Drought and institutional adaptation in Alberta and Saskatchewan, 1914-1939

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1. Introduction and aims

During the past one hundred years, at least 40 droughts have occurred in the Canadian Prairie Provinces. In the Great Plains of Alberta and Saskatchewan (and the southwestern corner of the province of Manitoba), extensive, multi-year droughts were observed in the1930s, 1980s and early 21st century. While the prolonged drought of the 1930s is one of the more significant of this series, intense, large-area and multi-year droughts still occur, producing severe hardship, even to those regions accustomed to coping with droughts (O'Brien, 1994; Wheaton, 2000; Wheaton *et al*., 2005). The drought of 2001 and 2002 is an example of such a recent event. This drought covered much of Canada and may be one of the first cost to coast droughts on record. As in past droughts, the provinces of Alberta and Saskatchewan were hardest hit by meteorological drought resulting in adverse economic impacts. Some individual climate stations in those provinces had even lower annual precipitation amounts than in the 1930s (Wheaton et al. 2005). Thus multi-year drought continue to challenge Canada and improved adaptation to these extreme events are needed. Climate change is increasing this risk and with it the need for even more effective adaptation in the future.

Williams et al. (1988) were among the first to demonstrate that a doubling of greenhouse gases would lead to a more drought-prone climate (due to increased potential evapotranspiration) in the Great Plains of North America, with increased variability of extreme dry and wet spells. Most global climate models project increased summer continental interior drying and a greater risk of droughts for the 21st century (Watson *et al*., 2001). Based upon expert judgment, there is a 66 per cent probability of an increase in the area affected by drought (IPCC, 2007). Other factors that indicate future drought challenges include the paleo-climatological analyses that demonstrate that droughts in the climatological record of observed data are minor compared to those occurring before the agricultural settlement of the Canadian prairies (Sauchyn *et al*., 2003). Another factor heightening risk is the increasing human demand for water. Population and economic growth, as well as the recognition of ecological (non-human generated) water needs, will increase the demand for water supplies in this region.

Important lessons about adaptation can be drawn from the historical experience of the extensive drought of the 1930s. Successive years of lack of precipitation coupled with high winds eventually generated dramatic dust storms – the infamous dust bowl of the Dirty Thirties (Wheaton, 1992). The impact of prolonged drought and blowing topsoil crippled the once-wealthy farm economy of this part of North America raising questions about the economic viability and the future of the region. In Canada, provincial and national governments reacted to the situation by developing programs to assist people in the region, to rehabilitate the soil and farms or, in certain places, to change the nature of agriculture itself and relocate population to more promising areas.

As a consequence of suffering a more localized but prolonged drought in the late teens and 1920s, the provincial government of Alberta had a well-developed program of converting farms to ranches and relocating excess population from the southeast to parts of the province less affected by drought. By the 1930s, drought affected virtually the entire southern prairie region creating near starvation conditions for tens of thousands of farm families. In response to the crisis, the government of Canada established a new agency for the Prairie Provinces called the Prairie Farm Rehabilitation Administration

(PFRA), to address the wide extent of soil degradation and water supply issues, thereby helping producers adapt to the vagaries of climate (Gray 1996).

This paper has three purposes. The first is to contrast the historical narrative of droughts in southeastern Alberta and southern Saskatchewan with a spatial and scientific depiction of agricultural drought between 1914 and 1939. The second purpose is to apply the concepts of exposure and vulnerability as defined in the climate change literature to the historical circumstances of farmers in this region during the relevant time period. The third and final purpose is to more closely examine institutional adaptation in terms of two organizations that evolved out of these earlier droughts: the Special Areas Board and the PFRA. These organizations were selected because they have been generally perceived as examples of relatively successful institutional adaptation. More importantly, looking to the future, the Special Areas Board and the PFRA remain among the most significant governmental policy players in managing land and water resources in the prairie provinces of Alberta and Saskatchewan.

2. The historical record: Drought exposure and vulnerability

Both scholarly and popular histories of drought in twentieth century Canada tend to focus on the decade of the 1930s. While there were a few exceptions, particularly the work exploring the droughts in the Alberta portion of the Dry Belt before the 1930s (Jones, 2002; Jones and Macleod, 1986), most historical accounts focus on the Dirty Thirties. There are at least two major explanations for this focus. The first is the contributing impact of the Great Depression, in terms of depressed grain prices along with high unemployment, to the persistent affliction of drought burden faced by farmers and rural communities throughout the Palliser Triangle. The second is the fact that the droughts prior to the 1930s were more restricted in area – a relatively small part of the Palliser Triangle in southeastern Alberta and southwestern Saskatchewan known as the Dry Belt (Villmow, 1956) – whereas the droughts that began in 1929 afflicted all of the Palliser Triangle, as discussed later on. In response, the federal government initiated a spate of studies including the Royal Commission on Dominion-Provincial Relations, more commonly known as the Rowell-Sirois Commission, in response to the near-bankruptcy of the prairie provincial governments as a result of drought and depression (Stapleford, 1939; Canada, 1940).

[Insert Figure 1: Palliser Triangle, the Dry Belt and Soil Zones]

As can be seen in Figure 1, the Palliser Triangle in Canada covers more than 200,000 square kilometers of area in southern Saskatchewan, southeastern Alberta, and extreme southwestern Manitoba (Lemmen and Dale-Burnett, 1999). When Captain John Palliser surveyed the region on behalf of the British government in the 1850s, the region was experiencing a dry cycle. As a consequence, Palliser identified this region as an extension of the Great American Desert and, unsurprisingly in the circumstances, declared it unsuitable for agriculture.

Lying in the heart of the Palliser Triangle is the Dry Belt, as defined by Villmow (1956) and Nemanishen (1998). Described as a region of perpetual drought (Gorman, 1988), the Dry Belt is located in the rain shadow of the Rocky Mountains to the west and the Cypress and Sweet Grass Hills to the south. As Nemanishen (1998, p. 2) points out, the Dry Belt is a region of double misfortune. First, its geographical position ensures that it receives, on average, less than 350 mm of precipitation per year, well below the average of the Palliser Triangle in general. Second, it is subject to high moisture loss because of winter Chinooks (warm dry wind) combined with summer heat waves that are often more intense than heat waves in the rest of the Palliser Triangle. Adding further difficulties is the fact that the Dry Belt lies entirely in the Brown soil zone with mostly chernozemic and solonetzic soils. These soils are of lighter texture, and have a lower water retention potential thus making the area a little more sensitive to droughts. Based on the definition used by the United Nations, the Dry Belt is at risk of desertification (UNEP, 1994: p. 1334). With less natural protection, dryland soils are exposed to erosion by wind and rain. Under native prairie and average climate conditions, erosion is limited to steep slopes (badlands) and sandy soils (dunes). Soil degradation is very much accelerated however by the cultivation of prairie soils and drought conditions (Sauchyn *et al*., 2005). Long droughts in particular are likely to exceed soil moisture thresholds below which plants wilt and die and soil is subject to desertification.

As the provinces of Alberta and Saskatchewan were being established in 1905, the Palliser Triangle was in the midst of a wet cycle which, in turn, precipitated a rush into the region, including the Dry Belt, by new immigrant settlers from Europe and the United States encouraged by the government of Canada as well as local real estate speculators. These farmers planted wheat on what had previously been ranch land or pristine prairie (Friesen, 1987; Strojich, 1940; Rust, 1956). As Fowke (1957, 285) pointed out in his major study of the prairie wheat economy a half century ago, the central failure of Canadian settlement policy was a lack of attention paid to climatic and soil surveys that would have helped farmers avoid homesteading in “those areas wholly unfitted for cultivation”.

Contrary to Palliser’s original predictions, substantial wheat crops were produced in the Palliser Triangle at first. The Dry Belt then suffered a major drought in 1914. Moisture conditions improved in 1915 and 1916. High crop yields were accompanied by artificially high prices for wheat caused by the exigencies of the First World War, and even more land was converted into wheat production (Thompson, 1978). By 1917, however, crop yields in the Alberta portion of the Dry Belt were cut back by the lack of rain. By the 1918 crop year, the region was facing widespread drought that would continue in most parts of the Dry Belt, and some contiguous regions within the Palliser Triangle, until the abnormally wet year of 1927 (Jones, 2002; Jones and Macleod, 1986). As can be seen in Table 1, this had a dramatically negative impact on wheat yield inside or near the Alberta Dry Belt.

[Insert Table 1: Wheat Yields per Acre in or near Alberta Dry Belt Districts, 1914-1921]

After enjoying above-normal precipitation in 1927, extremely dry weather returned in 1928 and would not relinquish its hold until 1938. This time, the droughts covered, on average, a much larger area than the Dry Belt. In some years, virtually the entire Palliser Triangle faced drought conditions. This also resulted in rural depopulation. The trend in the Dry Belt’s population growth relative to the rest of Alberta and Saskatchewan is shown in Figure 2, a growth rate stunted by the prolonged agricultural droughts of the teens, 1920s and 1930s.

[Insert Figure 2, Trend in Population for the Dry Belt and the Rest of Alberta and Saskatchewan, 1901-1941]

In Alberta, population in the Special Areas (roughly estimated using Alberta Census Divisions 1, 3 and 5) declined by 6,528 people during 1931 to 1941. Similarly, the corresponding Saskatchewan Dry Belt (also roughly estimated using Saskatchewan Census Divisions 4 and 8) registered a much more significant loss of 12,342 people during the same period. Due to the earlier depopulation as well as the conversion of farm land into ranch land in the Alberta portion of the Dry Belt in the 1920s, the rural communities on the Saskatchewan side of the Palliser Triangle, particularly in the Dry Belt, were much more exposed to the effects of drought.

3. Drought exposure and vulnerability

Figure 3 provides a conceptual framework for understanding the linkages between past vulnerability to prolonged drought and vulnerability to future prolonged drought. The past vulnerability of the region is a function of both past exposure, itself a product of both drought and land use, and past adaptations, in particular the institutional adaptations led by both provincial and federal governments in coping with the consequences of recurring drought in the Palliser Triangle from 1914 until the end of the 1930s.

[Insert Figure 3: Conceptual model of drought vulnerability]

In general terms, exposure to climate change is a function of both the physical stimulus of climate and the human occupancy characteristics of the land (Smit and Wandel, 2005; Smit and Pilifosova, 2003; Downing, 2003). Generally speaking, human vulnerability is positively correlated with the extent of drought exposure and negatively correlated with the ability of people to adapt successfully to drought. In addition, ability to adapt is enhanced by previous similar experience that resulted in greater resilience, a positive feedback cycle of adaptation to drought. While individual human adaptation has always played some role in major drought crises – for example, unassisted human migrations out of the North American dust bowl during the 1930s – the extensive literature on drought planning and organized adaptation illustrates the critical role played by institutions in lowering the degree of human vulnerability to drought (Wilhelmi and Wilhite, 2002; Wilhite, 1993; Riebsame *et al*., 1991). The role of institutions in modulating human behaviour in general has been recognized in the literature (Polsky and Cash, 2005). Institutions link science, technology and resources to individual human actors and collective organizations attempting to change and better manage their environments (Keohane and Levy, 1996).

Institutions have been critical to local, regional, national and international efforts in reshaping agriculture in drought-prone environments. Because of this, Wilhite and Pulwarty (2005) have recommended a more proactive approach to reduce vulnerability to drought and similar natural hazards. Included among these is an emphasis on preparedness planning and the development of appropriate mitigating actions and programs. In the United States, the establishment of organizations such as the National Drought Mitigation Center facilitates the production of salient, credible and legitimate information. Outside the United States, the recent focus on reducing vulnerability has increasingly centered on the production and dissemination of seasonable climate forecasts for use by organizations and individuals attempting to adapt to prolonged drought (Wilhite and Pulwarty, 2005).

Institutions can be broadly defined as the rules, social norms and organizations that facilitate the co-ordination of human action (Diaz and Rojas, 2006). Drawing upon Hall (1986, 20), we can narrow down institutions to the formal rules, compliance procedures and standard operating practices that structure the relationship between individuals and the state or economy, even while accepting, as historical institutionalists argue, that "institutions emerge from and are sustained by features of the broader political and social context" (Thelen, 1999, 384). We would go one step further, arguing that climate, and in particular prolonged periods of drought in an agricultural region, can generate political and social crises that, in turn, triggers profound institutional innovation and adaptation. This was certainly the case for the Palliser Triangle region of the Canadian west during the 1920s and 1930s, when governments created major institutions during a period of major political upheaval, to mitigate the crisis caused by the sustained droughts of these decades.

It is important to note that the earlier prevalence of drought in the Alberta portion of the Dry Belt had induced a major change from wheat farming to livestock operations by the 1930s thereby lessening actual exposure to drought on the Alberta side of the border. This was despite the fact that the region faced approximately the same amount of drought as measured in the drought maps shown below. The higher exposure of crop production to drought relative to livestock production is due to the lack of irrigation for grain growing in the Dry Belt and the greater resilience of the perennial plants which make up natural grasslands to drought. After 1934, some irrigation projects were built by the PFRA in the Dry Belt but these were limited to the production of livestock forage in 40-acre plots, not the production of field crops. In this sense, "exposure" to drought is the relationship between a lack of moisture *and* land occupancy characteristics which expose (or shelter) human activities to (or from) climate risks, variability and change (Smit and Wandel, 2005).

This higher exposure faced on the Saskatchewan side of the Palliser Triangle in the 1930s relative to the Alberta Dry Belt over a decade earlier is reflected in precipitous fall in provincial wealth per capita. In Saskatchewan, provincial income fell from $478 per capita in 1928-29 to $135 per capita in 1933. This 72% drop in income in Saskatchewan was higher than the drop registered in the other two provinces -- a 61% drop in Alberta (from $548 to $212 per capita) and a 49% fall in Manitoba (from $466 to $240 per capita) over the same time period (Canada 1940). The observed difference in the drop of income in Saskatchewan and Alberta is highly significant (Z=144.49, yielding a probability of less than 0.0001).

It is also evident in the fact that Saskatchewan wheat yields fell below the three prairie province average every year from 1928 until 1937 (Saskatchewan, 1937). Finally, this greater exposure was reflected in the provincial share of relief payments. Of the almost $292 million in relief distributed in the three prairie provinces from 1930 until 1937, 61% was concentrated in Saskatchewan compared to 22% in Alberta and 17% in Manitoba (Canada, 1940).

4. Defining and mapping agricultural drought, 1914-39

Most concepts of drought, particularly agricultural drought, consider the balance between the supply of water on the one hand and the demand for water on the other (Redmond, 2002). To more precisely calculate the severity of agricultural droughts, however, it is necessary to choose among a number of drought indices that have been developed by climatologists and other scientists. As noted by Heim (2002), Friedman (1957) posited four criteria which an effective drought index should meet:

(1) the timescale should be appropriate to the subject being examined

(2) the index should provide a quantitative measure of large-scale and long-continuing drought conditions

(3) the elements that make up the index should be applicable to the problem being studied

(4) a long accurate past record of the index should be available or, at least, capable of computation.

The most popular and first comprehensive drought index, the Palmer Drought Severity Index (PDSI), has weaknesses that are problematic for our analyses of drought in western Canada. These include:

(1) Palmer values account for soil moisture conditions in preceding months and therefore may lag emerging droughts by several months

(2) The classification of drought is based on conditions in central Iowa and western Kansas

(3) The PDSI is sensitive to the available water content of a soil type and thus mapping PDSI over a large region may be too general

The drought index selected for this study is a climate moisture index that expresses the moisture deficit in terms of mean crop year precipitation minus potential evapotranspiration (P-PET). This drought index incorporates supply and demand by using the precipitation term to represent supply and the potential evapotranspiration term to represent demand. Such an index, as described by Sauchyn *et al*. (2002), can be used to identify land at risk of desertification as was the case in southeastern Alberta before 1927 and through most of the Palliser Triangle during the 1930s. Specific values of the climate moisture index define the boundaries between the forest, parkland and grassland ecosystems of western Canada (Hogg, 1994) and thus there is a strong link between moisture balance captured by this index and the distribution of plant communities. Unlike PDSI, the values for P-PET have a physical meaning in terms of actual moisture deficit.

To map the climate moisture index over an area as large as the Prairie Provinces requires an extensive climate database and a relatively simple method of estimating PET. Evapotranspiration depends on air temperature, solar radiation, wind speed, humidity, and the nature of the soil and vegetation. Only temperature data are available at a reasonable spatial and temporal resolution to enable the mapping of PET across the Prairie Provinces on a monthly basis. Therefore we used the Thornthwaite equation for estimating PET as described by Sauchyn *et al*. (2002). This formula works best in mid-latitude continental climates where air temperature is strongly correlated with net radiation. Monthly PET is adjusted for day length according to latitude and month.

To map P-PET using a GIS, we used a gridded database of mean monthly temperature and total precipitation derived from the Canadian Climate Archive for the

Prairie Provinces (Sauchyn *et al*., 2002). Monthly P-PET was computed for each intersection on the 50 km grid. To smooth the boundaries between maps units (categories of P-PET), we further interpolated the data to a 5 km grid using a Kriging algorithm.

The maps in Figures 4 and 5 are for the crop years 1914-39. We summed the monthly values of P-PET for the annual period September 1 to August 31; that is, after harvest, when moisture accumulates in the soil to produce a crop that is harvested in August of the following year. On average, June is the month with the maximum precipitation, while autumn and winter precipitation restore the soil water balance for pastures and haylands as well as germination and early growth of annual crops in the following calendar year. Thus crop year P-PET for 1935, for example, is the sum of monthly values from September of 1934 to August 1935. This definition of the crop year was adopted by PFRA for mapping precipitation and drought (PFRA, 2006).

The drought maps are divided into two groups representing two periods when the moisture deficits had a different geographic extent. The first group of maps – covering crop years 1914-27 – illustrate the extent to which, on average, southeastern Alberta was drought-stricken relative to southern Saskatchewan. The 1914, 1917 and 1918 maps show the extent to which the first major drought was concentrated in the Alberta Dry Belt. While the 1918 map shows a much more distributed drought area, aridity is again mainly concentrated in the Alberta Dry Belt from 1920 until 1926. The 1927 maps shows a moisture surplus in large sections of the Palliser Triangle although a section of the Dry Belt as well as the region southwest of Regina to northwest of Saskatoon shows some moisture deficit.

[Insert Figure 4: Drought (P-PET) Maps of Canadian Prairies, 1914-1927 Crop Years]

In contrast to the first group, the second group of drought maps covering the late 1920s and the 1930s illustrate the extent to which the Palliser Triangle as a whole suffered from a moisture deficiency that began in 1928 and continued through the 1930s. In particular, it is interesting to note that extreme moisture deficiency did not differ appreciably between southeastern Alberta and southern Saskatchewan. However, since earlier institutionally-induced changes in land use on the Alberta side of the border resulted in less exposure by the 1930s, prolonged drought generated much more of a crisis in Saskatchewan.

[Insert Figure 5: Drought (P-PET) Maps of Canadian Prairies, 1928-1939 Crop Years]

5. Institutional adaptation to drought in Alberta and Saskatchewan

Relief was the most common, and the most expensive, governmental response to the impact of drought on rural communities. Its main objective was to sustain farmers and their families so that they could remain on the land. When successive drought and blowing topsoil made this impossible, governments encouraged the relocation of these farmers to regions that could support farming by paying for some or all of the transportation costs. Government policies and programs involving water conservation, dam building and grass replanting spearheaded the reclamation of agricultural land that successive droughts had turned into unproductive desert.

Federal and provincial governments set up numerous organizations and agencies to accomplish these goals. In what follows, the origins of two of the most significant public organizations created during this period are summarized: 1) the Special Areas Board set up by the government of Alberta; and 2) the Prairie Farm Rehabilitation Administration established by the federal government with the considerable support of the government of Saskatchewan. Both were innovative institutional responses to the exigencies of drought in the Palliser Triangle, and both continue to carry out their historic mandates in facilitating adaptation to drought in this part of Canada.

5.1 The Special Areas of Alberta

Today, the so-called Special Areas extend over 2.1 million hectares in southeastern Alberta. This region in the heart of the Alberta Dry Belt is administered by a Special Areas Board that is selected by, and accountable to, the provincial government. The Board is responsible for land and water use as well as operating schools and community pastures. Coping with potential drought remains a key part of its mandate: recently, for example, the Board has launched a study of major water diversion project involving the Red Deer River as a "long-term solution to recurring droughts in the Special Areas" (Special Areas Board, 2005). Although the boundaries have shifted somewhat over time, the Special Areas Board has been operating in a similar manner since its establishment in the 1930s (Gorman, 1988; Marchildon, 2007).

Before the droughts, much of the land in the Special Areas was used for wheat farming, encouraged by artificially high prices for wheat during the First World War (Jones, 2002). The droughts soon generated a political crisis for the provincial Liberal government. In addition to demanding relief in the form of seed and feed, farmers also requested that a public commission study the problem and provide longer-term recommendations. In 1921, a new political movement and party, the United Farmers of Alberta, won the provincial election in part because of promises to deal with the drought in the Dry Belt.

Provincial assistance was initially limited to relief as well as the subsidized relocation of farm families to regions more suitable for agriculture. In particular, the provincial government worked with the federal government and the railway companies to establish a program that provided free freight for farmers who wished to settle in more promising wheat growing parts of the province, including the far northern Peace River region of Alberta.

By the mid-1920s, people were leaving the Special Areas in large numbers, many without government assistance. By the 1921 census, the population of the Special Areas had reached a peak of 41,050, over 90% were rural farmers rather than town dwellers. By 1926, this population had plummeted to 29,785 (Strojich, 1940). Given that approximately 2,000 farmers had been resettled through the government-sponsored free freight plan by that time, it is clear that most of those who had moved during the early years of drought did so without government assistance (Alberta, 1927).

This sudden depopulation, as well as the poverty of the remaining farmers, had disastrous consequences for local governments in the Special Areas. With their loss of tax base, tiny rural municipalities found themselves bankrupt and unable to provide basic infrastructure and services from roads to schools. In 1926, the provincial government set up the Tilley East Commission to deal with the crisis, and the commission recommended that:

(1) the provincial government declare the Tilley East region to be closed to further settlement

(2) that the significant tax arrears owed be settled on a compromise basis between debtors and creditors

(3) that public claims for back taxes and other amounts of money owing be cancelled, if necessary

(4) that multiple municipal administrations be replaced by a single board appointed by the provincial government to administer all land and water use in the region.

In 1929, the Tilley East Special Area Board was established. The experiment proved successful enough in terms of encouraging out-migration and facilitating the establishment of larger and more economically-sustainable ranch-farm holdings, that it was extended to a neighbouring district know as the Berry Creek Special Area by 1932. In 1935, the Special Areas expanded with the addition of Neutral Hills, Sounding Creek and Sullivan Lake. Two years later, the Special Areas were completed with the addition of Bow West (see Figure 6). The *Special Areas Act* of 1938 brought all of these Special Areas – then constituting almost 3.0 million hectares as shown in Figure 6 – under a single law and a single authority of a three-member board, appointed by the provincial government, and headquartered in Hanna, Alberta. Although the size and structure of the Special Areas changed in the postwar period, 2.1 million hectares of land continue to be administered by the Special Areas Board (Marchildon, 2007).

[Insert Figure 6: Special Areas of Alberta circa 1942]

The mandate of the original Special Areas Board of 1938 (and individual boards before 1938) was to secure control of as much land as possible in order to promote the transfer of land use from grain farming to livestock operations by developing community pastures and renting out Crown lands at low rates. In addition, the Board was responsible for providing and maintaining basic road, school and hospital services for residents in the context of continuing depopulation. Although farming was not prohibited, everything possible was done to help develop self-sufficient livestock operations that would replace large-scale grain production in the region (Martin, 1977; Gorman, 1988).

Through the Special Areas Board, the government of Alberta had designed its own institutional response to recurring droughts and was less inclined to co-operate with new federal initiatives including the PFRA. In contrast, the Saskatchewan government cooperated extensively with the PFRA in its reclamation efforts in Saskatchewan.

5.2 Saskatchewan and the PFRA

As illustrated in the drought maps from 1915 until 1927, southwestern Saskatchewan was less exposed to drought than southeastern Alberta. In 1915, for example, while the region around Medicine Hat was suffering from a severe moisture deficit, the Saskatchewan side of the border from Maple Creek to Leader was actually experiencing more than average soil moisture. The same was true in southwest Saskatchewan in 1916.

Although drier conditions returned after this year, southeast Alberta experienced a much higher soil moisture deficit than Saskatchewan from 1917 until the abnormally moist year of 1927. Examining the Palliser Triangle during the period 1915-1927 as a whole, therefore, it is clear that Saskatchewan wheat farmers suffered less from drought exposure than Alberta farmers. This meant that there was significantly less pressure on the provincial government of Saskatchewan to alter its policies in a manner to the Alberta government's experimentation with the Special Areas.

As illustrated in Figure 8 (covering the 1928-39 crop years), however, southeast Saskatchewan suffered from drought (as measured by water deficit) as much as southwest Alberta. However, individuals and communities located in the Saskatchewan portion of the Palliser triangle had greater exposure, in terms of the more acute crisis precipitated by prolonged drought, much exacerbated by the Great Depression and the plummeting price of wheat (Stapleford, 1939; Marchildon, 2005).

The crisis forced the Saskatchewan and federal governments into action, both co-operating in an effort to facilitate adaptation by farmers and communities in the drought-stricken region. From 1930, the first year of basic relief to farm families in the form of food, clothing, seed and fuel, until 1937, the worst drought year of the 1930s, the provincial and federal governments collectively poured almost $175 million in rural relief for Saskatchewan. Though they originally held the responsibility for the distribution of relief, municipalities were bankrupted as their tax bases shrank. The provincial government stepped into the breach but the $100 million it sank into relief over this period made it the most heavily indebted jurisdiction in the country. Both Saskatchewan and Alberta were so close to bankruptcy that Prime Minister Mackenzie King establish the Royal Commission on Dominion-Provincial Relations in large part to make recommendations on the imbalance between provincial responsibilities and their fiscal capacity (Ferguson and Wardaugh, 2005).

One of the purposes of relief was to encourage farmers to stay on the land rather than drift into the cities to look for non-existent employment, a situation that could lead to civil unrest (Marchildon and Black, 2006; Neatby, 1950). But the situation was so dire that many farm families simply walked away from their farms to move into the cities or to northerly rural regions with a history of more rainfall. The provincial government helped out those farmers willing to move to the northern edge of settlement in the province by paying the freight costs. Between 1930 and 1938, approximately 7,000 farm families moved from southern Saskatchewan to settle in the northern edge of the Parkland Ecoregion (see Figure 1). Although early relocation efforts were heavily criticized for the ad hoc “dumping” of southern farmers onto unproductive “swamps” in the forest fringe, subsequent efforts adopted a more planned approach (Britnell, 1939; Powell, 1977).

In addition to relief and relocation, the federal government, in close collaboration with the Saskatchewan government, eventually spearheaded a major land reclamation effort under the aegis of the *Prairie Farm Rehabilitation Act* in 1935. Two years later, the Prairie Farm Rehabilitation Administration (PFRA) was established with its head office in Regina, Saskatchewan.

The PFRA greatly extended the activities that had been conducted by the federal government through its Department of Agriculture. These activities, largely conducted at its experimental farms in the prairie region (part of the Dominion Experimental Farms Service), included a panoply of scientific and technical work. For decades, this work had involved some soil surveys, crop improvement projects and experimentation, analysis of mechanical cultivation and harvesting techniques as well as soil and water conservation techniques (Gray, 1996). To this work would be added so-called cultural work: encouraging farmers to adopt new farming methods designed to counteract the negative effects of soil drifting and soil erosion as well as new methods to conserve surface water as well as a concerted effort to construct dugouts for stockwatering on thousands of prairie farms. In addition, the PFRA initiated a comprehensive soil survey at one-mile intervals throughout the Palliser Triangle (Balkwill, 2002).

The *Prairie Farm Rehabilitation Act* provided for the appointment of an expert advisory committee to recommend to the federal Minister of Agriculture the best methods to reclaim drought-stricken lands in the Palliser Triangle. To fight soil drifting, the PFRA established a series of District Experimental Sub-Stations in the Palliser Triangle. The method was simple: PFRA employees sought out successful farmers and paid them to allow their farming methods to be re-organized. The objective was to demonstrate to neighboring farmers how wind erosion could be prevented. These methods included strip farming – dividing fields into alternate narrow strips of crop and summer fallow at right angles to the prevailing wind – the planting of shelterbelts, and trash-cover fallowing.

Water shortages were addressed through the construction of small dams and dugouts for irrigation and stock-watering. PFRA engineers facilitated water projects through surveys, soil and hydrological studies, drainage design and air photo analysis. In addition, the PFRA offered a subsidy of three cents (soon raised to 4.5 cents) per cubic yard of earth moved in constructing a dugout, dam or irrigation project, to a maximum of $75 per dugout, $150 per stock-watering dam and $350 per irrigation project. By the end of the 1930s, the PFRA was involved in large-scale construction of storage dams and irrigation systems for entire communities. By 1945, the PFRA was responsible for an additional 300,000 acre-feet of stored water in the Palliser Triangle (Fowke and Britnell, 1962).

6. Conclusion

The social, economic and environmental impacts of the droughts of the 1920s and 1930s were very much a function of the almost uniform agrarian settlement of the Palliser Triangle without regard for the capacity of climate, soil and water to support crop production. The Dry Belt in particular has been prone to more frequent droughts, as evidenced in the paleoclimatic data for the region. Although water deficits occur in all regions of Canada, prolonged droughts in the Palliser Triangle have posed the most serious threats to the livelihood of the people living in this region. Only through major institutional adaptation have the people of the region been able to avoid widespread starvation and hardship on par with drought-stricken regions in poorer countries.

The harshest effects of the prolonged drought, from 1917-27 in the Alberta Dry Belt, and then the 1930s throughout the Palliser Triangle, were mitigated through relief payments as well as relocation and rehabilitation initiatives of new institutions, in particular, the Special Areas Board and the PFRA. Both of these institutions – the first established by the Government of Alberta and the second by the Government of Canada – remain among the most significant examples of permanent institutions generated in response to climate events. Their continued existence is a strong evidence of them being successful institutional adaptation measures. In the case of southeastern Alberta, the

Special Areas Board not only led the drive to convert the region into a more drought-resistant form of land tenure but also consolidated and then managed roads and social infrastructure to ensure their sustainability into the future (Marchildon, 2007).

In southern Alberta and Saskatchewan, the PFRA spearheaded the construction of dugouts on farms for stockwatering, the distribution of seedlings for shelterbelts to reduce the effect of wind erosion, the establishment of community pastures to reduce the pressure on farmers to develop quality forage on their own units, and small-scale irrigation projects, as well as larger projects where feasible (mainly in southwestern Alberta), all of which has contributed to environmental improvement, economic stability and diversification in the region (Gray, 1996).

The 2001 and 2002 drought would likely have been much worse without the lessons learned from the earlier droughts and the institutional adaptations of the 1930s. In particular, permanent changes in land tenure plus improved land and water conservation practices, plus tillage practices which minimize topsoil loss and maximize moisture retention have been major adaptation measures. Although wind erosion of soil still occurred during the 2001 and 2002 droughts (Wheaton *et al*., 2005), anecdotal evidence indicates that wind erosion was much less severe than in the dust bowl of the 1930s. One surprise is that the possible atmospheric causes of the drought of 2001-02 were different than those of other major droughts, including those of 1988, 1961 and possibly the 1930s. This finding indicates that more scientific research is required to enhance understanding of the causes of large-area droughts over North America (Bonsal and Wheaton, 2005).

There are numerous lessons for strengthening adaptation, thereby lowering vulnerability to prolonged drought, gained from this historical case study. One of the most important is the inherent weaknesses of municipal governments – at least in the Canadian case – in preparing for, as well as responding to, prolonged droughts. Municipalities in both southeastern Alberta in the 1920s, and in both southern Alberta and southern Saskatchewan during the 1930s, were crippled financially by the exigencies of prolonged drought. More importantly, the rural municipalities were simply too small and fiscally weak to have the human capital necessary to plan and prepare for droughts, a situation which continues to hold true. Only governments at the provincial and, most significantly, the national level, have the requisite critical mass of scientific and managerial expertise – much less the public mandate and the political legitimacy to act in the public interest – to plan and prepare for the prolonged droughts predicted by current climate change models.

Another lesson is the importance of scientific knowledge concerning soil and climate in determining the appropriate long-term, sustainable agricultural use of land. The original settlement of western Canada proceeded without this knowledge and the results, though successful in the very short term, were disastrous in the longer term. Fundamental changes in land tenure have been necessary and may continue to be necessary in the more vulnerable parts of the Palliser Triangle. Beginning in the second half of the 1930s, the PFRA conducted the first truly comprehensive soil survey of the Palliser Triangle, and the PFRA continues to study and monitor soil conditions throughout the region.

In the area of climate, however, much more is required of the federal government. In particular, there is a need to expand and enhance Canada's current drought and drought impact and adaptation monitoring capability. This will include research regarding the process of adaptation and the effectiveness of adaptation in reducing vulnerability to drought. This will allow better prediction of future possible adaptive strategies as illustrated in Figure 3. It should also include an improved understanding of the physical characteristics and processes influencing droughts in the Great Plains in order to generate better scenarios of future drought exposures. Bringing these two strands of research together will, hopefully, facilitate the type of institutional innovation required to help the residents of the Palliser Triangle adapt to the climate changes that are forecast for the 21st century.

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