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# **Historical Drought Detection and Evaluation Using the Standardized Precipitation Index and Gridded Data**

## **CCIAP A932 “Canadian Agricultural Adaptations to 21<sup>st</sup> Century Droughts: Preparing for Climate Change”**

### **Extended Abstract**

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## **Extended Abstract**

Drought is a hazard which is difficult to define, detect and measure. Drought (not aridity) affects all climates as it relates to some deviation from the normal moisture supply. To evaluate drought in Canada, which bridges several climate zones, one requires a universal index. We chose to use the Standardized Precipitation Index (SPI). We gridded monthly precipitation data for the Canadian provinces from 1900 to 2004 on a 0.2 by 0.2 degree grid and then applied an established algorithm to calculate the 1, 2, 3, 6, 9, 12 and 24-month SPI at each grid point for the duration of the data set. The resulting SPI data permits identification of droughts by severity, area and duration.

Since 1950 the top three spring/summer droughts in Canada were 1961, 1958 and 1967. The drought of 2001 (which inspired this study) ranked 4<sup>th</sup>. The 2001 drought was unique in several ways:

- (1) It affected the Prairies, Southern Ontario/Quebec and the Maritimes simultaneously,
- (2) On the prairies it was the most severe since 1967 (34 years) and
- (3) In Southern Ontario/Quebec it was the most severe since 1962 (40 years).

## **Summary and Conclusions**

### ***The Data and Analysis***

We assessed drought in the agricultural areas of Canada using the Standardized Precipitation Index which was derived from monthly gridded precipitation data. Particular attention was paid to the 2001 and 2002 seasons.

Drought severity was quantified as the area, within the agricultural domain, where the precipitation anomaly for the season as measured by the Standardized Precipitation Index was less than -1.5. For any point this corresponds to about the 7<sup>th</sup> percentile. The seasons considered were June-July-August (August SPI-03) and March-August (August SPI-06). The seasonal patterns were generally ranked in a top-ten fashion for the 1950 to 2004 period.

Since the occurrence of a “National Drought” is rare in a country as large as Canada, we broke down the analysis into the 3 regions that are pertinent to this project; the Prairies, Southern Ontario/Quebec and the Maritimes.

## Prairies

Table 1: Ranking of Drought Seasons by SAD Index in Prairie Agricultural Area (1950 – 2004)

3-month SPI			6-month SPI		
Rank	Year	SAD Index	Rank	Year	SAD Index
1	1961	58.7%	1	1961	56.9%
2	1967	48.0%	2	1958	39.7%
3	1958	27.7%	3	1967	32.5%
4	1979	17.1%	4	2001	20.2%
5	2003	17.0%	5	1984	8.7%
6	1984	10.3%	6	1950	8.2%
7	1985	9.5%	7	2002	6.5%
8	2001	8.8%	8	1998	5.1%
9	1977	8.1%	9	1988	4.4%
10	2002	7.6%	10	1979	4.2%

In the period from 1950 to 2004 the driest summers (June to August) were 1961, 1967, 1958, 1979, 2003, 1984, 1985, 2001, 1977 and 2002. 2001 was the 8<sup>th</sup> driest and 2002 was 10<sup>th</sup> driest.

The driest (March – August) 6-month periods were in 1961, 1958, 1967, 2001, 1984, 1950, 2002, 1998, 1988 and 1979.

In 2001 the drought affected most of the agricultural areas on the Prairies. In 2002 the drought area was further north. Three of the top ten droughts in the 1950 – 2004 period occurred in the 21<sup>st</sup> century. The 2001 drought was the most intense since 1967 – 34 years earlier.

## Southern Ontario and Quebec

Table 2: Ranking of Drought Seasons by SAD Index (August SPI-03) in Ontario and Quebec Agricultural Area (1950 – 2004)

Year	SAD Index
1983	23.0%
1953	17.9%
1962	14.2%
1964	9.7%
2002	9.3%
1960	9.1%
2001	8.7%
1975	8.5%
1989	7.1%
1991	6.6%

**Table 3: Ranking of Drought Seasons by SAD Index (August SPI-06) in Ontario and Quebec Agricultural Area (1950 – 2004)**

Year	SAD Index
1958	26.9%
1962	26.5%
<b>2001</b>	<b>15.2%</b>
1966	8.5%
1971	7.5%
1999	6.3%
1965	6.2%
1957	5.6%
1964	5.6%
1975	4.8%

The growing season of 2001 was the 7<sup>th</sup> driest and the growing season of 2002 was the 5<sup>th</sup> driest on record during the period 1950 to 2004. The top ten driest (June – August) summers were 1983, 1953, 1962, 1964, 2002, 1960, 2001, 1975, 1989 and 1991.

The driest (March – August) 6-month periods were 1958, 1962, 2001, 1966, 1971, 1999, 1965, 1957, 1964 and 1975.

In 2001 the drought stretched along the Windsor to Montreal corridor. July was the driest month. In 2002 the drought was concentrated over southwestern Ontario and in the St. Lawrence River Valley around Montréal. August was the driest month.

## **Maritimes**

**Table 4: Ranking of August SPI-03 and SPI-06 in the Maritimes**

3-month SPI			6-month SPI		
Rank	Year	SAD Index	Rank	Year	SAD index
1	1975	21.7%	1	1965	42.9%
2	1978	19.2%	2	1978	17.7%
3	1960	18.6%	3	1968	16.7%
4	1965	13.2%	4	1966	9.7%
<b>5</b>	<b>2001</b>	<b>11.1%</b>	5	1975	7.6%
6	1997	10.7%	6	1957	5.4%
7	1957	8.5%	7	1987	4.1%
8	1968	6.8%	8	1960	3.3%
9	1953	5.8%	9	1992	3.1%
10	1961	5.8%	<b>10</b>	<b>2001</b>	<b>3.1%</b>

During the period 1950 to 2004 the driest summers were 1975, 1978, 1960, 1965, 2001, 1997, 1957, 1968, 1953 and 1961.

The driest 6-month periods were 1965, 1978, 1968, 1966, 1975, 1957, 1987, 1960, 1992 and 2001.

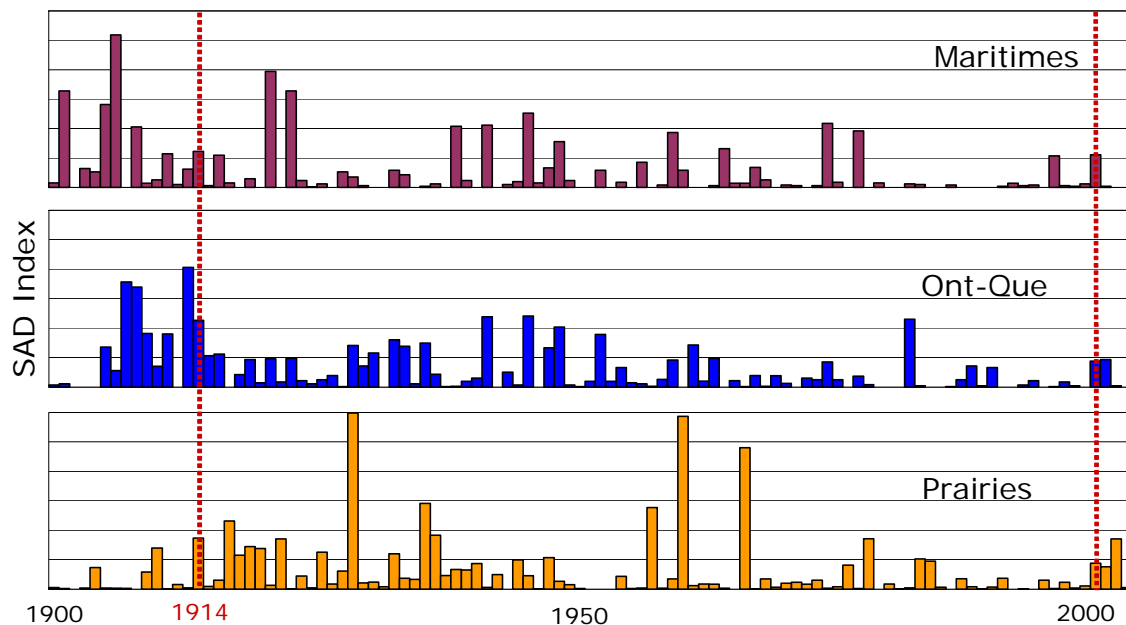
The growing season of 2001 was the 5<sup>th</sup> driest on record. Southern New Brunswick, northern Nova Scotia and all Prince Edward Island (in particular the western half) were affected by a lack of precipitation. The drought conditions persisted into September and October.

The 3-month SPI indicates that 2002 was not an unusually dry summer in the Maritimes.

### ***Coincident Drought***

Typically dry conditions in one part of the country are balanced by wet conditions elsewhere. A unique aspect of the 2001 drought is that the Prairies, southern Ontario/Quebec and the Maritimes experienced dry conditions coincidentally. This is a rare occurrence. The last time a comparable situation occurred was 1960. While the severity of the 2001 or 2002 drought was not a record in any area, the coincident nature may have exacerbated the national impact and be a key difference in the perception of drought severity in 2001 from other years. The presence of drought conditions would have been noted as a national story rather than a regional one.

## Coincident Droughts (1900-2004)



# Years with Coincident Droughts (Based on Jun-Aug SPI)

8%	5%	3%
1914	1914	1914
2001	1933	1916
	1948	1929
	2001	1933
		1934
		1946
		1948
		1960
		2001

## ***Suggestions for Future Work***

### **Temperature**

This study relies on precipitation to assess drought. For agricultural purposes the effect of temperature and thus evaporation may also be important. It is suggested that the work could be extended by producing gridded temperature fields that could be combined with precipitation to derive other drought indices.

### **Daily Data**

A risk of using monthly data is that the monthly total of precipitation gives no information as to how the precipitation was distributed over the month. One could have 30 dry days followed by a rain event on the last day of the month. This month could appear the same as another where the precipitation was evenly distributed in time. In addition, monthly time blocks are too long to adequately assess drought conditions in areas (like the Maritimes) where soil moisture holding capacity is low and the type of crops depend on regular moisture. The solution to this problem is to use daily data so that shorter time blocks or even running blocks can be employed.

### **Precipitation Trends**

The analyses based on precipitation data in this study suggest that severe drought was more frequent in the earlier part of the record. It is recommended that the data be studied to determine if there are trends in the precipitation climate and if these trends are due to variability in climate or not.

Further Work