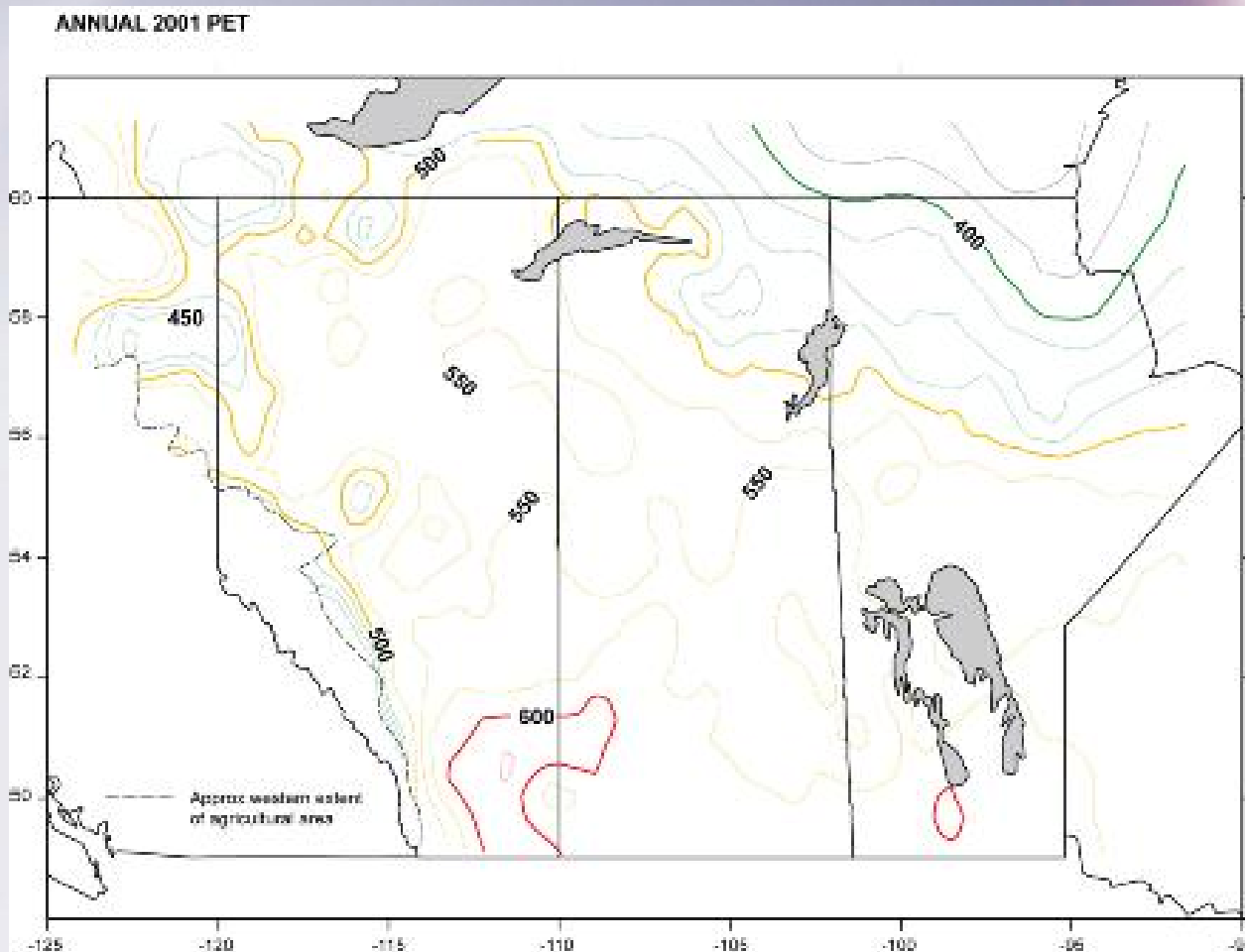


2001/2002 PDSI Drought Patterns

(Bonsal and Regier 2006)

**Some similarities
Across Canada effect**

Spatial pattern of annual potential evapotranspiration 2001



Dry Day Sequences during 1999 to 2003 Saskatoon, SK

Dry day sequence = consecutive days without measurable rain (>0.2 mm)



Ê 40d in 2000: 25 Sep to 5 Nov

Ê **35d** in 2002: 2 May to 5 June

Ê 21d in 2001: 5 Aug to 4 Sep

Ê 20d in 1999: 1 Nov to 20 Nov

Ê 43d in 1961 (16 May to 28 June)

Ê Note importance of timing vs water use

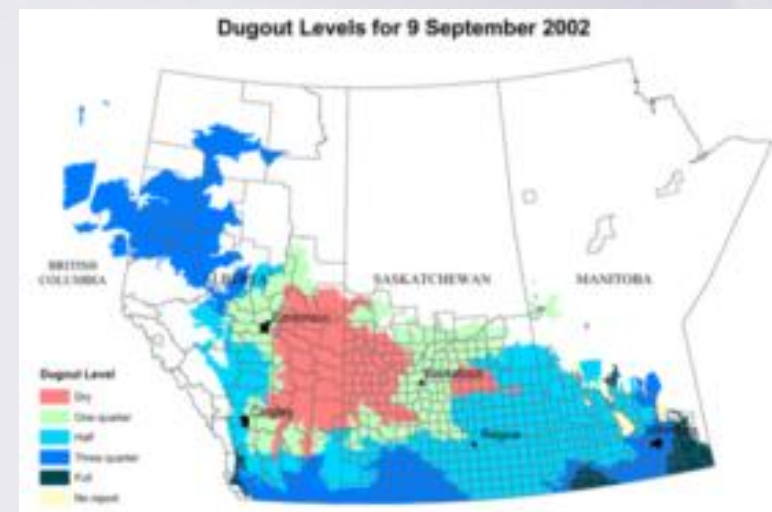
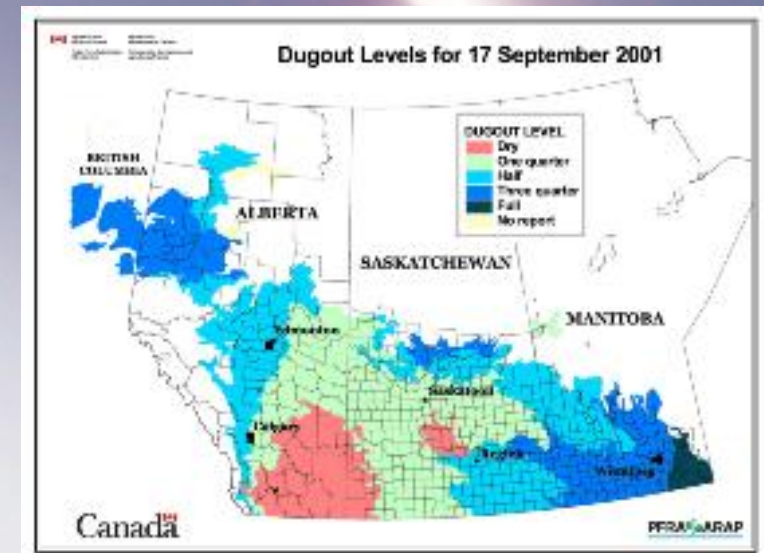
Surface Water Impacts – Prairies



Ê AB and SK streams had **well below average** (or no) flows in 2000-2002

Ê **Dugouts**- often essential adaptations to water scarcity on Prairie farms, esp. for livestock and household use

Ê Dugouts were **drying** out by the fall of 2000, and this trend became worse in 2001



More Impacts of 2001-2002



- Ê Poor **pasture** growth encompassed all of Alberta, stretching in a wide swath across SK into much of southwestern MB
- Ê **Livestock** production was especially difficult because of scarce feed and water; some inventories decreased
- Ê **Crop** production losses were devastating across Canada for a wide variety of crops



Benefits of the Research to Users?



- Ê Drought indices are used to compare with **impacts** to determine the risks of drought
- Ê Methodologies- improve the depiction of drought characteristics, **dynamics**, to improve monitoring and early warning systems
- Ê Understanding of drought **migration** would help address questions such as: how quickly can droughts move or intensify/dissipate? What is the direction of movement?
- Ê Estimates of possible impacts and **adaptations**
- Ê Actions toward decreasing **vulnerabilities**
- Ê Links with Themes 2 and 3 (4 and 5 shhh)
- Ê OTHERS?

Abstract



- Ê Wheaton, E. and B. Bonsal. 2007. Exploring the Surface Characteristics of the 1999-2005 Drought in the Canadian Prairies. Abstract for the Canada DRI workshop 11-13 January 2007, Winnipeg, MB.
- Ê The main objective of this analysis is to characterize the surface meteorological conditions associated with the 1999-2005 Canadian Prairie drought. In particular, the research will quantify the spatial extent and severity of the drought through examination of several drought indices that incorporate observed temperature and precipitation. This will involve a comparison of drought indices in terms of their ability to describe surface drought conditions and associated agricultural and hydrologic impacts. Insight toward the improvement of these drought indices will be provided including an assessment of potential methods appropriate to analyze the migration of drought in both time and space. This research directly addresses Theme One of DRI in terms of its characterization of the climatological features associated with the drought. It also addresses Theme Five by providing initial information to other researchers and possible users to improve linkages