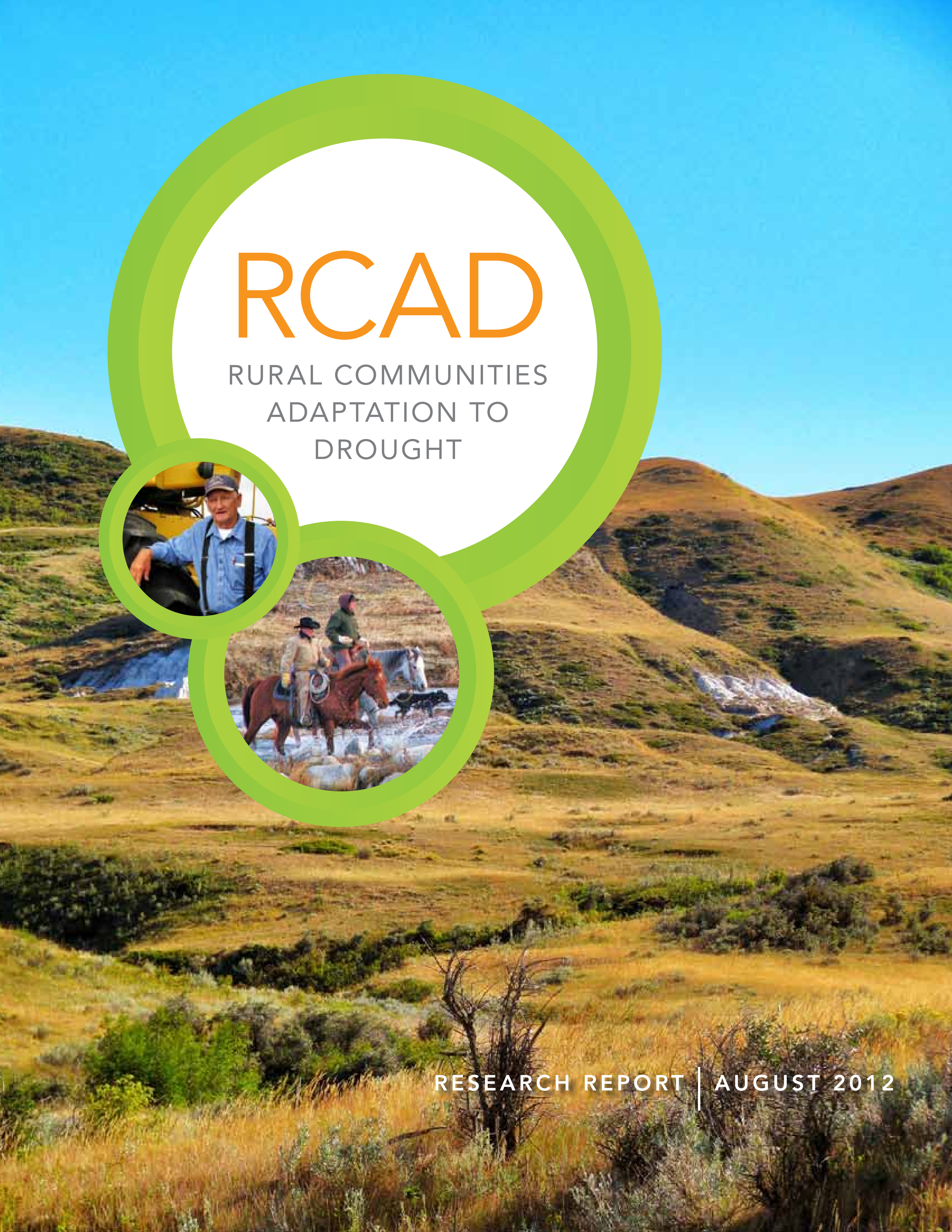

RCAD

RURAL COMMUNITIES ADAPTATION TO DROUGHT

RESEARCH REPORT | AUGUST 2012

ACKNOWLEDGEMENTS

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CONTENTS

Despite high levels of technical adaptation, human capital and vibrant social and information networks, agricultural producers in Saskatchewan's portion of the Palliser Triangle region remain highly vulnerable to severe droughts lasting more than two to three years.

Agricultural producers in the Saskatchewan portion of the Palliser Triangle region have made significant advances in production methods that have enhanced their capacity to withstand drought. The near universal adoption of minimum tillage practices is the most significant adaptation to occur since the severe droughts of the late 1980s. That adaptation served to improve resilience and somewhat mitigate the impacts of drought for many producers during the severe drought of 2001 and 2002 (relative to the experience in years such as 1988). Widespread soil erosion, for example, was less of a problem in 2001 and 2002 than it had been in 1988. Adaptations enhancing on-farm water management have also been made on many production units. Well and dugout construction have been underway for several decades. However, following the drought of 2001-2002 there has been an increase in the construction of pasture pipelines and regional pipelines. These pipelines enhance resilience related to the effects of drought on livestock watering and domestic water supplies for many farmsteads.

Despite high levels of technical adaptation, human capital and vibrant social and information networks, agricultural producers in Saskatchewan's portion of the Palliser Triangle region remain highly vulnerable to severe droughts lasting more than two to three years. Levels of vulnerability on individual production units are naturally related to each unit's access to natural capital. With that qualification in mind, the availability of economic capital stands as the most significant non-natural constraint to sustainability in the face of prolonged drought. Economic vulnerability results from the cost price squeeze whereby increasing input costs combined with low commodity prices restrict capital accumulation on the part of primary producers. Economic vulnerability is also affected by the limitations of the current set of senior government-supported farm risk management programs.

The resilience of rural-urban community water systems to prolonged drought varies considerably between communities. This is a function of significant differences in natural capital and existing infrastructure. Some communities are better located in relation to reliable quality water sources than others. Shaunavon, for example, is located over an aquifer that provides ample high-quality drinking water that requires minimal treatment. Gravelbourg, on the other hand, relies on a surface water source that is vulnerable to drought and requires more intensive treatment. Some communities have been able to overcome natural disadvantages by constructing ameliorating infrastructure systems. For instance, Kindersley and neighbouring communities have a pipeline to the South Saskatchewan River, which has allowed them to overcome quality and quantity problems associated with local surface and groundwater sources. The limited financial capacity of these communities restricts their ability to achieve greater water security.

The small irrigation projects in the southwest corner of the province remain vulnerable to the drought exposures they were putatively constructed to address. A combination of deteriorating natural capital, inadequate infrastructure and management issues contributes to the challenges facing these projects.

The findings of paleoclimate research and projections based on future climate change scenarios suggest that droughts could become more frequent, more severe and of longer duration in the Palliser Triangle region over the course of the 21st century. This is troubling, given the current resilience threshold of two to three years of back-to-back severe drought identified by the RCAD research. Without significant efforts to further enhance drought preparedness as well as the adaptive capacity of agricultural producers and the town and countryside communities they support, the long-term sustainability of the current social and economic character of the region is in doubt.

PART I: INTRODUCTION

ORGANIZATION OF THE REPORT

The introductory section of the report, Part I: Introduction, describes the RCAD project's objectives and the research methodologies we employed.

Part II: The Impacts of Drought in 2001-2002 provides an overview of the impacts of a severe multi-year drought (2001-2002) on agriculture on the Canadian Prairies.

Part III: Study Results summarizes the findings of this study of six communities. It includes a brief overview of the six study communities, and then applies the concepts of vulnerability, exposure/sensitivities, and adaptive capacity to the community field research data collected for the project. That data is in the form of 178 in-depth, transcribed and coded interviews.

In Part IV: Climate Change Scenarios for Southwest Saskatchewan, the report presents the finding of a study of paleoclimatic research describing streamflows for the southwest corner of Saskatchewan. The paleoclimatic data is supplemented by an assessment of future climate for the area based on the downscaling of future climate scenarios to the study area.

The final section of the report, Part V: Conclusions, synthesizes the research, highlighting areas of concern and suggesting approaches that policy-makers should consider in view of future climate predictions.

An Appendix that includes statistical tables is attached to the report, providing additional information on the demographic and economic context of the study communities. One table provides census data and a calculation based on census data for the proportion of area for each rural municipality (RM) that was employed for crop production as opposed to use for pasture, forage production and summerfallow in 2010. It also includes average prices paid for pasture and cultivated land in study area RMs over the 24-month period from February 2010 to February 2012. A second table provides average yield data for spring wheat and canola in the study area RMs over the 2001-2010 period.

PROJECT OBJECTIVES

The Rural Communities Adaptation to Drought (RCAD) project investigated the processes of adaptation that have enabled communities and agricultural producers to function in relatively dry and drought-prone regions of Saskatchewan. A key objective was to learn how residents of the study communities understand and apply these processes and how they contribute to their adaptive capacity. We were particularly interested in the ways people formulate their responses to current and forecasted drought risks and the impacts of drought on the supply and management of water resources in dryland environments. A complementary objective for the project was to estimate how the process of climate change may affect the climate of a major portion of the RCAD study area. We assume that studying adaptive processes and the levels of resilience resident in the study communities has the potential to shed some light on the ability of these communities to adapt to the more intense climate exposures predicted under selected climate change scenarios.

METHODOLOGY

The project objectives were addressed through an ethnographic study of six Saskatchewan rural communities and their surrounding agricultural areas at different stages of social and environmental vulnerability. Five of the study communities (Shaunavon, Maple Creek, Gravelbourg, Coronach and Kindersley) are located within the Palliser Triangle—noted for its long-term moisture deficit and recurrent exposure to extreme drought events (e.g., Marchildon, Pittman and Sauchyn, 2009). The sixth community, Maidstone, lies outside the Palliser Triangle region. It was selected to inform our understanding about whether or how the more frequent drought experience of the other five communities influences resilience.

Community selection criteria

Communities were selected for the RCAD study according to the following five criteria:

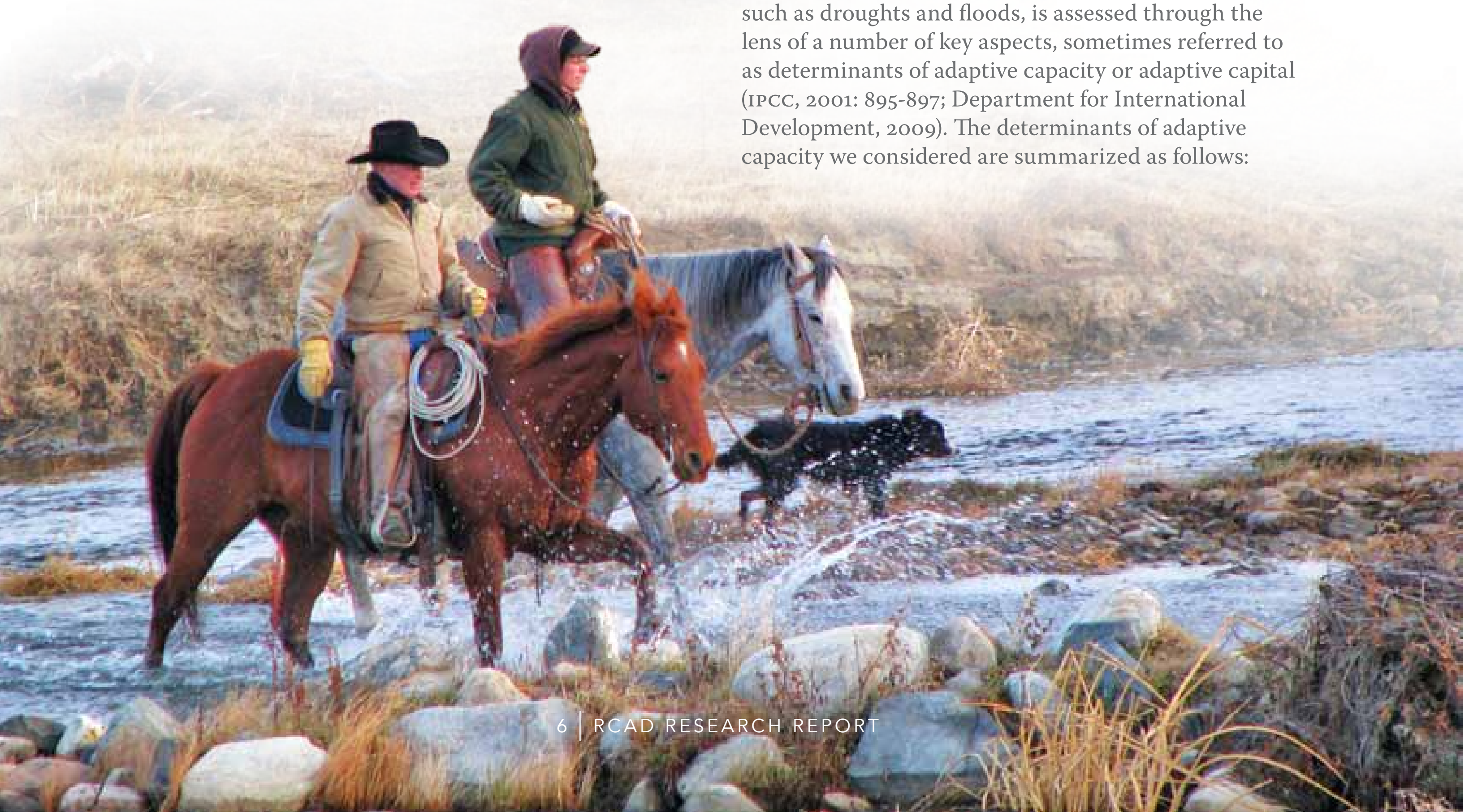
1. The communities all have a rural-urban or "town and countryside" character as defined by Lonechild and Williams (2008). These are communities that share aspects of what have historically been called agricultural market towns or farm service centres. They are communities that exhibit a strong interdependence between the urban community and its surrounding agricultural community. We selected towns (with populations greater than 1,000 but less than 5,000), as opposed to cities. Cities were excluded, in part, to ensure that a community's relationship with agriculture played a prominent role in its economic life. The assumption was that city economies could involve greater diversity in which the role of agriculture might be less prominent than it would be in a smaller town and countryside community.
2. We selected urban communities that were experiencing population growth or at least a relatively low rate of population decline, as opposed to the experience of many rural-urban communities that have had significant population loss over the past few decades (dying towns). The selected communities were among those that appear to have withstood the consolidation of the grain delivery and transportation system and the competition from big box retail and other services available in cities. The study focused on both the urban centres and their surrounding rural municipalities (RMs). The impacts of drought and related adaptations were examined from the perspectives of farmers and ranchers and the residents of the urban communities.
3. All the study communities experienced one or more years of severe drought involving a crop failure (as defined by Saskatchewan Crop Insurance) during the 1971-2010 period. Five of the communities are located in the Palliser Triangle, a region defined by annual moisture deficits where droughts occur more frequently than in other regions of the province. A sixth community is situated outside the Palliser Triangle and stands as a means to compare the adaptive capacity of regions where drought was more frequent to an area where drought was a somewhat novel experience.
4. The communities selected have different municipal water sources and delivery systems along with different water treatment challenges. This variety enabled the RCAD study to include examples of each of the municipal water systems commonly employed in the province (as characterized by the Saskatchewan Ministry of Environment). These

include: groundwater wells (GW); groundwater under the direct influence of surface water (GUDI); surface water sources (SW); water supplied by pipeline from non-local surface water source(s) (pipeline); water supplied by pipeline from non-local well(s) (pipeline); groundwater that may be under the influence of surface water (GUDI?); source water that requires significant treatment; and source water that requires minimal treatment.

5 One of the communities has an irrigation project that is not connected to the South Saskatchewan River system. We were interested in understanding the challenges faced by producers who rely on local-origin prairie streams for irrigation.

Drought has caused significant social and economic hardship on the Canadian Prairies and, prior to the advent of minimum tillage, did serious damage to soil resources through erosion.

In-depth interviews with a total of 178 residents of the six study communities constituted a major part of the research effort. Interview contacts were developed using a "snowball" selection process, whereby initial contacts were established with local public officials, mainly rural municipality (RM) and town administrators, or people with a wide range of contacts, such as elevator agents, who constituted central nodes of connection within local social networks. These initial contacts were asked to provide suggestions for prospective respondents with well-informed views, experience with successful adaptive strategies or novel approaches to drought-related issues. These contacts were in turn asked to provide suggestions for additional interview subjects and so on until we had conducted approximately 30 interviews per community. Interviews were conducted between June and September 2010 with agricultural producers, urban and rural municipal officials, business operators, and a variety of other people representing diverse occupational and institutional categories. The interviews were recorded and transcribed. Respondent comments were then categorized according to various research themes using NVIVO interview coding software and assessed by the members of the project research team.



Determinants of adaptive capacity

The interview data assessment employed the measures of adaptive capacity that have been identified in the academic literature and by international organizations such as the Intergovernmental Panel on Climate Change (IPCC). Adaptive capacity in response to climate hazards, such as droughts and floods, is assessed through the lens of a number of key aspects, sometimes referred to as determinants of adaptive capacity or adaptive capital (IPCC, 2001: 895-897; Department for International Development, 2009). The determinants of adaptive capacity we considered are summarized as follows:

1. the natural capital that is available to a community (e.g., is the impact of drought reduced because a river flowing through a dry region supplies needed water?);
2. the technological capital and infrastructure available in a community (e.g., is there a dam reservoir and irrigation system available to mitigate the impacts of drought and is the technical capacity required to maintain and operate these systems available in the community?);
3. the economic capital available in a community (e.g., does a community have the financial resources required to improve its water delivery system in response to drought? Do agricultural producers have the financial resources required to withstand a series of consecutive crop failures?);
4. social capital—the institutional capital operating in a community (e.g., are there well-organized institutions and institutional networks, including organizations such as irrigation associations, agricultural producer groups and government agencies, that assist communities in reducing their vulnerability to drought? Are there informal networks of support from neighbours and community groups that help people to deal with extreme climate exposures?). This determinant of adaptive capacity was considered to include aspects of human capital available in the communities (e.g., are there residents with technical expertise, the ability to innovate, with access to knowledge and knowledge networks?).

The RCAD project also investigated the potential for extreme climate exposures in the study area that exceed current resilience thresholds. This effort was facilitated by an examination of the paleoclimatic history of streamflows in a major portion of the study area and the downscaling of IPCC scenario-based regional climate change projections to the study area scale. Those projections consist of computer-generated climate models based on a number of scenarios developed by international climate scientists. Comparing the findings of the climate analysis with current levels of resilience (measured in terms of adaptive capacity) has the potential to inform study area residents, communities and policy-makers when anticipating a future where exposures are more extreme than those the communities have typically experienced.

The RCAD project includes a dissemination component that includes the production and distribution of this booklet to community stakeholders and policy practitioners and the publication of related papers in the academic literature. The information provided in this booklet can provide significant insights on the capacity of the communities to adapt to climate extremes and, in this way, constitutes a basis for discussion about the development of community adaptive strategies.

PART II: THE IMPACTS OF DROUGHT IN 2001–2002[1]

This section of the report provides a frame of reference for the biophysical and hydrological nature of drought and its economic impact on the prairies. Its focus is the drought of 2001-2002, the most recent example of widespread multi-year drought affecting prairie communities. The research in support of this section informed methodology for the RCAD study and our assessment of the research findings.

Drought has caused significant social and economic hardship on the Canadian Prairies and, prior to the advent of minimum tillage (min till), did serious damage to soil resources through erosion (i.e., soil drifting caused by wind). The RCAD project has relied on the economic and climatic assessment undertaken by Wheaton et al. (2008) of the drought of 2001-2002 to inform the methodology for both its ethnographic and climatic components. The drought of 2001-2002 was the most recent large-area, intense and prolonged drought in Canada. It was also Canada's most costly natural disaster in a century, resulting in a $5.8 billion drop in Canadian GDP and 41,000 lost jobs (Wheaton et al., 2008). It was also the first major drought to occur on the Canadian Prairies following the widespread adoption of minimum tillage practices and technology. This section provides an overview of the nature of this Canada-wide drought event, with emphasis on the Prairie Provinces. It includes a description of the impacts of the drought on agriculture and other sectors of the economy. This drought impacted Canadian society despite the adaptive measures that were previously undertaken. Some examples of these adaptations that were used to deal with the adverse impacts of the drought are also provided.

1 This section of the report was authored by Elaine Wheaton, Saskatchewan Research Council and Suren Kulshreshtha, Policy, Business and Economics, University of Saskatchewan.

The drought, which spanned as long as 1999-2005 in some regions, showed many unusual features, including: 1) an atmospheric and oceanic circulation that resulted in dry conditions stalling over the Prairies; 2) strong differences between wet and dry areas; and 3) a variety of feedback loops that resulted in socio-economic difficulties (Hanesiak et al., 2011). Causal factors were also different. Patterns of atmospheric circulation were markedly different from those of other severe prairie droughts in 1961 and 1988 (Bonsal and Wheaton, 2005). The drought of 2001-2002 was unusual by many standards, including area of coverage, severity, causes, and extent. It was one of the worst droughts in at least 100 years on the Prairies and other parts of Canada (Wheaton et al., 2008; Bonsal et al., 2011).

Characteristics of the Drought: initiation, migration, duration, intensity, area, locations, and demise

Droughts are known as "creeping" hazards, as they begin as a series of pleasant warm sunny days. The impacts of drought are not easily recognized at their onset or even during early stages unless carefully monitored. For the 2001-2002 drought, dry conditions actually began in 1999 in some locations, as drought expanded from the northern United States into southwestern Alberta. Very little precipitation fell during the winter of 2000-2001, especially in Alberta and western Saskatchewan. May to June 2001 continued dry and that point is considered to be the onset of the drought, with dryness spreading to large parts of Canada, but focused on southern Alberta and agricultural Saskatchewan. During the summer of 2002, record dry conditions covered most of southern Canada. Expansion of dry conditions occurred rapidly and more than 50% of the agricultural prairies was under severe drought by September 2001. The accompanying above normal temperatures increased the severity of the drought because of higher evapotranspiration. Extreme storms are not unusual during periods of droughts, as strange as that may seem. Heavy rainfall fell over the southwestern prairies in June of 2002, but it was almost too late for agricultural purposes. The severe drought area expanded northward and eastward and peaked in January 2002, afflicting most of the agricultural area of Alberta and Saskatchewan (Wheaton et al., 2008; Bonsal et al., 2011).

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During 2003, the drought continued its slow retreat, although some pronounced pockets of severe drought were still evident over northern Alberta and Manitoba and extreme west-central Alberta and Saskatchewan. In 2004, a meteorological drought index showed that drought conditions remained only over northern Alberta and, to a lesser extent, northern Manitoba; however, agricultural and hydrologic drought (as indicated by the Palmer Drought Severity Index) persisted over much of Alberta. By 2005, drought indices showed a switch to widespread, wet conditions over most of the prairies (Bonsal et al., 2011).

Various lines of evidence showed that this drought was very significant on both continental and century-length scales. New lessons from this work for drought monitoring, awareness and adaptation preparation include the following findings: 1) drought areas in the northern United States should be carefully watched as they can move into Canada; 2) drought may peak in the winter and persist into the growing season; and 3) major droughts can have different sets of causes, and perhaps changing causes.

Impacts on Agriculture

This major drought was a very strong reminder of the crucial importance of water and the immense challenges of water scarcity. The dry conditions were especially hard on both crop and livestock production (Wheaton, Kulshreshtha and Wittrock, 2010). Large areas of Alberta and Saskatchewan reported record low crop production in 2001 and 2002 compared with a 25-year averaging period. Alberta crop producers lost an estimated $413 million in 2001 and $1.33 billion in 2002. Estimated losses of crop production in Saskatchewan were $925 million in 2001 and $1.49 billion in 2002. Within Canada, Saskatchewan was the most affected province in 2001, with 48% of the Canadian drought-induced losses to agricultural production. Both Saskatchewan and Alberta shared the highest 2002 Canadian agricultural production losses, with each having about 45% of the Canadian total (Kulshreshtha, 2005).

Grass growth was poor over most of the prairies between spring and fall of 2001, with May and June 2002 being the worst months. This was a massive blow to the cattle industry, as this period is a very important time for grazing and provision of drinking water supplies. Only a narrow portion of southeastern Saskatchewan escaped the poor growth conditions. Facing forage shortages, many producers sold portions of their herds. Alberta's cattle herd reduction in 2001 and 2002 produced the lowest cattle numbers for the period since 1997 (Wheaton et al., 2008).

Cattle producers felt negligible economic impacts in 2001, as some sold cattle early in anticipation of the drought persistence. This action produced an oversupply of cull animals in the marketplace and reduced cattle prices during the last quarter of 2001, with the trend continuing well into 2002. The resulting impact peaked in 2002, with a significant estimated loss to producers of $143.4 million, about half in Alberta (Kulshreshtha and Marleau, 2005). These adaptive measures suggested serious negative impacts over future periods. However, the discovery of a cow in Alberta infected with bovine spongiform encephalopathy (BSE) in the summer of 2003 caused an even greater collapse in cattle prices. Ironically, producers who sold cull cows at drought-induced lower prices in 2001 and 2002 typically received more than producers selling cull cows after BSE between 2003 and 2007.

Many other agricultural and environmental problems seem to accompany drought. These included proliferation of some insect pests, such as grasshoppers, as well as weeds, poor water quality, and soil erosion by wind. These were also costly and disruptive to agriculture and exacerbated the direct impacts of the drought.

Producers were not the only ones affected, as many industries have strong ties with agriculture. For example, farm input suppliers had lower demand for their products, and food processors experienced local shortages of raw material. Recreational activities, particularly water-based recreation, were severely curtailed. Manitoba Hydro was impacted as well, since due to water shortage the same amount of hydroelectric power could not be generated. The economic impacts of the 2001 to 2002 drought were felt throughout the entire Canadian economy (Kulshreshtha and Guenther, 2005).

Adaptations

Many types of adaptations to drought were employed by producers, ranging from standard to innovative methods (Wittrock, Kulshreshtha and Wheaton, 2011; Diaz et al., 2009; Pittman et al., 2011)). An increased reliance on irrigation was a primary and important adaptation, but one that came with higher energy, labour and, sometimes, infrastructure costs. Other types of adaptations included reductions in inputs, such as fertilizer, herbicide applications, and fuel, and use of extension information (Wheaton et al., 2008).

Wittrock and Wheaton (2007) assessed characteristics of the adaptation process to the 2001-2002 drought using methods such as media reviews. They found that the main issues of concern for agricultural impacts, and therefore adaptation, were crops, livestock and access to water. Subtopics in these categories included technological developments, government and community programs, farm production practices, and farm financial management. Barriers to adaptation documented included lack of knowledge of water supplies and water use, lack of funds, lack of research, and difficulty in making changes. Recommended options were compared with actual adaptation and several differences were noted, including innovative options, such as types of community support.

Several adaptation options were practiced by livestock producers, including transporting hay from moister areas to areas where drought had reduced forage production, using novel types of feed (e.g., pea and lentil straw), using available public and private lands as well as crop lands, and use of community pastures. Coping was very challenging, and when so much crop, grazing and hay land is affected so intensely for such an extended period, limits to adaptation were reached and suffering resulted (Wheaton et al., 2008).

Various government responses and safety nets partially offset the negative economic and social impacts of the 2001-2002 drought. These included Crop Insurance, the Rural Water Development Program, the Net Income Stabilization Account, the Canadian Farm Income Program, and the Livestock Tax Deferral Program. However, the wide coverage, intensity and severity of the drought resulted in immense losses of many types that were difficult to surmount (Wittrock and Koshida, 2005).

Conclusion

In the history of Canadian agriculture, the drought of 2001-2002 would be recalled as a unique natural disaster. Not only was it the most costly natural disaster, but also it covered most Canadian provinces. Impacts on agriculture were severe. In the province of Saskatchewan, for the first time since 1940, the net cash income dipped down to a negative value. Both crop and livestock producers were affected in spite of all the adaptive measures undertaken. However, due to the long period of impact, even such measures were limited and resulted in loss of economic activity and employment, not only in agriculture, but also in related sectors. The economic health of rural areas was devastated, but residents of even large communities were affected. Irrigation provided the most reduction of adverse impacts of the drought.

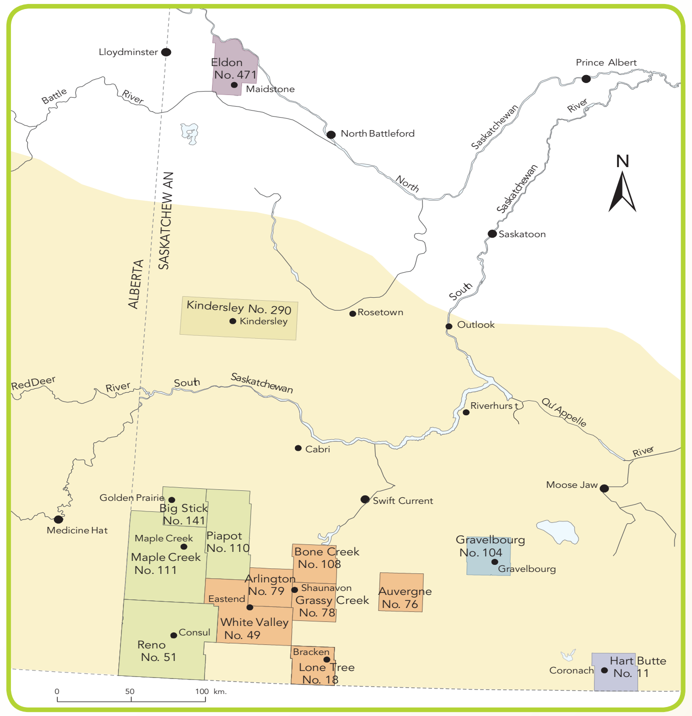
PART III: STUDY RESULTS[1]

COMMUNITY OVERVIEWS

Maple Creek Study Area

The Maple Creek study area includes the town of Maple Creek and a number of surrounding rural municipalities that encompass the southwest corner of Saskatchewan. This is predominantly a ranching area that includes large tracts of native and domestic forage pastures. The producers engaged in dryland farming typically experience crop yields below the provincial average. There are four Hutterian Brethren Colonies in the area that practice large-scale mixed farming. Less than 2% of the area's farmland is irrigated.

The town of Maple Creek is an agricultural service centre. It benefits from being a Viterra grain delivery point and has an active livestock auction market. The town also provides services to the oil and gas industry. There is a small federal correctional facility located on the First Nation Reserve southeast of Maple Creek. The Cypress Hills Interprovincial Park and Fort Walsh National Historic Site attract over 250,000 visitors annually. Agriculture and Agri-Food Canada has a regional Agri-Environment Services Branch, formerly known as Prairie Farm Rehabilitation Administration (PFRA) office, that supports irrigation projects and federal community pastures in the study area.



Map 1. Locations of Study Areas

Maple Creek Study Area · Gravelbourg Study Area · Kindersley Study Area · Shaunavon Study Area · Coronach Study Area · Maidstone Study Area · The Palliser Triangle interpreted from Palliser's 1860 Report.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Maple Creek	2,270	2,198	$68,684,325	GUDI?	FSC, OGSC, Rec, Ret., Trans., H., K12
RM of Maple Creek #111	1,156 HC 4 FN 1	1,167 HC 4 FN 1	$125,733,550	PFRA Irrigation	Ranch, Farm, OG, Rec.
RM of Piapot #110	424	392	$95,234,725		Ranch, Farm, OG
RM of Big Stick #141		182	$169,109,340		Ranch, OG, Farm
RM of Reno #51	457	462	$94,553,046	PFRA Irrigation	Ranch, Farm, OG

1 This section of the report was largely drafted by the graduate student researchers who conducted the field research for the RCAD project: Jim Warren, PhD candidate, University of Regina; Saima Abasi, Master's candidate, University of Saskatchewan; and Fanny Luk, Master's candidate, University of Waterloo.

Shaunavon Study Area

Dryland farming followed by ranching are the dominant economic activities in the Shaunavon study area, which includes the town of Shaunavon and surrounding rural municipalities. The predominantly agricultural economy has recently been supplemented by a surge in oil and gas exploration activity. The current energy boom follows a lull in activity that followed an earlier period of exploration and development activity in the 1970s.

Currently, the town of Shaunavon serves as a service centre for both the agriculture and energy industries. Shaunavon, like the other study communities, is home to a significant number of retired farmers. The town lost its status as a delivery point for mainline grain companies during the grain transportation and railway rationalization process of the 1980s and 1990s. Nonetheless, the community continues to play a role in grain transportation by serving as headquarters for the Great Western Railway, a private company owned primarily by local area shareholders.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Shaunavon	1,775	1,691	$36,947,070	GW	FSC, OGSC, Ret, Trans. H., K12
RM of Grassy Creek #78	401	305	$35,560,775		Farm, OG
RM of Arlington #79	371 HC 1	413 HC 1	$75,213,017		Farm, Ranch, OG
RM of Bone Creek #108	377	321	$72,490,945		Farm, OG
RM of Auvergne #76	355	329 HC 1	$32,986,390		Farm, Ranch
RM of White Valley #49	570	518 HC 1	$79,502,348	PFRA Irrigation	Farm, Ranch, OG
RM of Lone Tree #18	190	150	$21,276,775		Farm, Ranch

KEY FOR TABLES IN THIS SECTION

Sources

Municipal population data are from the Census of Canada for 2001 and 2006. Municipal assessment information: Saskatchewan Ministry of Municipal Affairs, Municipal Directory. Economic and public services characteristics are based on RCAD interview data.

Population

HC = the number of Hutterian Brethren colonies in the municipality

FN = the number of First Nations reserves in the municipality

Public water

Includes municipal, provincial or federal owned-and-operated water infrastructure as well as community-based cooperatives and user associations.

GW = a public potable water delivery system reliant on groundwater wells
GUDI = a public water delivery system reliant on groundwater wells that are under the direct influence of surface water
GUDI? = a public water delivery system reliant on groundwater that may be under the influence of surface water
PFRA Irrigation = irrigation projects in which the major supply infrastructure is owned and operated by the federal Ministry of Agriculture but the land under irrigation is owned by individual ranchers and farmers. *(Note: Agriculture and Agri-Food Canada's Prairie Farm Rehabilitation Administration, known as PFRA, was created and established by the Government of Canada in 1935 to help the Prairie provinces and the agricultural sector adapt to climate-induced water stress by addressing soil and water conservation issues and seeking sustainable agricultural practices for the region. PFRA was transformed into the Agri-Environment Services Branch (AESB) in 2009 to fulfill a national agri-environmental mandate within the federal Ministry of Agriculture and Agri-Food Canada)*
RMP = Regional municipal pipeline supplying two or more urban municipalities and farmsteads

Economy

A rough estimate of the major economic activities in an urban or rural municipality.

FSC = Farm and Ranch Service Centre
Farm = annual field crop agriculture (including mixed farming)
Ranch = cow-calf and grasser production
OGSC = oil and gas industry service centre
OG = oil and natural gas wells that generate tax and surface rights revenue
Mining = mineral resource extraction other than oil and gas
Trans. = important transportation infrastructure, including grain delivery points or the headquarters of a shortline railway
MFG = manufacturing, including electrical power, value-added agricultural production and shortline equipment manufacturing
Rec. = recreation and tourism (e.g., National Parks, Provincial Parks, tourist attractions and facilities)
H= Hospital
K12 = K-12 educational facilities
Ret. = the community is supported by a population of retirees, many formerly involved in agriculture

Coronach Study Area

The Coronach study area includes the town of Coronach and the Rural Municipality of Hart Butte. The main economic drivers for the town are Sherritt Coal's Poplar River Mine and the associated SaskPower electrical generation plant. The SaskPower plant produces power for approximately one-third of the province. The mine and the power plant together employ around 300 individuals, which is more than one-third of the town's population.

Dryland annual field crop production is the dominant form of agriculture practices in the RM of Hart Butte followed by mixed farming and cow-calf ranching. A small tourism industry has developed in association with the area's history and badlands geography.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Coronach	822	770	$12,579,485	Wells and dewatering line/wells from SaskPower	FSC, Trans., Ret., Rec., H, K12
RM of Hart Butte #11	311	272	$101,596,395	Wells and dewatering line/wells from SaskPower	Farm, Ranch, MFG, Mining

Gravelbourg Study Area

The Gravelbourg study area includes the town of Gravelbourg and the Rural Municipality of Gravelbourg #104. The town has more than 100 businesses and serves as a regional service centre for the surrounding dryland farming community. Agriculture in the area is dominated by cereal grains and pulse crops. There is a regional AAFC-AESB (PFRA) office located in Gravelbourg that supervises community pastures in the area and provides extension information services to producers.

The town has a manufacturing base that includes Trailtech, an equipment manufacturer, and Mustard Capital Inc., which employ more than 150 individuals.

The community has a number of tourist attractions associated with its status as an historical centre for French culture and the Roman Catholic Church in Western Canada.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Gravelbourg	1,187	1,089	$21,243,184	Surface water	FSC, Trans, MFG, Ret., Rec., H, K12
RM of Gravelbourg #104	409	329	$38,846,519	Some farms on pipeline	Farm, MFG

Kindersley Study Area

The Kindersley study area includes the town of Kindersley and the Rural Municipality of Kindersley #290. Kindersley is the trading hub for a dryland agricultural region with a population of approximately 40,000. Natural gas and oil deposits in the Kindersley area support an active resource extraction industry, making oil and gas along with agriculture the main drivers of the local economy. With a population of 4,412, Kindersley constitutes the largest community studied by the RCAD project.

A lack of groundwater supplies of acceptable quality in the area prompted the construction of a regional pipeline system that conveys water from the South Saskatchewan River to Kindersley and other neighbouring communities and farmsteads.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Kindersley	4,548	4,412	$204,339,180	Regional pipeline system	FSC, OGSC, Trans., Ret., H, K12
RM of Kindersley #290	1,138 HC 1	1,042 HC 1	$195,736,145	Some farms on pipeline	Farm, Ranch, OG

Maidstone Study Area

The Maidstone study area includes the town of Maidstone and the surrounding Rural Municipality of Eldon #471. Maidstone's business sector is dominated by accommodation and food service businesses. Maidstone's status as a farm service centre relates primarily to public services such as the school and a hospital as opposed to supply and repair services. The community also serves as a bedroom community for oil and gas industry workers employed both locally and in communities as distant as Lloydminster. The RM of Eldon is considerably smaller in terms of area than some municipalities in the southwest of the province; nonetheless, due to the high level of energy sector activity, it has the highest assessment of any of the communities studied by the project.

Municipality	Pop. 2001	Pop. 2006	Municipal assessment	Public water	Economy and public services
Town of Maidstone	995	1,037	$38,766,290	GW pipeline from Waseca	FSC, OGSC, Ret., H, K12
RM of Eldon #471	776	750	$335,026,976		Farm, OG

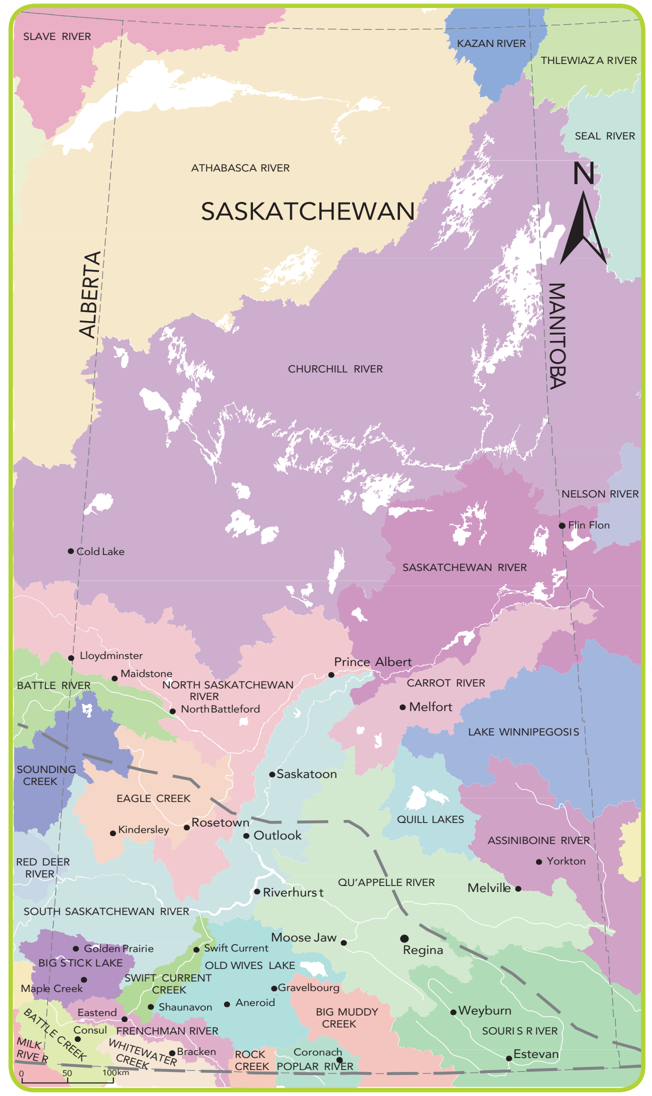
Note: additional statistical information is provided in the Appendix to the report.

COMMUNITY VULNERABILITY
—EXPOSURES AND SENSITIVITY

Primary agriculture is highly dependent on weather conditions, more so than other industries such as oil and gas or manufacturing.

Not surprisingly, agricultural communities are vulnerable to extreme climate events. A community's level of vulnerability to climate hazards is dependent on the characteristics of the climate and weather events it is exposed to and its sensitivity to those exposures (Smit and Wandel, 2006; Wisner et al., 2004). For example, the economic impacts of drought can vary depending on how significantly crop production is affected. A mild drought might reduce yields modestly, whereas a more severe drought could produce a total crop failure. Thus, the resilience, or coping capacity, of an individual agricultural producer or a community in the face of drought depends on the severity of the drought and the strength of other factors such as price levels and the adaptive assets described above in Part I. In other words, communities and individuals can have different thresholds of drought tolerance influenced by their levels of adaptive capital and the severity of the exposures experienced. Sensitivity described in this way relates to the negative impacts of changing weather and climate. It is also important to consider beneficial sensitivities. For example, the value of irrigated crop production can be enhanced when nearby areas or global competitors are exposed to drought.

While residents of rural-urban communities are often not involved in primary agriculture, their livelihoods are often dependent on providing services to agriculture. Hence the negative impacts of drought on crop yields and grazing conditions are felt by local businesses and can affect employment. For example, drought in 2001 reduced the amount of grain handled at the Viterra elevator in Maple Creek by over 50% and resulted in the hiring of fewer part-time employees during the typically busier harvest and post-harvest seasons.



— — The Palliser Triangle interpreted from Palliser's 1860 Report.

Map 2. Major Saskatchewan Watersheds

Notable exposure events

As noted earlier in this report, the drought of 2001-2002 was notable for Canada as a whole. It was also memorable on the Prairies because regions outside the Palliser Triangle that do not typically experience severe drought were impacted. The Maidstone study area is such a neighbourhood. The drought experienced in 2002 was the most severe that our respondents from the Maidstone area had experienced in their farming careers. That said, for RCAD respondents who operate in areas where drought is more frequent, 2001-2002 was not always considered the benchmark for severity. Many respondents viewed 1988 as the driest year of their farming careers. It is noteworthy that between the drought of 1988 and the drought of 2001-2002 most of our farmer respondents adopted minimum tillage technologies. Our respondents credited minimum tillage for the lower levels of wind erosion on their fields in 2001 and 2002 compared to the soil drifting they experienced in 1988.

Maple Creek and Shaunavon Study Areas

Exposure to climate hazards varies across the Maple Creek and Shaunavon study areas due to significant variations in the distribution of natural capital. For example, some agricultural producers in the area have access to irrigation systems supplied by streams originating in the Cypress Hills. While these systems are not entirely reliable, they do enhance drought tolerance for those with access to the water. Interregional variation in natural capital is reflected in the fact that this study area overlaps three different watersheds. There is an internal drainage basin to the north of the Cypress Hills. The area south of the Hills is within the Milk River watershed and the area to the east is in the South Saskatchewan River basin.

Our respondents maintained that exposures such as early or late frosts and low levels of precipitation are influenced by the effects of elevation on weather patterns. This area has the most significant differences in elevation of any region in Saskatchewan. Ranchers and farmers in the Cypress Hills operate at elevations from 3,200 to 3,500 ft. The surrounding prairie to the north averages less than 2,500 ft., while to the south and east of the Cypress Hills people farm at elevations up to 3,000 ft. While the entire area might be considered relatively dry, even for the Palliser Triangle, some areas are much drier than others (e.g., much of RM #51 experiences drier conditions on average than is the case in RM #108 north of Shaunavon).

Respondents in the Shaunavon area reported spring wheat yields on stubble from around 18 to 30 bushels per acre over the past 10 years (an average of 27), which is lower than the average yields reported in the Maidstone area, which lies outside the Palliser Triangle, of over 35 bushels per acre. Spring wheat yields in RMs #51 and #11, on the other hand, were as low as 10 and 5 bushels per acre respectively in the drought year of 2001. The 10-year average for these two southwestern RMs is approximately 22.5 bushels per acre (see the Appendix for additional yield data). Average yields in this study area are generally lower than yields in moister regions; exceptionally dry years occur with greater frequency in the Palliser Triangle region. For example, while many respondents from the Maple Creek/Shaunavon study area reported experiencing a minimum of two and as many as five years of significantly reduced yields (25% or more below normal) due to drought during their farming careers, respondents currently farming in the Maidstone study area had experienced just one. Similar to the situation with surface water, groundwater resources are not evenly distributed across the study area. The town of Maple Creek and ranchers in the Cypress Hills have been able to take advantage of relatively reliable spring water sources. The town of Shaunavon has a reliable supply of high quality water supplied by relatively shallow wells. The aquifer supplying the town's wells has provided a steady supply for almost 100 years, which included

Higher elevations in the Cypress Hills can contribute to higher levels of precipitation than are received on the surrounding plains.

For farmers who are already experiencing tough financial times, a moderate drought of one to two years may put them out of business.

numerous drought events. On the other hand, many agricultural producers have had to contend with less reliable water sources, including dugouts and streams subject to drying up during drought years or the necessity to drill deep-water wells that do not always provide water of adequate quality.

The farmer and rancher respondents from the Maple Creek/Shaunavon study area were almost unanimous in estimating that all other things being equal, three consecutive years of drought severe enough to produce total or near total crop failures would force many producers to exit agriculture. The exhaustion of financial resources following two to three years of minimal production was the major factor they saw as limiting their capacity to cope. They assumed they would simply not have the cash or financing required to operate after two to three years in which they generated little or no farm or ranch income. Some ranchers estimated they could survive more than three years of drought. As one rancher put it, “I believe we could last for four or five years, but that assumes we could find really good off-farm jobs.”

Coronach Study Area

Primary agricultural production in the Coronach area is sensitive to climate hazards of which drought is the problem most frequently encountered. Drought conditions in the late 1980s are thought by our respondents to have been the most severe in recent memory. The area is within the Palliser Triangle but somewhat less dry on average than some areas further to the west and northwest. The variation in climate within the Palliser Triangle region is suggested by the relatively lower impact of drought conditions in the Coronach area in 2001. By way of comparison, the negative impacts of that drought were felt much more strongly in the Maple Creek and Kindersley study areas. Agricultural producers, the town of Coronach and the area’s largest non-agricultural industry, coal-fired power generation, all rely on both surface water and groundwater. However, surface water supplies have been declining following a succession of low runoff years.

The Coronach study area is in the Poplar River watershed, which is a northern extremity of the Missouri River Basin. Surface water resources in the area include small streams and associated reservoirs. The source water for these streams is locally and regionally generated, unlike a source such as the South Saskatchewan River (SSR), which transports water generated in the Rocky Mountains to prairie regions hundreds of kilometres away. Therefore, source water is more greatly impacted by drought in this region than it is for communities supplied by the SSR.

The demand for surface water and groundwater has occasionally produced supply challenges. For example, the original source of cooling water for the SaskPower electrical generating station in the late 1970s was a stream-fed reservoir along with water supplied through the dewatering of local strip mine sites that supply the power station’s coal. In association with drier climate conditions, reservoir levels have been low in recent years, which has at times required the use of supplemental groundwater. The increased demand for local groundwater resources has had supply implications for the town of Coronach, area farmers and ranchers, and the power station. Wells supplying the town are relatively shallow for the region. Given the effects of increased exploitation of groundwater sources on some area wells, this suggests the possibility that protracted drought and extraction by the power plant could negatively impact the sustainability of the town’s water supplies. Severe drought lasting two or more years has implications for electrical power production, water supplies for the town and for the water requirements of farmers and ranchers.

Similar to findings from the Maple Creek and Shaunavon study areas, producers from the Coronach district claimed that their tolerance threshold for severe consecutive droughts would likely range from two to three years. As producers are faced with poor grass growth in pastures and depleted dugouts during dry years, they may have to buy feed or reduce their herd size. For farmers who are already experiencing tough financial times, a moderate drought of one to two years may put them out of business.

Gravelbourg Study Area

The Gravelbourg study area is located within the Old Wives Lake watershed. The watershed is internally drained—surface water mainly leaves the system through evaporation and groundwater infiltration. Surface water resources are limited because the area typically experiences large annual moisture deficits. Precipitation does not always contribute to streamflow because of high evapotranspiration and poorly developed natural drainage systems. Runoff from winter snowmelt constitutes the major contribution to streamflows. Thomson Lake, a reservoir supplied by the Wood River, is the sole source of water for the town of Gravelbourg.

The concentration of minerals in local stream water, possibly due to groundwater discharge into streams, has been exacerbated by low runoff levels over recent years. The effects of reduced runoff and eutrophication on water quality in Thomson Lake have placed Gravelbourg somewhat outside the tolerance threshold for water quality established by federal and provincial authorities. The Town has obtained permission from the Saskatchewan Ministry of Environment to deliver water that does not meet some regulatory standards with the provision that it work with the provincial Crown water utility, SaskWater, to develop a treatment solution. Some solutions proposed to date have been viewed as prohibitively expensive from the perspective of local ratepayers. Protracted severe drought conditions are expected to exacerbate the degree to which the town’s water fails to comply with regulatory thresholds. While town residents have not been especially concerned about water supply shortages in the past, it is reasonable to suspect that a series of severe droughts could threaten water levels in Thomson Lake.

Dryland grain farming is the dominant agricultural production model in this area. As a result, crop yields are highly sensitive to changes in precipitation. That said, timely rains can translate into respectable crop yields even in years when overall annual precipitation is below average. Rain that occurs after seeding and prior to anthesis (flowering), for example, can result in an average crop even though the rest of the year is much drier than normal. Given the general shortage of reliable surface water sources in the area, wells are the most common source of domestic water supplies for area farmers. Area residents describe a trade-off whereby shallow, relatively inexpensive wells produce higher quality water but are subject to failure due to drought. Deeper wells, on the other hand, may provide a more reliable supply, but the quality is frequently poor due to high mineral concentration.

One of the major crops grown in this area is mustard, which requires relatively moist soil conditions. An increasing amount of mustard is being produced in this region in response to the operations of a local processing facility. This increases the sensitivity of producers to agricultural drought. Hot and dry conditions during the flowering period of mustard cause moisture stress and, eventually, lower yields. Moreover, drought not only affects the quantity, but also the quality of the mustard seed. This puts the agricultural sector in this region in a more vulnerable position compared with other sectors in terms of agricultural drought.

Producers are familiar with recurring droughts and estimated that they can withstand two to three years of consecutive drought. Some producers explained that, in the first year, the crops would take up the moisture and nutrients that are available from last year, producing an average or below average crop. For the next spring, the crops would start off totally dry and, if they do not get any moisture during the growing season, there will be a major crop failure. Therefore, most producers' degree of vulnerability will increase after two years of drought in the absence of significant government support. A few producers admitted that they have been living on the edge following years of low commodity prices; therefore, they could withstand only a single year of drought. They are at the breaking point and if their financial situation does not improve they will have to quit farming.

Kindersley Study Area

Dryland annual field crop production is the dominant agricultural model in the Rural Municipality of Kindersley. Producers in the Kindersley area experienced two consecutive years of severe drought in 2001 and 2002, followed by a third year of well below average yields in 2003. While spring wheat and canola yields were above the 10-year average in 2008 and 2009, dry weather was having an impact on pasture and forage production. Livestock producers in the area were eligible for payments under a federal provincial Pasture Recovery program in 2010 in response to dry conditions in 2008 and 2009. This situation demonstrates that different production models have different weather vulnerabilities. Adequate rain in the post-seeding to flowering period may suffice to produce a dryland grain crop. However, a lack of rain over other periods of the year can negatively impact grass and forage production.

Respondents from this area reported on a secondary problem that accompanies drought, namely grasshopper infestations. They described how dry soil conditions and warm weather are ideal conditions for grasshopper reproduction. Thus, drought-induced yield losses were further reduced by hordes of hungry grasshoppers. Similarly, respondents in the Maple Creek area reported that they experienced a boom in Richardson's ground squirrel populations in conjunction with especially dry years—although there was no consensus as to whether there was a causal relationship.

Taken together, these events make the Kindersley study area the region most adversely impacted by climate hazards over the past decade among the various areas we studied—with the exception of a five-year drought pocket (2004-2009) in the Ponteix region north and east of Shaunavon.

Based on the consensus among producers from the other study areas within the Palliser Triangle, farmers in the Kindersley area have been pushing the limits of resilience available for dealing with drought. The impact of the cascade of exposures on farm operations has been mitigated for some producers by opportunities of employment and surface rights income resulting from oil and gas industry activity in the area.

The rural municipality and town of Kindersley are located within the South Saskatchewan River Basin. However, the study area has few significant natural surface water bodies. A pipeline from the South Saskatchewan River provides the town and other communities and farmsteads along its route with relatively secure water supplies.

Maidstone Study Area

The Maidstone study area lies beyond the conventional boundaries of the Palliser Triangle dry belt. Agriculture in the study area is dominated by dryland annual field crop agriculture followed by a minority of producers who ranch or mixed farm. Maidstone and the neighbouring Rural Municipality of Eldon lie within the North Saskatchewan River watershed. Despite the relative proximity of the North Saskatchewan and Battle rivers to the study area, irrigation activity is virtually non-existent. This speaks to the relative consistency of rainfall in the area. Respectably high crop yields can generally be achieved by employing dryland methods. Because of productive soils and relatively high average rainfalls, the producers we interviewed had never had a crop failure due to drought except in 2002. Many respondents identified 2002 as the worst year of their farming careers. In 2002, a smaller winter snowpack and virtually no spring and early summer rains resulted in crop failures. According to one respondent, "I had never seen it this bad. My dad is 90; he said it's worse than the '30s because in the '30s they had lots of snow in the winter, and it filled the potholes. There were no potholes anymore, anywhere during 2002."

That said, the minority of respondents who summer-fallow reported that, even in 2002, some summerfallow canola crops yielded 25-30 bushels per acre—although stubble crops could be total failures. Livestock producers were similarly stressed due to poor pasture growth and the loss of surface water sources for stock watering.

Hail damage along with a late spring and early frosts were the most significant long-term climate-related concerns for the area's farming community. Many farmers mentioned their crops were completely wiped out due to hail in 2005. During the study period (August 2010), there was excessive moisture due to heavy rains in the area.

Despite being located in an area where drought is infrequent, the town of Maidstone's water supply proved susceptible to drought in 2002. Water levels in Maidstone Lake, the traditional source of supply for the community located 8.2 km to the south, became low enough in 2002 to produce undesirable mineral concentrations. This fact in combination with problems related to the age and composition of the existing pipeline infrastructure prompted the town to construct two new wells close to the nearby village of Waseca, along with a new pipeline to supplement the supply from Maidstone Lake.

A few producers admitted that they have been living on the edge following years of low commodity prices.... They are at the breaking point and if their financial situation does not improve they will have to quit farming.

ADAPTIVE CAPACITY OF COMMUNITIES

In the interest of brevity and avoiding repetition we have grouped certain study areas in the assessments that follow. By virtue of relatively similar circumstances, the Maple Creek and Shaunavon study areas are handled in one section, as are the Gravelbourg and Coronach areas. Kindersley and Maidstone are treated separately given their relatively unique situations. Maidstone is located outside the boundaries of the Palliser Triangle, and Kindersley experienced more severe droughts than the other areas in the decade prior to the study.

Readers should note that many of the issues relating to adaptive capacity are common across all of the study areas. These include the adoption of min till technology (i.e., minimum tillage, or cropping practices that reduce tillage and minimize soil disturbance to reduce risk of soil loss by wind erosion) and frustration with certain government-supported risk management programs. It would be beneficial for readers interested in a particular study area to read all of the summaries, as certain features covered under the heading for one set of communities often apply to others.

Maple Creek and Shaunavon Study Areas

Natural Capital

Natural assets are not distributed equally across the Maple Creek and Shaunavon study areas. A major influence is the widely varying elevations associated with the Cypress Hills. Elevation influences weather patterns, especially precipitation amounts. The higher elevations enjoy higher precipitation than the surrounding plains. Respondents often attributed rainfall shadows and areas of higher precipitation on the plains to the blocking effect of the hills and elevation.

Ranchers in the Cypress Hills reported greater access to springs and creeks for livestock watering than those at lower elevations. As one rancher respondent stated, “We’ve been lucky here in the Cypress Hills—we’ve had water when other folks didn’t.”

Access to well water at lower elevations is also unevenly distributed. Producers operating in some of the sandier regions north of the Cypress Hills can obtain drinking water via shallow sandpoint wells, whereas many producers south of the hills require deep wells (250-600 feet or more in depth). Many respondents from this last area commented that the water from their deep wells is often seen as unpalatable, not suited for drinking or cooking, but considered adequate for livestock. One respondent described the water from his family’s 800-foot well as follows: “Technically, it is supposed to be safe to drink, the cows seem to like it, but I wouldn’t drink it unless I was looking for a laxative—it sure does clean you out.”

One of Shaunavon’s two water towers (left). The high quality of source water produced by Shuanavon’s wells requires minimal treatment beyond that provided by chlorination equipment housed in small outbuildings.

Natural capital in the form of source water quality dictates the configuration and expense of treatment infrastructure. Maple Creek’s current delivery and treatment system (right) cost approximately $4 million.

The Town of Maple Creek has taken advantage of the presence of springs and surface-fed groundwater on the north slope of the Cypress Hills as a source of potable water. Shaunavon has the advantage of an apparently sustainable aquifer (based on experience as opposed to hydrological study). Shaunavon’s raw water is naturally high in quality. With the exception of mandatory chlorination, no additional treatment of the water is required.

Snow pack in the Cypress Hills feeds a number of creeks that have been tapped for irrigation on both the north and south slopes of the hills. Access to irrigation, in theory, should assist ranchers in producing hay crops with far higher yields than could be obtained through dryland forage production. However, three decades of reduced snow packs in the hills has made irrigation much less reliable than it is in other regions of the prairies. One respondent described the situation as follows: “When we were first married, we used to get two full irrigations. And we’ve been married since 1977. Now we’re lucky if we get to irrigate half our land once a year. Last year we had no irrigation at all and we had just a single half-irrigation during each of the four years prior to that.”

Approximately 100 producers in the Maple Creek and Shaunavon study areas have access to irrigation water supplied by streams originating in the Cypress Hills. The acreage under irrigation in the study communities was estimated by respondents to be less than 10,000 acres. Respondents involved in water management estimated that approximately 250 producers irrigate around 20,000 acres of land with water of local origin (as opposed to those who rely on Lake Diefenbaker) in all of southwestern Saskatchewan. That 20,000-acre total includes the irrigated acreage in our study area. The irrigation projects associated with Lake Diefenbaker constitute the majority of Saskatchewan’s 300,000 irrigated acres. While water managers estimated that irrigated hay accounts for only 10% of hay production in all of southwest Saskatchewan, our respondents maintained that in drier regions where dryland hay production was less reliable (such as in RMs #51 and #49), irrigated hay accounted for a much higher proportion of the cattle feed produced locally. Indeed, for a number of the ranchers we interviewed, irrigation plots produced most or all of their winter feed.

While the amount of grass (in terms of biomass) that can be grown in the brown soils of this study area is limited by precipitation, the region’s native grasses are hardy and retain nutritional value even after growth has ceased due to dry conditions. Dryland crop yields average much less than they do in moister parts of the province. However, producers have adapted their operations to lower yields through processes related to min till, and land values in the area generally reflect lower productivity (the exception being a surge in land values on the north slope of the hills in RM #111).

The presence of oil and natural gas deposits in the Maple Creek and Shaunavon study areas has added to producer incomes through surface rights revenue and employment opportunities for many production units. However, since much of the ranchland in the Maple Creek area is Crown lease land, surface rights revenues do not contribute as much to farm incomes as they do in the Shaunavon study area, where a higher proportion of the acreage is deeded land.

The capacity of local institutions to influence access to natural capital is not great. For example, until very recently irrigation in the region was managed entirely by the PFRA/AESB. Irrigators have now established irrigation project committees, but these groups do not have any control over water allocations. The community pasture systems operated by the provincial and federal governments (along with a few co-operative pastures in the study area) allow for community input into grazing allotments. Decisions about increasing or decreasing the number of animal units each producer can graze are administered by advisory committees made up of patrons and the pasture manager. These committees also make decisions about admitting new patrons into the pasture. On the other hand, decisions about the awarding of leases on Crown grazing land (of which there is a large amount in the southwest) are made by Ministry of Agriculture officials in Regina.

Overstocking is anathema to the ranchers we interviewed. They insist that their families' survival in the region over the past 100 plus years is the result of their sound stewardship of grazing land.

Technological Capital and Infrastructure

Dryland farmers in the Maple Creek and Shaunavon study areas, like producers throughout the Brown Soil Zone, were quick to adopt drought-mitigating min till technologies following the drought years of the late 1980s. Respondents attributed the widespread adoption of minimum tillage practices to the convergence of several factors, including:

1. the extreme wind erosion—soil drifting and top soil loss associated with the drought years of the late 1980s;
2. increases in the cost of diesel fuel which made mechanical summerfallowing more expensive;
3. a reduction in the price of glyphosate herbicides which made chemical summerfallowing less costly;
4. the development of new tillage tools and machinery, many of which were designed and built by Saskatchewan's shortline machinery manufacturers;
5. the engagement of producers in a variety of soil conservation organizations active across the province;
6. the inventiveness and initiative of a handful of farmers who experimented with minimum tillage practices, and the fact that most other farmers became very early adopters of the new methods. As one innovative producer, who was among the first in the province to adopt minimum tillage, remembered, "I went from wing nut to innovator in the space of about five years."

The various production practices falling under the min till umbrella are in use across the Palliser Triangle region. These include chemical as opposed to tilled summerfallow (chem fallow), direct seeding and, in wetter more so than drier areas, continuous cropping. Min till practices have been incorporated as standard management practices that deal with dry climate conditions and are employed regularly year after year. A producer's options after the onset of severe drought, however, are rather limited. Some respondents reported that if conditions are extremely dry prior to seeding it can influence fertilizer application rates, the selection of crops they might grow, or encourage them to leave a larger amount of land than usual in summerfallow. When the onset of drought is identified post-seeding, the options available include: adjusting the application rates for inputs like fertilizer or herbicide; filing for a Crop Insurance payment (if the producer is insured); ploughing a failed crop into the soil as green manure; and cutting a poor crop for livestock feed.

The irrigation works in the Cypress Hills region require ongoing maintenance. Repairs to this canal were required after washing out in June 2010.

Ranchers have also been adopting new technologies to increase their resilience, particularly in the area of water delivery to pastures. Shallow bury pipeline systems and the use of solar- and wind-powered dugout pumps have improved access to water, water quality and range utilization on a number of respondent operations. Traditional ranching practices such as managing stocking rates to allow for carry-over grass (to trap snow and provide feed in the event of a following dry year) are universally employed by our rancher respondents. Overstocking is anathema to the ranchers we interviewed. They insist that their families' survival in the region over the past 100 plus years is the result of their sound stewardship of grazing land. In the odd case where a new entrant to the ranching industry might overstock pastures, there is considerable community disapproval expressed. Ultimately, producers who abuse their pastures suffer long-term economic consequences and can have their Crown grazing leases revoked.

There is a range of management strategies employed by ranchers in response to drought, including: pumping water to depleted dugouts; hauling water; renting pasture in areas not affected by drought; selling yearlings or part of the cow herd; purchasing feed; drilling new wells; and constructing new dugouts. Rotational grazing strategies common in moister regions are frustrated in this area given that in many years new grass growth is limited to spring and early summer. However, if summer and fall rains encourage greater than average grass production, cattle are moved accordingly. Some producers employed rest rotation systems in which certain fields were left unused for an entire grazing season.

Producers have adapted advances in plant and cattle genetics to the conditions on their production units. New crop varieties such as canola and pulses are now grown in the area, and ranchers recognize the benefits of selecting cattle genetics suited to a dry region where cattle need to be tolerant of heat and cold and often have to travel relatively long distances to obtain grass and water. Much of this innovation has been led by university and government research institutions and commercial seed growers. However, we interviewed respondents who actively collaborate with institutional research agencies by managing test plots on their land. Ranchers typically have herd improvement objectives, whereby they select breeding stock that fits their particular rangeland conditions and complements their existing herd genetics. Some describe this as a generations-long project.

With the notable exception of Hutterian Brethren colonies in the study area, only a minority of production units are mixed grain and livestock operations. This is not to say that dryland farming is not diversified, as the variety of crops grown in the region has expanded considerably since the early 1990s. This has been facilitated by the development of new heat- and drought-tolerant crop varieties and new marketing opportunities.

A number of respondents from the Maple Creek and Shaunavon study areas demonstrated remarkable technical capabilities. In two separate instances, respondents dealt with failed water wells by purchasing and rebuilding used drilling rigs, and drilled their own wells along with wells for hundreds of other producers. A farmer from Shaunavon refurbished used motor vehicles to provide his community with a fire truck, ambulance and Zamboni. Another respondent, from Maple Creek, reported how his father developed a new implement to facilitate minimum tillage decades before the practice became popular. The high degree of technical/mechanical capability resident in the study communities demonstrates a linkage between technical and human capital that enhances sustainability in the region.

A wheel-move irrigation pivot in the Frenchman River valley.

The principal crop grown by the approximately 100 irrigators in the Maple Creek and Shaunavon study areas is alfalfa and mixed alfalfa-grass hay. Most of the irrigators use their production to provide winter feed for their own beef cattle. When surpluses beyond personal needs are produced, the hay is sold locally to other beef producers. The existing Agri-Environment Services Branch (AESB, formerly PFRA) owned-and-operated structures are not capable of storing enough water to provide optimal irrigation in many years. The problem is in part the result of low snow packs and runoff in recent decades. The system improvements required to capture more of less runoff have not been made. Similarly, many producer irrigation plots (but not all) are located on sub-optimal soil and serviced by flood systems as opposed to the more water-efficient pivot systems. Capacities related to technology and infrastructure are in effect limited by the declining role of the former PFRA in the area. This is a reflection of the inter-relationships between the various forms of adaptive capacity. In this instance it involves the relationships between institutional capital, infrastructure and technical capital.

The Town of Maple Creek has recently completed a new water treatment plant and delivery system upgrade partly in response to health concerns raised by a suspected human case of waterborne E. coli in 2001. While there had previously been consideration given to plant upgrades, the decision to make improvements was precipitated by the Ministry of Environment's imposition of a boil water advisory on the community. There was considerable dissatisfaction among citizens. Some respondents believed the process was being dictated by government officials who were exaggerating safety issues. The new plant cost approximately $4 million and has contributed to higher water delivery fees along with improved water quality. This added expense fell on some residents who already felt their municipal tax burden was excessive. The nanofiltration system employed at the water treatment plant comes with high maintenance costs related to the periodic replacement of filters. A more daunting problem involves the capacity of the water infrastructure to sustain growth of the community, as well as its ability to withstand a severe protracted drought, given the reliance on wells that are possibly influenced by surface water accumulations.

Economic Capital

Despite large investments and substantial equity in land, livestock and machinery, producers in the Maple Creek and Shaunavon study areas remain vulnerable to consecutive years of negative farm income. Many producers supplement their agricultural incomes with off-farm jobs and business ventures and some (with deeded land) receive surface rights revenue from oil and gas wells. Respondents estimated the proportion of families with at least one member working off the farm or ranch at between 60-80%. Nonetheless, two to three years of severely reduced farm income could result in the failure of the farm unit. Failure may come in the form of bankruptcy or an exit from agriculture in response to an impossible or discouraging financial situation.

The already precarious economic situation is exacerbated by drought. Dryland farmers face the prospect of applying expensive inputs to their land at seeding time, with little or no return in the event of a crop failure. A succession of years in which this is the case can exhaust the availability of operating capital and cause producers to default on longer-term debt payments (e.g., for land or machinery). Similarly, ranchers who found themselves purchasing feed, reducing their herds or shipping cattle to rented pastures in areas not impacted by drought indicated they could not sustain the associated expenses and revenue shortfalls indefinitely. A common complaint among those who had shipped cattle to greener pastures outside a drought area was that southern cattle tended to perform poorly on northern and eastern pastures.

The limited economic resources of many producers who irrigate in the study area means that system-wide improvement of the region's irrigation infrastructure is unlikely without significant assistance from senior government. This requires government to recognize its need to adapt to evolving conditions. Some producers, such as Hutterite colonies, may have access to the capital required to install pivot systems on their land using existing system infrastructure, but others do not. However, it is likely the case that not even the most prosperous producers, including Hutterite colonies, could afford to maintain the entire dam and canal system on their own.

Economic vulnerability, of course, varies among production units. Some are better capitalized than others. Some have greater access to credit. Some have better off-farm income opportunities. And indeed, some producers are more prepared than others to devote the earnings from off-farm income to saving the farm for a succession of years. The

In contrast with the strained relationship between area residents and the institutions of senior government, there are thriving local institutional networks and effective regional and national producer organizations.

Maple Creek area offers a number of avenues for off-farm employment. The oil and gas sector is an important source of jobs and there are opportunities related to recreation available in association with the Provincial Park and National Historic site located in the Cypress Hills. In the Shaunavon area, the oil and gas sector is a prominent source of off-farm income, as are jobs in the local service sector.

We found a number of respondents who exited traditional ranching ventures, but continue to live and work in their rural communities. These include a family who operate a tourism enterprise and a bottled water business, and also retain a small cow herd. Another family left ranching to establish a winery business, but continue to operate from their original home quarter.

Water problems have had a far more significant economic impact on the Town of Maple Creek than the Town of Shaunavon. Maple Creek, as noted previously, recently had to spend approximately $4 million on a treatment plant (only $1.25 million of the cost was covered by government grants). Shaunavon, on the other hand, has been able to operate and maintain its water infrastructure at far less cost. The town is located over an aquifer that provides highly potable water and has proven reliable during past droughts. Some respondents maintained that the cost of water service in Maple Creek combined with an already large tax load has the potential to limit opportunities for growth of the community. Should the existing network of water sources in either Maple Creek or Shaunavon fail due to drought, the two towns could face rather daunting economic challenges.

Institutional Capital

As noted above, respondents typically estimated that most production units could not withstand more than two to three years of severe drought. These predictions were based on the assumption that this multi-year drought would occur under the current regime of government-supported agricultural risk management programs. The AgriStability and AgriRecovery components of the federal-provincial Agricultural Policy Framework were universally criticized as inadequate by respondents in all six RCAD study communities. Saskatchewan Crop Insurance was somewhat more popular, although many respondents, ranchers in particular, did not view Crop Insurance premiums as a worthwhile investment. Ranchers maintained that payouts did not justify the size of premiums. Some grain farmers reported that the shift to continuous cropping produced large declines in coverage limits; and that under the previous NDP governments, successive years of widespread losses had resulted in program deficits, which translated into unaffordable premiums.

Across the Maple Creek and Shaunavon study areas, respondents demonstrated a sense of alienation or disconnectedness from senior governments. The government risk management programs were viewed as window dressing—programs that gave the appearance of support without actually providing any. There is a sense that the institutions of senior government are not committed to sustaining family agriculture in the region. Only three of the dryland farmers interviewed expressed concern over the possible dismantling of the Canadian Wheat Board. A few producers heralded the Wheat Board's demise, but most simply reported that the issue was controversial in their neighbourhood.

The antipathy toward senior government is heightened among irrigators in the study area who are attempting to deal with the departure of the PFRA (now referred to as AESB) from irrigation activity. AESB is currently consulting with producers regarding a staged divestiture of its irrigation assets, which are to be turned over to the current water users by 2017. Irrigators are concerned that they will be inheriting a system that is inadequate given the runoff rates of recent decades and less than optimal storage infrastructure. An added irritant is the fact the Saskatchewan Watershed Authority has not yet promised to extend water allocations to the producer-run irrigation projects once the AESB has abandoned its allocations.

Municipal governments on the other hand, despite their limited jurisdiction, are viewed more favourably and play a central role in distributing program information and applications for senior governments, and are active in lobbying on behalf of agricultural producer interests. Local municipal officials are active in their provincial umbrella groups, the Saskatchewan Association of Rural Municipalities (SARM) and the Saskatchewan Urban Municipalities Association (SUMA).

Social Capital, Local Institutions and Networks

In contrast with the strained relationship between area residents and the institutions of senior government, there are thriving local institutional networks and effective regional and national producer organizations. Indeed, the Southwest Drought Committee, created by local producers and municipal governments in response to conditions in the Ponteix drought pocket from 2005-2009 (including RM #76), is widely assumed to have contributed to the creation of two of the more popular senior government responses to drought. These include the Farm and Ranch Water Infrastructure Program, which assists producers with the development of community wells, shallow bury pipelines and dugouts; and the tax deferral program that allows cattle producers who sell off breeding stock due to drought to forego paying tax on the sale of cows, enabling them to use the full amount of sale proceeds to purchase replacement animals when the drought abates. In the same vein, when the CPR abandoned the rail line that supported the southwest corner of the province, farmers, municipal governments and local business people got together and established their own shortline railway company, Great Western Rail.

These efforts illustrate the high degree of community solidarity and "do it ourselves" initiative that survives in the study area despite the significant trend toward depopulation of rural neighbourhoods. The fact that irrigators in the study area have not yet developed a strong community-based response to their challenges is something of an anomaly. One might reasonably speculate that given the fact that, until recently, the PFRA looked after virtually all of the irrigators' water infrastructure and management requirements, it will take a certain period of time for local water management institutions to develop. Developing that local institutional capacity may take more time than the PFRA initially envisioned for the transfer of responsibility.

LEFT: Clay and Kristi Yarshenko, Maple Creek, Saskatchewan.

INSET: Eric Lawrence, a third-generation rancher at Maple Creek, Saskatchewan.

As noted above in connection with technical capital and infrastructure, many producers in the study area have considerable technical and mechanical expertise. Most producers have the capacity to repair and sometimes build specialized equipment. The area is well supplied with repair and welding shops (which are often thriving with the extra work provided by the oil and gas sector). There are a number of contractors capable of digging dugouts. However, water well drillers are becoming rare in the area. The region is well supplied with scientific crop experimenters, pedigreed seed growers, and prominent cattle and horse breeders.

While many people in these communities live on geographically isolated farmsteads located a long distance from town, it would be incorrect to think of them as totally isolated. Producers have access to knowledge networks and industry advocacy organizations that extend far beyond the study area. Learning is fostered by local networks such as the labour-sharing systems employed by ranchers and the activities of community service organizations. Producer groups such as the Wheatland Conservation group, the Canadian Seed Growers Association, the Saskatchewan Stock Growers Association, and various cattle breed associations have active members throughout the study area. Producers take advantage of agricultural field days and exhibitions, such as Agribition in Regina (November), the Crop Production Show held in Saskatoon (January), and the Farm Progress Show in Regina (June) to obtain information about developments in their industry.

At the local level, institutions like coffee row, and other meeting places such as the grain elevator, the cattle auction market, the curling and hockey rinks, and the bar provide face-to-face social networks for the sharing of information and social support for people in the study area. Ranchers, in particular, rely on work sharing or trading with their neighbours for labour-intensive operations such as branding (processing calves) and weaning. Groups of neighbours travel from ranch to ranch over the course of one or more months assisting each other as payment for help received. This system facilitates performance of the necessary tasks and provides a platform for socializing and information sharing.

Residents of the Maple Creek and Shaunavon study areas have a shared tradition of resilience in the face of drought and other economic hardships. They have a reflexive approach to adaptation in agriculture. They view themselves as highly adaptive—as survivors. They have had to adapt to survive and, because of that shared adaptive experience, view themselves (not unreasonably) as people with a high degree of technical ability and adaptive capacity. This suggests that people who wear their adaptive capacity on their sleeves as a badge of identity are, by their own definition, receptive to change.

A number of respondents reported on the importance of planning. As one farmer put it, "You just can't go out in the field in the spring and start seeding. You need to plan around things like prices and moisture conditions and really think about what you should be doing to optimize returns."

At the same time, the same producers often described the dangers of being too rigidly attached to a plan. "You have to adapt to conditions as they emerge. If things are looking especially dry prior to seeding, you might need to rethink your cropping options, or maybe do a little more summerfallowing."

A comment by a Shaunavon study area farmer captures the attitude toward drought common throughout the study area. "This is a dry country, and if you haven't figured that out, or haven't figured out how to cope with it, you've got no business farming in this area."

For ranchers, planning for drought is deeply integrated into their overall management strategy. For example, the use of carry-over grass to trap snow and provide fodder in a potentially dry upcoming year was a universally shared tactic employed by our respondents. It is just one of many things that ranchers have done as part of their century-long tradition of operating in a dry region.

A Maple Creek area rancher said, "People have survived farming and ranching in dry areas because they've learned what they needed to do to survive… That includes both learning from the past and being adaptable enough to roll with the punches when things change."

The Coronach and Gravelbourg Study Areas

Natural Capital

Coronach and Gravelbourg are situated in the Palliser Triangle, which is characterized by its dry climate. There is limited surface runoff in the summer owing to the limited rainfall and the sandy soil, which is usually unsaturated at the surface. Owing to evaporation, much of the water is exhausted before infiltration can occur. Therefore, water resources are limited and this makes this region particularly sensitive to changes in climate.

Some producers raised a concern about their competitiveness against other producers in Canada. As the study communities are located in a semi-arid area, given that the input costs and the prices of product are the same across Canada, they are in a disadvantaged position. While producers in areas outside the Palliser Triangle, such as the Maidstone area, can harvest as much as 45 bushels of spring wheat per acre in a particularly good year, record harvests for farmers in the Coronach and Gravelbourg area rarely exceed 30 bushels—and this is largely because of the climate. Taking this unfavourable geographical condition into consideration, they are more vulnerable to extreme climate events, such as drought.

Technological Capital and Infrastructure

Many producers indicated that technological advancement has contributed significantly to their livelihood in the dry years. The principal improvement recognized is the adoption of min till technology followed by improvement in the drought and heat tolerance of new crop varieties. Area farmers are now growing crops such as canola that a few decades ago were limited to moister and cooler regions.

…record harvests for farmers in the Coronach and Gravelbourg area rarely exceed 30 bushels—and this is largely because of the climate.

There are large lignite coal deposits in the Coronach area. The coal mining operation near Coronach has projected that its mining activities can continue until 2039, which is approximately when the coal resources will be depleted and when the approximate life expectancy of the power plant will be reached. As a result, many of the employment opportunities available today at the mine and power plant are expected to disappear. This threatens the sustainability of the community and neighbouring agricultural producers. The mine and the power plant currently provide town residents and agricultural producers with abundant off-farm jobs with flexible working hours. The projected 2039 closure is expected to have a major impact on the overall well-being of the town, including population decline and a loss of available economic capital in the area.

Older farming practices diminished soil organic matter and nutrients at a rate faster than it could regenerate naturally. As a result, producers have changed their farming practices over time and they are now more dependent on fertilizers, pesticides and other chemicals to maintain their productivity. Maximizing productivity by purchasing more land and decreasing certain unit (per acre) costs by purchasing larger or more efficient equipment have been commonly employed economic adaptation strategies in all six study communities. Depending on individual circumstances, improving overall farm unit economic performance can enhance the capacity to cope with drought years. It can also have the effect of increasing vulnerability when drought impacts a producer's ability to service a debt load incurred for land expansion or improved machinery.

Coronach has made use of government assistance to build three community wells for the farmers to load their water tanks with non-potable water for field spraying and for their livestock. It is an adaptation strategy provided by the RM "for the security of the people down the road in a drought." If the producers want treated water, they can haul water from town and this gives them two different options.

Gravelbourg has also built a number of wells and tank-load stations for producers. Almost one-third of the RM has access to those systems and producers do not need to drive long distances to fill their tanks. The RM also took over local rural pipelines from a water board, allowing it to expand the pipeline to more farms. Approximately 70% of the farmsteads in this RM will soon have access to water supplied by the pipeline.

In terms of household water use, there have been significant changes in appliances that reduce the amount of domestic water use. Some people conserve water by replacing old appliances with water-efficient ones or using rain barrels to store rainwater for garden irrigation and other cleaning purposes. Technological development is improving water use efficiency and can constitute an effective way to build adaptive capacity when it reduces the necessity of constructing costly new infrastructure such as wells, pipelines and treatment facilities. These appliances are made affordable with rebate programs, and most of the respondents claimed that they are open to the option of changing their appliances into water-efficient ones when the old one needs to be replaced.

One of the major reasons some producers say they resist adopting new technologies is because of a lack of knowledge about how to fully utilize them and problems related to fixing the electronic components in newer machines. Whereas farmers have the capacity to make many repairs to older models themselves, computerized machinery often requires outside assistance. Some people attend workshops or search on the Internet whenever a new technology comes out. A number of respondents were discouraged by the increasing use of computer technology in new equipment. This was seen as an impediment to making on-farm repairs. Rapidly inflating prices for items such as combines and tractors was another factor that was hindering some producers' decisions to make new purchases.

In order to maintain their livelihoods and farming operations, more than 60% of our respondents have other sources of income—primarily off-farm employment.

Economic Capital

For producers in the Gravelbourg and Coronach study areas, decades of low crop prices have reduced their economic resilience. In more extreme cases, producers who cannot make payments to financial institutions and suppliers have to sell land and/or equipment to service debts. As the costs of machinery are rising, some producers cannot afford to upgrade their equipment. They have had to change their operation by finding a way to farm without some of the equipment that they used to have, and it makes their operation less productive. Some producers indicated that the price of new machinery prevented them from upgrading to new models. In order to minimize the cost required to obtain new technologies, a few producers in the Coronach have formed farm clubs to share the cost of machinery, which makes new technologies more accessible.

In order to maintain their livelihoods and farming operations, more than 60% of our respondents have other sources of income—primarily off-farm employment. As the expense of farming is rising, some conventional farmers have switched to organic farming, assuming the prices for organic products are higher than conventional products and that expenses will also be lower. Critics of organic methods wonder if the reduced yields due to lower inputs are fully accounted for by higher prices. With all the costs that add up throughout the year, many producers can live and plan only on a day-to-day basis. One grain producer commented, "It's hard to go forward because every drought or a little bit of crop failure takes away from your income." For ranchers, financial issues tend to be in a vicious cycle. When cattle producers sell their cows owing to financial difficulties or drought, they are giving up the income that they can earn from the calves next year. As drought is a recurring event on the Prairies, the government has developed financial programs to assist municipalities and producers in improving their adaptive capacity by helping them to drill wells and dig dugouts to improve water access for farm families and livestock needs. For example, the provincial government has a Farm and Ranch Water Infrastructure Program that cost-shares well drilling, dugout construction and installing pasture pipelines with producers. The program was initially available only to producers in drier areas but was expanded into a province-wide program in 2008. Many producers have made use of the grants provided by the program to ensure water availability in the future. Half of our respondents claimed they have made use of government financial support to increase their sources of water supply. However, some of the programs are capped, and government provides producers with funding only up to a maximum amount depending on the project. Many producers claimed that they could not afford their portion of the project. For example, irrigation is often identified as an effective adaptive strategy to cope with drought. However, with the increasing cost of irrigation equipment and the short supply of surface water in the area, irrigation is viewed as impractical. Some ranchers who had planned to build pasture pipelines to improve their adaptive capacity towards drought found the cattle market so poor after BSE hit they had to cancel their pipeline projects.

For the coal industry, adaptive capacity is also restricted by the availability of economic capital. Sherritt Coal staff indicated that the scale of the coal mine operation makes adaptation strategies more expensive. When they face water shortages, their options are restricted by cost. For example, the application of salt was the only cost-effective method available to replace water for dust control in previous drought years.

The RM of Gravelbourg took advantage of government grants to facilitate the construction of its rural pipeline project, which provides water to almost 70% of its ratepayers. A respondent stated that without financial support from the government, this project would never have been feasible for the RM. With the pipeline, residents have another source of domestic water, which enhances their adaptive capacity. The RM of Hart Butte utilized government funding to build community wells. An RM official reported, "The primary reason [for building community wells] was because the government provided 85% of the funding, so we're spending only 15% to develop the program… that's the biggest driving factor". Results of the interviews show that government financial support encourages proactive measures in drought-prone areas.

Institutional Capital

Most of the respondents claim they prefer assistance programs managed by the provincial government rather than by the federal government. The assumption is that provincial programs are usually downscaled and tailored to the specific conditions within the province, while the federal government designs programs that work across wider regions and do not always benefit the people actually needing help. Respondents argued that programs should target people who need the support instead of a blanket approach that ends up benefiting those it is not intended for.

One of the most widely subscribed government programs in the Coronach and Gravelbourg areas is Crop Insurance. More than half of the interviewed producers carry crop insurance. However, not all the farmers are satisfied with the program. Some of them said that they never collected any money—even in the major drought in 1988. Those producers thought that the yield average for triggering claims was so low that they have never had a situation where they needed to make major claims and they are better off saving their money in the bank. Therefore, it is hard to justify spending money on crop insurance.

> Today, area farmers are growing a much wider variety of crops than they were a few decades ago—crops such as lentils, canola, and canary seed, in addition to traditional cereal crops such as spring wheat, barley and oats.

Similar to our findings in the Maple Creek and Shaunavon study areas, AgriInvest and AgriStability were widely criticized. Some producers saw the programs as inequitable. Small farmers who need help are left out, as they cannot afford the accounting fees required to apply. The AgriStability reference margin is a concern for ranchers whose incomes had remained low for five years following BSE. With the low cattle prices, they never had the profitable years needed to establish better baseline data. An accountant we interviewed stated that half of his/her clients dropped out in 2009 because they were not getting the support they wanted.

Timely payments are crucial in helping the producers in need. Many producers complained that, most of the time, they do not receive the payment until a year after they need it. Institutional support failed to support producers during drought years, as producers have already done what they had to do to get through the disaster before they receive the payout.

Lastly, there have been many changes to the programs in the last decade and many producers admitted they have a hard time keeping up with the programs, and they often mixed up the names and details of the programs. Because of the complicated paperwork, this makes the accountants the winners and the money often does not go back to the producers. Therefore, the respondents hoped that the design of government programs could be improved so as to ensure that the producers are the ones who are being supported in times of difficulty.

Social Capital, Local Institutions and Networks

Regional resource sharing is practiced among the towns of Coronach, Assiniboia and Gravelbourg. Regional meetings are held regularly among the economic development officers to discuss the possibilities of sharing resources to contribute to the overall economic prosperity of the region. This initiative facilitates communication among the three major service centres in the region and helps to improve community adaptive capacity.

Local groups are essential in dealing with issues that concern the producers. Since the coal seam near Coronach is covered by groundwater, dewatering is required to lower the water table for coal excavation. A local Surface Rights Organization was formed to deal with issues arising from groundwater use by the area's coal mine. Residents bargained for an alternative water source when mining processes allegedly depleted their wells. As a result, the mine has re-drilled a number of farm wells, constructed pipelines to pipe water to some farms, and set up some tank-load facilities for local producers. This has improved the community's ability to cope with future water shortages. In Gravelbourg, the Wood River Riparian Authority helps to promote beneficial management practices that protect the health of the riparian area along with the Wood River. In addition to educational programs that teach the producers how to protect water quality, they also help the producers to fill out application forms for financial support programs.

There are also other community-based institutions that help to enhance adaptive capacity. The Agricultural Producers Association of Saskatchewan (APAS) is a farm organization supported by participating municipalities, which focuses on improving the economic well-being of producers in Saskatchewan. Participation in APAS was not universal among the municipalities included in this project's study areas.

All the respondents stressed the importance of relatives and neighbours. Many of them gave examples of help being offered because of sickness or other emergencies. There is also a lot of learning that occurs through informal producer interaction. Some respondents shared the experience of getting through a drought by buying hay from their friends. "Word of mouth is usually how news travels. It is not by advertising in the newspaper. You just know if someone is trying to get rid of some (hay) and you need some, you will get a call…that is super important in rural areas." Access to information by word of mouth improves the producers' adaptive capacity by saving the producers money in buying hay from a closer location.

Kindersley Study Area

Natural Capital

Natural capital is more evenly distributed in the Kindersley study area than it is, for example, in the Maple Creek and Shaunavon regions. However, there are variations in soil type and productivity between agricultural production units. The succession of droughts impacting dryland farming in the Kindersley study area over the past three decades ranks it among the most adversely affected of the areas examined in this project. The only comparable region is the Ponteix drought pocket, which experienced a rather unique five-year drought period between 2004-2009 (described in connection with the Shaunavon study area). As described earlier in this report, the infamous drought of 2001-2002 lasted more than two years in some areas. The RM of Kindersley #290 is an area where crop production was adversely impacted for three years between 2001-2003 (see Appendix for details).

The Kindersley area lacks the surface water sources that would facilitate irrigation agriculture. Similarly, local surface water sources have proven inadequate for supplying larger area towns. The lack of reliable high quality surface water and groundwater encouraged the Town of Kindersley and the neighbouring community of Eston to construct a pipeline to the South Saskatchewan River (SSR), which is approximately 46 km south of Kindersley, to secure adequate supplies of reasonably good quality water. This measure was costly relative to costs experienced by a community such as Shaunavon, which has been able to exploit a high-quality local aquifer. In Kindersley's case, the distance to the SSR is not so great as to rule out a pipeline solution. However, in the Gravelbourg and Coronach study areas, a similar solution, while being advocated by local governments, has not garnered support from senior governments, in part due to the relatively greater distance to the SSR and/or the Qu'Appelle River system that it helps supply (approximately 180 km in the case of Coronach).

The potential for constructing a pipeline to the SSR in support of irrigation agriculture did not emerge as a theme in the discourse around drought mitigation with respondents from the Kindersley study area.

In common with the Maple Creek, Shaunavon and Maidstone study areas, the Kindersley area has exploitable deposits of natural gas and oil that contribute significantly to the area's economy. Indeed, fossil fuel resources are important to the local economies of all the study areas with the exception of Gravelbourg.

Technological Capital and Infrastructure

Dryland farmers in the Kindersley study area have embraced min till technology following the severe droughts of the late 1980s. Another important change in the farming over the past few decades is the diversification of crops. Today, area farmers are growing a much wider variety of crops than they were a few decades ago—crops such as lentils, canola, and canary seed, in addition to traditional cereal crops such as spring wheat, barley and oats. In concert with producers in the other study areas, farmers in the Kindersley area are equipped with modern direct seeding implements and make use of chem fallow and regular fertilizer application.

Residents of the study area, both urban and rural, have been able to take advantage of the water pipeline infrastructure originally built to service the communities of Kindersley and Eston. Adjacent small urban communities and farmers have been able to connect to the pipeline to secure domestic household water and water for livestock.

Many of the farmers interviewed attributed their decreased vulnerability to drought to the adoption of effective farm management skills.

Economic capital
In conformity with what is a recurrent theme in our findings for all the communities studied, agricultural producers in the Kindersley study area have been impacted by the long-term cost price squeeze in agriculture in addition to recurrent drought. Oil and gas industry activity in the area has contributed to the sustainability of farm and ranch units in the region due to the off-farm employment it provides and through surface rights revenues that accrue to producers lucky enough to have oil and gas wells on their land. The off-farm jobs of both adult male and female farm household members are a big support during hard economic times in agriculture. These off-farm jobs enable many to put groceries on the table and to make farm payments.

The oil and gas sector also contributes to the economic diversification for the Town of Kindersley. Were the town reliant only on its role as an agricultural services hub, its prospects over the past few decades would probably not have been as bright as they have been due to oil and gas activity. Not surprisingly, Statistics Canada (2007) reports the unemployment rate for the RM of Kindersley as zero.

Institutional Capital
The most popular government-sponsored business risk management program, as reported by respondents, was Crop Insurance. In Kindersley, a majority of the respondents carry crop insurance, although, among those who had crop insurance, a majority were not satisfied with the program. The main concern was high premiums and a low guarantee for loss coverage. Nonetheless, many testified that Crop Insurance provides minimum revenues to be able to continue farming in the next growing year. As is the case with producers in the other study areas, many producers found AgriStability to be overly complex. According to one respondent, "The AgriStability application is so complex, that many of us have to hire accountants, and sometimes we don't know what we will get from this program."

Farmers were also asked about the role of institutions in building the adaptive capacity to deal with droughts. Many respondents stated that the Prairie Farm Rehabilitation Administration (PFRA) has played an important role in providing the technical and financial support for the construction of dugouts and managing community pastures.

The extension staff of the Saskatchewan Ministry of Agriculture is another institutional resource for local farmers to access information on improved farming practices. In the Kindersley area, many farmers mentioned that it is nice to have Saskatchewan Agriculture staff in the community: "If we ran into trouble, such as diseases or any concern related to varieties we can access them easily and they are very helpful." Until recently, many communities had been lacking in access to face-to-face service with ministry extension staff. The NDP government had significantly reduced the number of extension offices in the province in 2004. The Kindersley office was reopened by the Saskatchewan Party government in 2009.

Social Capital, Local Institutions and Networks
Many of the farmers interviewed attributed their decreased vulnerability to drought to the adoption of effective farm management skills. Farmers who were incapable of applying appropriate agronomic and business practices in their operations were simply less capable of withstanding the combined impacts of recurrent drought, high input costs and low commodity prices. Good farm management combined with the safety net provided by crop insurance and the ability to generate non-agricultural income are key factors in sustaining production units in the study area.

Social capital in the town of Kindersley area includes informal networks such as church groups, youth and cultural groups, and recreational and sport facilities typical to other study area communities. However, in the farming community, many respondents noted the deterioration of social capital. Factors contributing to the decline included population loss—the fact that the farm community was getting smaller, while farms were getting larger. While off-farm work is often key to a production unit's sustainability, it draws human resources away from social activities and organizations. The Kindersley area has a Farm Club that has a mandate to share technological information, but only a minority of respondents were members. Respondents stated that their reliance on external institutions such as seed, chemical and financial organizations has affected their local links. Farms in the area are now individual businesses: "We are in a competitive relationship." Kindersley has a drought committee but its level of activity has dropped off since 2002. One member of the committee said that they met only once after 2002. The committee appears to have been a reactive response to extreme drought as opposed to a platform for developing resources to plan for future climate events.

The drought of 2001-2002 severely impacted the Kindersley area. The local town administration put enormous effort into upgrading its water system and enhanced its capacity to deal with future water-related stress. As farming in the area is moisture dependent, any future multi-year moisture deficit could limit the agriculture production in the area. A majority of the farmers claimed two consecutive years of drought was the threshold for absorbing drought impacts; beyond that, viability of many production units in the area would be in question. Water is a big constraint and it always has been in dryland farming. Farmers in the area have been able to mitigate its impact because they are using better technology, better varieties, and better management programs. Nonetheless, a lack of timely rains has a negative impact on crop yield. One responded noted that "there are lots of things we have done to offset the moisture-related problems to an extent, but at the end of the day, the big one is weather. If it rains too much or too little we have problems. But we live with it because that is part of the business."

Maidstone Study Area

Natural Capital

The Maidstone study area is unique among the communities we studied, given its far less frequent experience with severe drought. This area falls within what John Palliser referred to as the Fertile Belt, which lies to the north and east and west of the Palliser Triangle. As noted previously, many respondents from this region indicated that the drought of 2002 was the first serious episode of drought they had experienced in their farming careers. This considerable advantage in natural capital (especially when combined with good soil conditions) is somewhat offset by the relatively higher prices paid for farmland in the Maidstone study area. For example, Farm Credit Canada reports that native pasture land in RM #51 of the Maple Creek study area was selling for as little as $129 per acre in 2011 whereas in the Maidstone area the average selling price for cultivated land was $883 per acre (see Appendix for details).

The relative proximity of the North Saskatchewan River suggests that there could be potential for the development of irrigation agriculture in the Maidstone area. However, given the relatively reliable precipitation in the area and resulting high dryland crop yields, developing irrigation is not a priority among area farmers.

Technological Capital and Infrastructure

The advances in farm technology associated with min till have been widely adopted by producers in the Maidstone area. Continuous cropping is common, and area producers have diversified their crop varieties well beyond the cereal grains that dominated production a few decades ago. Water supply infrastructure for the town was redeveloped in response to the drought of 2002. There were, however, issues with that infrastructure pointed at the need for eventual replacement prior to the drought. The supply infrastructure was old and reaching the limits of its life expectancy and it included a clay-asbestos pipeline that would no doubt have been targeted for replacement if and when major problems arose. But problems with the quality of water supplied by the Waseca wells has meant that water from Maidstone Lake needs to be mixed with the Waseca well water to improve the quality of the town's drinking water supply.

The drought of 2002 resulted in a total crop failure for many Maidstone area producers. The impacts of crop loss were accentuated by the fact that a majority of producers in the region did not carry crop insurance.

The relative infrequency of drought in the Maidstone area is reflected in the fact that a majority of our respondents from the area do not participate in crop insurance. Moisture conditions in this area make continuous cropping a more viable practice than it is in many areas within the Palliser Triangle.

However, when drought did occur in the area, its impact was significant. Despite the fact the Maidstone area has more ample surface water than, for example, the Kindersley region, the drought of 2002 reduced water levels on Maidstone Lake to the point that the town was prompted to seek out a new source of supply. The town benefited from the fact that a groundwater source within 16 km of Maidstone (near the village of Waseca) could be tapped to supplement reduced supplies from the Lake. The need to drill new wells and install the necessary pipeline was an expensive exercise for the community.

The total cost for acquiring the additional supply at Waseca and the necessary pipeline was $3.06 million. The quality of the mixed Waseca-Maidstone Lake water is relatively low—low enough to encourage many town residents to purchase bottled drinking water. That said, the town's water rates remain low, averaging $77 every three months per household, which compares favourably to rates at Maple Creek, which run at approximately $86 per month—albeit for higher quality water.

Economic Capital

The drought of 2002 resulted in a total crop failure for many Maidstone-area producers. The impacts of crop loss were accentuated by the fact that a majority of producers in the region did not carry crop insurance. Determining economic vulnerability in association with drought conditions in 2002 is a complex exercise because it involves gaining an appreciation of the financial circumstances of individual production units. For example, a well-established producer with minimal debt, some oil well surface revenues and cash reserves could conceivably recover more easily than a younger producer carrying a larger debt load. And while the drought of 2002 was a unique experience in the area, yield losses and crop failures due to other climate hazards are not uncommon. Respondents were familiar with crop losses due to hail, late and early frosts, or excessive moisture—so a single year of disaster due to drought was in effect a new type of exposure, but with similar economic consequences to others they were already accustomed to.

Many consecutive years of crop yields higher than the provincial average may indeed provide some producers in the Maidstone area with greater economic resilience than producers in some areas of the Dry Belt. However, as noted above, higher yield areas are associated with higher land values and are also often dependent on higher rates of fertilizer application. A crop failure on expensive land following the application of expensive inputs is a challenging business problem.

Institutional Capital

As noted above, crop insurance, while a major institutionalized financial safety net, has less than majority uptake in the Maidstone area. Nonetheless, many respondents acknowledged that crop insurance does provide a minimum level of revenue support that can assist producers in staying in business until the next growing season following a bad year. And, similar to the experience in other study areas, AgriStability is not viewed as an effective support program. For example, under the averaging system used for triggering payments under the program, a single-year drought like 2002, regardless of how severe it might have been, would not necessarily provide any financial support.

The Town of Maidstone was able to garner provincial and federal government financial support for the changes it made to its water supply system in the wake of drought in 2002. A grant of $845,290 was provided to the town by the Canada Saskatchewan Infrastructure Program (CSIP). This is a somewhat similar level of financial support as was obtained by Maple Creek to improve its water supply in response to quality concerns.

While Maidstone was able to tap into support from senior governments, government financing is always provided to communities facing water supply challenges. In addition, programs such as CSIP are by no means permanent institutions. They appear and disappear in response to the levels of funding senior governments wish to make available or in concert with election cycles whereby new governments abolish or recalibrate programs initiated by their predecessors.

Social Capital and Local Institutions and Networks

Respondents in the Maidstone area reported a lack of enthusiasm for collective action among farmers. Many respondents noted that the town had lost the grain elevators because of a lack of effective lobbying. Some wondered why Husky Oil was able to pump fresh water from the North Saskatchewan River for its operations, but the town and RM were not successful in lobbying for a similar pipeline to the river when they faced a water quality problem in 2002. Maidstone is home to many community-based service clubs such as the Kinsmen and the Canadian Legion. Respondents reported that these organizations are slowly fading out because there are fewer young people in the town. And those younger people who are farming lack the time required for involvement because they are often holding down off-farm jobs.

PART IV: CLIMATE CHANGE SCENARIOS FOR SOUTHWEST SASKATCHEWAN[1]

Past experience and scientific projections are the basis for scenarios of the future. Climate change scenarios describe only possible future climate conditions, so they are not definitive predictions of future climate. They are used in investigating the potential consequences of climate change for ecosystems and people.

LOOKING BACK

Our degree of exposure to drought has been limited by the short agrarian history of southern Saskatchewan. Weather and water levels have been measured since the late 1880s, but only at a few locations and not without interruption. In order to construct more accurate scenarios of the future climatic conditions, it is important to understand how climate has unfolded in the long-term past, placing current climatic variability into historical perspective, providing data to evaluate forecasting models and to evaluate the impact of climate change. Climate scenarios show the shift in average precipitation and temperature conditions. However, these models do not provide meaningful information about the future of extreme events and the short-term climate variation caused by natural internal forcings. Therefore, tree rings from species collected in the Cypress Hills (Saskatchewan), and the Bears Paw Mountains and Sweet Grass Hills (Montana) have been used to evaluate past climatic conditions and reconstruct streamflow. Tree rings act as an indirect measurement of natural climate variability, and because both trees and river systems integrate the effects of point source precipitation into a larger spatial unit representing hydroclimate (Axelson, 2009), we are able to reconstruct and summarize some of the most extreme climate conditions in terms of magnitude, severity, and duration (Meko, 2001; Woodhouse, 2006). Tree ring records show that drought has been a recurring theme in the region where the communities are established, and suggests that some droughts in the last millennium have exceeded in severity any drought recorded in the instrumental record (Sauchyn, Vanstone and Perez-Valdivia, 2010). Therefore, through an understanding of historical streamflow variability, we can better adapt to changing disturbance regimes in climatic parameters such as severe drought and flood occurrences.

1 This section of the report and the associated research were produced by Samantha A. Kerr, an MSc. candidate in Geography and Professor David J. Sauchyn, Department of Geography and PARC, University of Regina.

The flows for Swift Current Creek, Battle Creek, and the Frenchman River have been reconstructed using tree ring data from 1793 to 2001. Figure 1 shows this reconstructed streamflow for Battle Creek. Figure 2 compares the Battle Creek reconstruction with actual streamflow measurements taken between 1939 and 1966. It shows high and low flows captured in both the instrumental and reconstructed data, demonstrating how well the reconstruction captures the inter-annual variability of the instrumental data. The Battle Creek tree ring data for over two hundred years (Figure 1) shows that severe hydrologic drought events occurred in the late 1700s to early 1800s, the late 1800s, the early 1920-30s, and late 1980s. Whereas the single-year droughts of the 1980s are the most severe in the tree ring reconstructions, the period with most sustained low water levels was immediately prior to the settlement of southwestern Saskatchewan from the 1880s to the early 20th century. The hydrologic droughts identified in the reconstruction coincide with low flows in other reconstructions across western North America, therefore serving as validation for the drought years identified (Case and MacDonald, 2003; Watson and Luckman, 2005; Beriault and Sauchyn, 2006; Axelson, 2009).

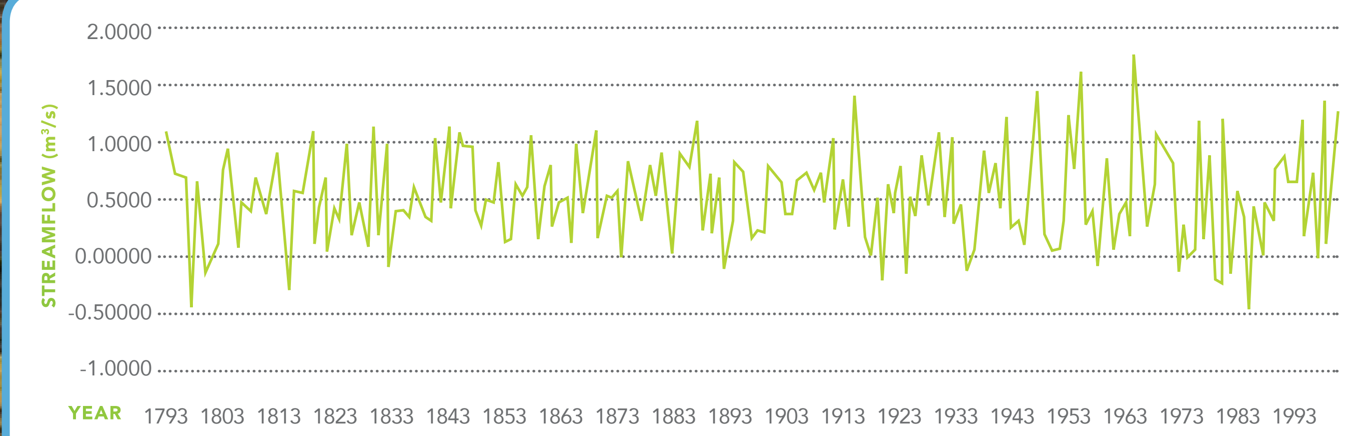


Figure 1. Reconstructed streamflow for Battle Creek, based on tree ring records, 1793-2001

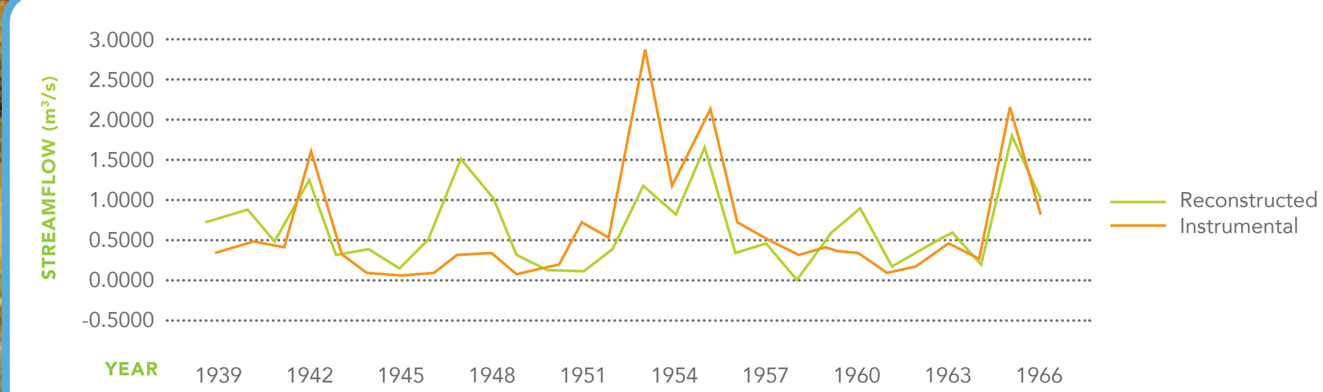


Figure 2. Reconstructed streamflow for Battle Creek, based on tree ring records, compared with actual streamflow measurements, 1939-1966

LOOKING FORWARD

Using the most recent models available (IPCC, 2007), regional climatic impacts were assessed through the use of multiple global climate models (GCMs) and scenarios. GCMs are 3D representations of the Earth-atmosphere system driven by changes in atmospheric composition, which are dependent upon a number of factors, including the influence of population, economic growth and energy use (Barrow, 2009). Multiple scenarios are used in order to express uncertainty by spanning a range of possible future climates (an extreme range of changes, as well as the average range of climate conditions).

For the purpose of this project, future climate change scenarios for southwestern Saskatchewan focus on a multi-model average projected change of temperature and precipitation on a monthly, seasonal, and annual timescale for the selected communities studied. Based on average temperature and precipitation conditions from 1971-2000, climatic conditions were projected for future time periods: the 2020s, 2050s, and 2080s. And through scenario evaluation, analyses show significant warming and both increases and decreases in precipitation for the study area, depending on the season.

Temperature

Trends identified in Figure 3 show significant warming for southwestern Saskatchewan. Climate change scenarios show a projected annual increase in temperature of approximately 3-4°C for all months of the year by the 2080s. The most notable changes include warming in winter months; for example, in March, temperatures may change from a negative monthly average to a positive monthly average by the 2080s, and November may also see significant increases in monthly average temperature. These higher temperatures in spring and fall will result in a significantly longer frost-free season.

Precipitation

Trends identified in Figure 4 show a general increase in average precipitation amounts for winter, spring and autumn months (January to June; October to December), but a general decrease in average summer precipitation (July to September) by the 2080s. Climate change scenarios project an annual anomaly (increase or decrease) of approximately five percent for southwestern Saskatchewan. The greatest increase in precipitation may occur in spring months by an average of approximately 15 mm, while summer may see an average decrease of 5 mm.

These changes in precipitation and temperature are expected trends and they refer to averages. However, at local and regional scales the major climate hazards are extreme conditions—such as droughts—rather than shifts or trends in the means. The critical characteristic of drought is duration since impacts on water resources and ecosystems are cumulative. Most adaptive responses to drought are effective for one to two years, because droughts of longer duration have not occurred since the 1930s. Droughts of greater severity and duration occurred prior to the settlement of the Canadian Prairies. These droughts are evident in historical records and in moisture-sensitive tree ring records.

The past is a good indication of the future only if climate variability remains relatively constant. This of course is not the case under global warming. Therefore, droughts in the future should be at least as severe and prolonged as those that predated agrarian settlement, and could occur with increased frequency and severity as a consequence of global warming. Studies of the future climate of the Canadian Prairies using climate models suggest an increase in both the number of dry days and the dry spell duration during the April to September frost-free period. Even though a small increase in annual precipitation is expected over most of southern Canada, higher temperatures translate into greater evaporation and more severe droughts. The occurrence of future drought remains a major knowledge gap; land-atmosphere interactions and ocean-atmosphere circulation anomalies (teleconnections) associated with drought are at present not consistently or adequately simulated by climate models. ⦿

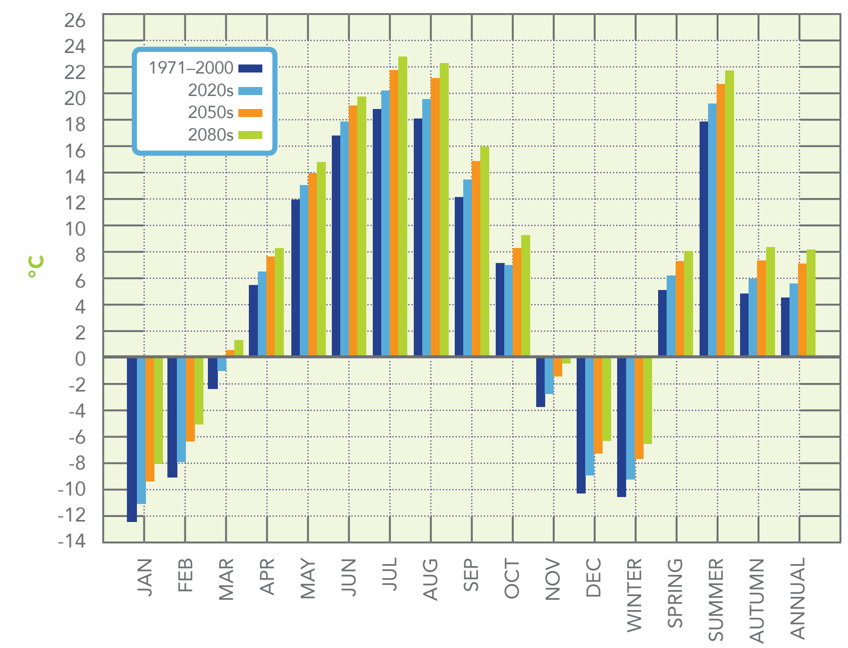


Figure 3. Air Temperature Climate Scenario based on global climate models (GCMs)*: monthly, seasonal and annual mean air temperature in °C (measured at 2 metres above ground level)—actual for 1971-2000 and projected for 2020s, 2050s, and 2080s

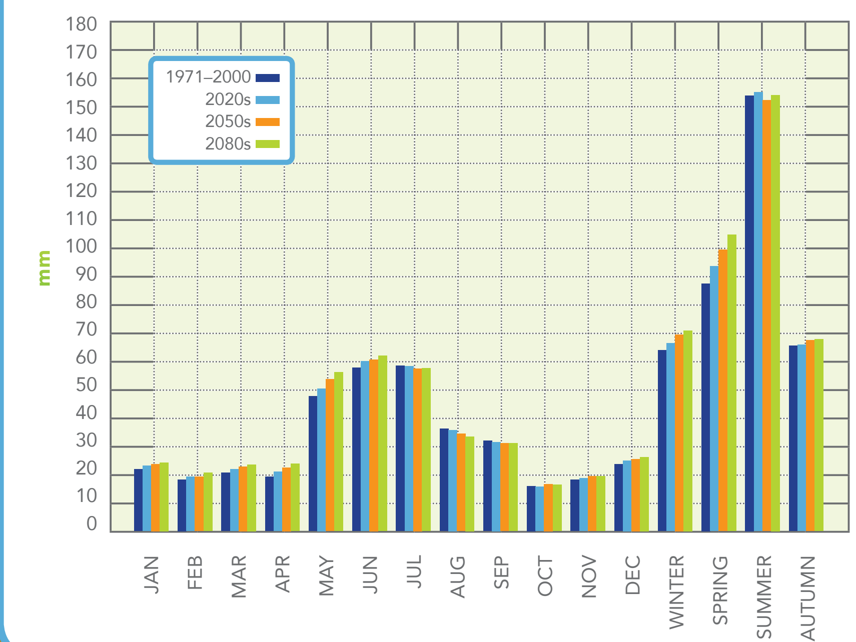


Figure 4. Precipitation Climate Scenario based on global climate models (GCMs)*: total monthly and seasonal precipitation in mm—actual for 1971-2000 and projected for 2020s, 2050s, and 2080s

**Figure 3 and Figure 4 scenarios based on an ensemble of GCMs using greenhouse gas emissions scenario A1B. GCM data provided by international modeling groups to IPCC (Intergovernmental Panel on Climate Change) and CMIP3 (Coupled Model Intercomparison Project) database, with support of the U.S. Department of Energy, with further analysis by the Canadian Climate Change Scenarios Network.*

PART V: CONCLUSIONS

Our concluding section deals first with an assessment of community sensitivity to non-climate hazards, followed by the highlights of our findings regarding the adaptive capacity of the study communities based on their experience with past droughts.

The key findings related to natural and economic capital are discussed followed by a point-form synopsis of our key observations. The second part of the conclusion addresses the potential effects of future exposures as suggested by the climate portion of the study and current levels of adaptive capacity. We have identified areas of critical concern, posed some questions and made suggestions about how communities and policy-makers might enhance adaptive capacity in the event that future droughts are longer and more severe than those which producers and communities currently have the capacity to withstand.

COMMUNITY SENSITIVITY TO NON-CLIMATE HAZARDS

Agricultural producers and the town and country urban communities that service agriculture in the study areas experience a host of non-climate exposures that can threaten their long-term sustainability. The predominant economic threat has traditionally been referred to as the *cost price squeeze*. Until rather recently, the prices available for the commodities produced by farmers in the study communities have been poor. Respondents reported that prices for cereal grains experienced a brief peak in 1975, a price level that was not achieved again until 2005. In the case of cattle prices, the BSE crisis (2003-2007) prompted a significant decline in producer incomes when important export markets were closed. Respondents maintain that commodity prices have been excessively low relative to increasing input costs for decades. Prices for machinery, fuel, fertilizer, labour, and many herbicides and pesticides rose apace for decades, while agricultural product prices remained low by comparison.

Profitability on many production units has fluctuated from marginal to negative for decades. This has necessitated the adoption of farm unit expansion to sell and market more product and obtaining off-farm employment as economic survival strategies. Climate hazards such as drought, early or late frosts, hail, and excessively cool or hot growing seasons exacerbate the already economically precarious circumstances faced by many producers. That said, respondents from the Palliser Triangle portions of the study area typically indicated that drought was the most frequent and costly climate exposure they have faced.

Sustainability of production units and the communities that service them is therefore sensitive to an interconnected combination of climate and non-climate hazards. Exposure to either a sharp drop in commodity prices or a severe multi-year drought could cause a production unit to fail. Indeed, hazards are commonly experienced in combination. One respondent characterized drought layered onto low commodity prices as a "double whammy." A production unit already suffering from severe economic stress is less resilient to drought than a production unit with greater economic resources—whether due to higher equity, access to credit, or high paying off-farm employment.

Not surprisingly, difficult economic circumstances for farmers and ranchers have a spillover effect into neighbouring rural-urban communities. Lower agricultural incomes translate into fewer purchases of services, chemical inputs and manufactured goods such as new machinery. As noted previously, the reduced yields caused by drought in 2001 significantly lowered the volume of grain handled at Maple Creek's Viterra elevator. Another similar example was provided by management of the locally owned and operated Great Western Railway. If farmers grow smaller crops, there is simply less freight for the railway to haul, reducing revenues and adversely impacting the company's bottom line. The feedback loop operates in both clockwise and counterclockwise directions. Reduced purchases within the local urban community over the long term can translate into fewer local businesses. The loss of local suppliers can result in higher costs for agricultural producers who now have to travel further for the services and supplies.

THE CRITICAL ROLES OF NATURAL AND ECONOMIC CAPITAL

Natural capital

Our research assessment describes high variability for access to natural capital between the six study communities and within study areas. By virtue of where they are physically located, some communities and agricultural producers have greater access to factors such as adequate precipitation and access to reliable surface water and groundwater sources. Others are less fortunate. Some of the producers in four of the study communities have access to surface rights revenue from oil and gas activity. However, two of the communities have no significant oil and gas sector activity, and producers in the Maple Creek and Shaunavon areas do not receive as much revenue from oil and gas wells on their Crown lease land as producers with deeded land receive. And, despite the shortcomings of the irrigation systems in the southwest corner of the province, local streams can contribute to increased feed production for producers with access to irrigable land.

Clearly, the distribution of natural capital is a critical factor in determining the adaptive capacity of communities and individual production units to drought. For five of the town and countryside communities we studied, the potential failure of their water sources as a result of protracted drought is not implausible. Two of the study communities, Coronach and Gravelbourg, are currently experiencing problems with their source water due to years of low streamflows and reservoir levels. It is true that the aquifer supplying Shaunavon has continued to provide adequate water supplies through past droughts. However, there is no hydrological data available to tell us what the actual extent of the aquifer is, what its recharge rate might be, or how fast it is being depleted. Maidstone's water supply system was negatively impacted by the drought of 2002. It was assumed that the wells drilled at Waseca would solve the resulting supply and quality problems. But, as events developed, water from Maidstone Lake was still required for mixing with the Waseca well water. We are left to ask what the impact on Maidstone Lake would be in the event of two to three years of consecutive drought of similar severity to that which occurred in 2002? If the lake water supply fails, can the well water be successfully treated, and at what cost?

Maple Creek's wells are listed by the Ministry of the Environment as "possibly under the influence of surface water" accumulations. Area respondents were optimistic that the springs and groundwater "streams" supplying the town were relatively "drought proof," and that if events proved otherwise, drilling new wells or utilizing water held in irrigation reservoirs could fill the gap. But all that is speculation. One has to wonder whether the irrigation reservoirs would have the required water reserves in the event of a protracted drought, whether suitable new wells could be constructed, and how the community would cover the cost.

The land sale values and crop yields reported in the Appendix to this report suggest that marketplace signals reflect the differences in the distribution of natural capital (RM #111 being the principal outlier). Average prices for land in areas where average crop yields are highest are higher than those paid in areas where average yields are lower. That said, the average yields that those land prices tend to reflect are calculated for the past 10 years when (with the exception of the relatively localized Ponteix drought pocket, which includes RM #76) none of the communities experienced more than two consecutive years of severe drought. Current land values would conceivably have less relevance in a future where severe droughts extended beyond two years.

Clearly, the distribution of natural capital is a critical factor in determining the adaptive capacity of communities and individual production units to drought.

Economic capital

The availability of economic capital for communities and individual farm and ranch production units also imposes a significant constraint on adaptive capacity in the face of prolonged drought. According to many of our respondents, the relationship between input costs and commodity prices over recent decades has limited the amount of capital available to withstand back-to-back crop failures. In addition, agricultural producers were virtually unanimous in proclaiming the inadequacy of the current suite of federal-provincial risk management programs for sustaining them through more than two or three years of drought-induced crop failures. Despite their high degree of technical expertise, the adoption of improved farming practices and investments in state-of-the-art equipment, producers in the study communities remain highly vulnerable to multi-year drought. The inadequacies of some government programs as a financial backstop in the face of a farm income crisis (due to drought or some other hazard or combination of hazards) combined with one-size-fits-all programming, cumbersome application procedures and untimely payouts has contributed to a high degree of dissatisfaction and alienation between producers and senior government agencies.

Similarly, a lack of economic capital has the potential to frustrate the efforts of rural-urban communities to cope with the water treatment and delivery challenges that would arise should their current systems fail due to drought. Solutions to the problems faced by our study communities in the past typically came with high price tags. While cost-shared grant support was provided to Maple Creek, Maidstone and Kindersley, for example, there is no certainty about the availability of similar funding in the future. The expense of upgrading its water treatment system placed considerable financial and emotional stress on the town council and community of Maple Creek. One can reasonably imagine a point when local ratepayers are simply incapable of financing system upgrades through higher taxes and water rates.

THE KEY OBSERVATIONS IN BRIEF:

1. Most respondents predicted two to three years' resilience under the existing suite of government-supported risk management programs, although in some areas, producers have experienced two or more exposures to drought that resulted in well-below-average crop yields (Ponteix pocket 2005-2009) and many are still there. As one respondent noted, without additional research, we cannot know how many producers might have been forced out of agriculture by drought and/or other factors, and how those who stayed managed to do so. We assume it would likely be due to off-farm income, patient creditors, savings, selling land, etc. A cursory look at average crop yields and pasture and forage reports for RM #76 suggests that while pasture conditions and crop yields were stressed in the drought pocket over the 2005-2009 period, losses did not constitute the same degree of crop failure in all years as the droughts of 1988 and 2001-2002 produced in many areas of the province (see the Appendix for yield data). Without additional research we can only speculate about the factors influencing resilience in association with that prolonged particular drought. Nonetheless, a severe three-year drought will be big trouble and the projections indicate that this is possible. Many producers simply lack the economic capital and institutional support to cope for longer than three years.

2. The producers in all areas are highly adapted technologically to current conditions (probably as well adapted as dryland farmers anywhere on the planet). They are technically adept but still vulnerable due to their economic condition as well as the constraints imposed by natural capital.

3. Ranching appears to be more resilient than dryland annual crop production in the southwest corner of the province, given its greater suitability to the climate/ecology. The expansion of ranching in the face of droughts longer than two years is foreseeable.

4. Senior levels of government are not well connected in the region and this is exacerbated by the restructuring of PFRA/AESB. The disconnect between people at the local level and central government agencies threatens risk management program quality, uptake and delivery. Regionally and locally scaled and managed programs are preferred by people at the local level (e.g., FRWIP).

5. Most of the areas studied had no water source protection plans or watershed stewardship organizations. This type of local water governance participation could be particularly useful for water users in the Cypress Hills watersheds and could be a component of long-term planning around irrigation and drought mitigation for farm and urban water users.

6. Oil and gas activity are contributing to incomes in a significant way in some communities (coal and power generation in Coronach's case), but how long will these resources last? Can we expect further surges in exploration? What happens to the communities when these income opportunities dry up?

A wheel-move irrigation pivot in the Frenchman River valley.

FUTURE EXPOSURES

Both the paleoclimate data and the future climate projections presented in this report suggest it is plausible to assume that droughts will become increasingly common and more severe for the study communities by the second half of the current century. The paleohydrology data for streams in the southwest of the province suggests that droughts of much longer duration than those with which the RCAD respondents are familiar could potentially reoccur. The data provided in Figure 1 on page 41, for example, describes a period lasting from 1883 until around 1910 (a 27-year stretch) when there were very few years when streamflows were more than 0.5 m^3/sec above the reconstruction average. And, there were several years of well-below-average flows. A notable feature of the streamflow data presented is its conformity with the experience of our irrigator respondents in the Cypress Hills region. Our respondents reported a general reduction in the depth of winter snow packs, low runoff, declining streamflows and low reservoir levels from the late 1970s until 2010. These conditions had significantly reduced their ability to irrigate. The data is also compatible with respondent assertions that snow packs and streamflows had typically been adequate for meeting the needs of irrigators in the 1960s and most of the 1970s. A poignant example of changes in streamflow patterns is provided by the story of Ducks Unlimited's Orleans Lakes project constructed south of the Cypress Hills in 1946-1947 to divert reservoir water to potential waterfowl nesting areas. By the late 1970s, streamflows had become too low to supply the system and it was abandoned. A major driver of the variability of Western Canada's hydroclimate, the Pacific Decadal Oscillation (sea surface temperatures in the North Pacific), shifted in 1946-47 and then in 1976-77. This 30-year period had mostly high water levels, with low water levels in the preceding and following 30-year periods.

The climate projections presented indicate that while there will be increasing wintertime precipitation through the 21st century, higher winter temperatures will likely result in higher snowmelt and evaporation rates and less spring runoff. Evapotranspiration due to higher summer temperatures can likely be expected to increase the region's annual moisture deficits. In effect, the projections indicate the climate will be warmer and drier, and streamflows will on average be lower than the historical average. Furthermore, higher temperature regimes are predicted to increase the potential for extreme rainfall events—with the higher capacity of warm air to hold water vapour and transport it into our region.

Clearly, there is no absolute assurance that any of the climate projections presented will prove accurate, or that the climate patterns and moist-dry cycles of the past will repeat themselves. However, the past climate patterns presented and the projections provided constitute the extent of our scientific understanding. They are the best we can provide given what we currently know about the region's climate and climate change. With those qualifications in mind, the research tells us that communities in the Palliser Triangle could be exposed to droughts that exceed anything experienced during the 20th century and the first decade of the 21st century. Given the challenges currently limiting the adaptive capacity of agricultural producers to drought, and their two-to-three-year threshold of resilience, the status quo is likely unsustainable when we look several decades into the future.

The climate projections suggest that communities that are currently experiencing challenges due to low local runoff and declining surface water supplies, such as Gravelbourg, can likely expect these problems to worsen over coming decades. In the absence of detailed groundwater data and mapping, we do not have an accurate idea of the vulnerabilities of source water supplies for communities such as Maple Creek, Coronach, Shaunavon and Maidstone. It is widely assumed that the South Saskatchewan River provides Kindersley with a relatively drought-proof water supply. It would nonetheless seem reasonable to wonder whether even that source would remain entirely reliable decades into the future. The sustained pre-settlement droughts revealed in the tree ring record would have severely impacted even the large rivers; confirmation comes from the archives of the Hudson Bay Company, which could not move furs on the Saskatchewan River "for want of water" (Sauchyn and Beriault, 2003). As one respondent stated, "If that source [the South Saskatchewan river] fails, we might as well all pack up and move out of the country."

The Saskatchewan Watershed Authority is currently working to complete a comprehensive groundwater mapping exercise for southern Saskatchewan. Once completed, we may have the data required to develop plans around groundwater options for communities whose surface water sources or current groundwater supplies fail due to drought. As it stands, these communities have no viable "Plan B" should their water sources prove inadequate.

Preparedness planning for severe prolonged drought is lacking across a wide range of government and community institutions. Enhancing adaptive capacity in support of long-term community and agricultural sustainability will require policy-makers, communities and agricultural producers to recognize the current state of adaptive capacity and develop strategies for dealing with exposures that exceed current levels of resilience.

OBSERVATIONS, QUESTIONS AND SUGGESTIONS RELATED TO FUTURE EXPOSURES:

1. Given the potential implications of climate change on dryland farming and Saskatchewan's town and country communities, a broadly based discourse (that includes the relevant stakeholders) addressing drought preparedness and the future of dryland agriculture is essential. Efforts to develop and support the forums and institutions required to facilitate that discourse should begin now.

2. Producer and community perceptions regarding senior government risk management programming and water management could be improved by scaling programs to the local level as opposed to one-size-fits-all programming designed to operate at a region-wide level. Retaining and/or establishing a local presence for senior government agencies, combined with community stakeholder participation, could enhance program design, delivery and local buy-in.

3. The state of the irrigation systems in southwest Saskatchewan is troubling. Based on climate projections, the need for irrigation will be greater in the future but less water will be available. Irrigators and policy-makers are asking whether increased storage is the answer—or whether the projects should be abandoned. These options, among others, are currently under consideration. This is an area in which classic policy-making dilemmas associated with risk aversion and "no regrets planning" feature prominently. From the perspective of the ranchers in the area, who rely on irrigated hay for winter feed, operating without irrigation is a daunting prospect since it would require them to purchase feed and cope with the associated net income reduction. A reduction in winter feed supplies produced within the region could reduce the advantages of cow herd overwintering, possibly prompting increased grazing of yearlings raised outside the region. Alternatively, warmer open winters (winters with reduced snow pack) could facilitate an increase in cow herd winter grazing, provided producers have access to additional grazing acreage. The longer growing seasons predicted by climate projections suggest potential benefits through the production of higher value crops in the area—provided irrigation can be sustained. This is the sort of potential climate change benefit that planners should also be considering. Furthermore, should speculation regarding the effects of the Pacific Decadal Oscillation prove accurate, the next few decades could constitute a moist phase. If so, abandonment of the irrigation projects in the southwest would not allow for the realization of potential benefits available through irrigation.

4. Local social capital appears quite high in the Maple Creek and Shaunavon areas. It is therefore somewhat surprising that irrigators from those communities have not yet developed a more robust community-based response to the problems associated with the poor performance of the irrigation systems in the southwest and the PFRA/AESB's planned departure. Based on the examples of community solidarity and innovative solutions to past challenges, it is conceivable that the irrigators and other community organizations will develop solutions, provided they have the required time to organize and study their options.

   It is also possible that financial support from senior governments will be required to bridge the irrigators over from a government-owned-and-managed system to a locally managed system. This assumes that stakeholders conclude the systems can be made viable over the long term. Arguments do arise in relation to the subsidization of particular producer groups such as irrigators. The consensus of policy-makers and communities in other areas of the Palliser Triangle, such as the Taber and Lethbridge irrigation districts, is that the increased production and economic spin-offs generated by irrigation more than make up for taxpayer investments (Warren and Diaz, 2012). Irrigators in southwest Saskatchewan may or may not be able to successfully make a similar case.

5. The Saskatchewan Watershed Authority has been active in supporting the establishment of local watershed stewardship groups that provide community input into source water protection planning. Maidstone and Shaunavon both fall within the purview of established watershed committees. The creation of a similar body for the Cypress Hills area watersheds could form the basis for community-based planning that integrates rural-urban community and agricultural producer water use concerns.

6. Coronach's long-term economic future is precarious given the expected mine closure in 2039. The closure of the mine and power plant should, however, reduce demand on the area's water resources. Given the implications of the power plant and mine closure for the area's population, it is questionable whether the pipeline from Lake Diefenbaker, imagined by some area residents, would ever be built. An additional challenge related to that option is the environmental problem presented by an inter-basin transfer of water (from the Hudson Bay drainage basin to the Gulf of Mexico drainage basin).

7. Gravelbourg's water supply is vulnerable to prolonged drought. Is a pipeline connection to new wells or the South Saskatchewan River system the best long-term solution? Such measures would be expensive, but planners need to ask whether Saskatchewan can afford to lose communities of this stature in the region and not see agricultural activity jeopardized? Once such a line is extended to Gravelbourg, it would potentially be feasible to extend it further to other communities—perhaps even Coronach.

8. Water supplies for other rural-urban centres are also vulnerable—Kindersley is assumed to be in a sound position, and supplies should be secure, barring a collapse of flows in the South Saskatchewan River. Shaunavon's groundwater supply has never failed, but what if it did? Maple Creek's supply is potentially vulnerable to drought and high infrastructure maintenance costs. As noted above, more extensive groundwater information would assist communities in planning their options should their current sources prove inadequate.

9. Maidstone was surprised by the drought of 2002. Producers in the area coped despite the fact that many did not participate in Crop Insurance. One of the observations to come out of our research is the fact that crop failures due to exposure to natural hazards were something producers in the area were accustomed to. Drought was a rare event, but producers in the area were familiar with crop failures due to frost, wet harvests and hail. One suspects that if droughts became more frequent in the area, producers would be relatively capable of adapting in much the same way as have their counterparts in more southern neighbourhoods. The higher prices paid for farmland in the Maidstone area could be an added burden for producers who have land mortgages if their yield rates become more similar to those obtained in some regions within the Palliser Triangle (see the Appendix for yield and land price data).

10. Many (but by no means all) of the respondents interviewed in connection with this study were sceptical about anthropogenic climate change. That said, there is a wide consensus among rural community members, and agricultural producers in particular, that climates undergo significant change over time. Indeed, many respondents reported on the decadal level changes that have occurred over the course of their farming or ranching careers. The potential for severe protracted droughts over coming decades is also widely appreciated and can serve to encourage communities and policy makers to engage in greater preparedness planning as identified in point 1 above. However, optimizing preparedness efforts will require greater appreciation of the interaction between the climate conditions induced by global warming and the historical and paleoclimatic conditions experienced on the prairies. How greater awareness of these factors might be encouraged among community members and policy makers is an important challenge confronting those who hope to enhance the adaptive capacity of rural communities in Saskatchewan.

Table 1. Agricultural census, yield, and land value data

	2006[a]						10 yr. average yield[b]		Average land sale values /acre[c]	
	No. of Farms	Avg. age Farmers	Total hectares	% area in crop	No. cattle including calves	Gross receipts	spring wheat	canola	cultivated land	pasture land
Maple Creek Study Area										
RM of Reno #51	154	52.3	343,971	15%	35,452	$26,631,066	23.28	15.37	$260	$165
RM of Piapot #110	134	51.2	180,032	19%	40,796	$27,631,146	27.26	15.20	$503	?
RM of Maple Creek #111	219	51.4	321,011	17%	60,519	$45,447,985	22.45	21.72	?	$469
RM of Big Stick #141	73	51.4	80,128	27%	11,311	$11,680,076	29.10	?	?	?
							Avg: 25.52	Avg: 17.43		
Shaunavon Study Area										
RM of Lone Tree #18	74	52.4	82,744	54%	5,695	$16,288,799	26.32	?	$313	?
RM of White Valley #49	192	51.8	202,501	38%	34,681	$29,559,509	27.43	16.90	$367	?
RM of Auvergne #76	103	50.8	84,482	57%	14,389	$16,495	22.00	15.60	$502	$351
RM of Grassy Creek #78	86	49.7	84,213	38%	11,971	$14,168,551	26.27	17.15	$421	?
RM of Arlington #79	82	52.7	75,217	45%	11,638	$15,599,476	26.00	21.76	?	?
RM of Bone Creek #108	91	54.2	60,545	64%	6,370	$17,518,809	29.78	21.88	$627	$346
							Avg: 26.30	Avg: 18.66		
Coronach Study Area										
RM of Hart Butte #11	107	50.8	70,711	57%	9,729	$13,059,619	23.71	16.59	$527	$219
Gravelbourg Study Area										
RM of Gravelbourg #104	139	52.1	84,515	71%	4,507	$17,720,587	25.70	20.00	$603	?
Kindersley Study Area										
RM of Kindersley #290	295	53.2	211,483	56%	7,897	$47,489,460	27.92	24.26	$823	$202
Maidstone Study Area										
RM of Eldon #471	163	50.9	96,919	57%	15,485	$23,090,142	35.67	28.67	$883	?

a Data derived from Statistics Canada 2006 Agriculture Comminity Profiles www.26.statcan.ca:8080/AgrProfiles/cp06/ accessed March 15, 2012.

b Data derived from Saskatchewan Ministry of Agriculture Crop Yield by Municipality www.agriculture.gov.sk.ca/rmyields accessed March 15, 2012.

c Data derived from Farm Credit Canada, Farmland Values on Line www.fcc-fca.ca/en/onlineservices/flv online service e. asp accessed March 13, 2012. Average prices for the period between February 2010 and February 2012.

? Indicates that either no transaction occurred or fewer than three transactions occurred.

Table 2. Spring wheat and canola yields for study area rural municipalities (RMs), 2001-2010

	2001*		2002*		2003		2004**		2005		2006***		2007		2008		2009		2010	
	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola	wheat	canola
Maple Creek Study Area																				
RM of Reno #51	10.1	?	28.1	?	21.5	?	30.1	20.0	25.4	17.7	14.9	8.5	20.4	8	22.8	18.0	25.9	13	33.6	22.4
RM of Piapot #110	8.9	?	21.9	?	24.7	5.9	31.6	15.0	25.9	?	22.4	13.0	27.4	?	37.5	?	37.5	?	29.3	19.4
RM of Maple Creek #111	5.0	4	28.0	?	15.4	17.0	31.5	30.0	33.0	32.5	15.8	?	24	?	18.2	24.3	15.0	?	45.7	33.3
RM of Big Stick #141	8.9	?	21.6	?	26.0	?	33.8	?	37.5	?	29.4	?	27	?	39.2	?	39.2	?	28.8	40.0
Avg.	8.225	4	24.9	?	21.9	11.45	31.75	21.7	30.45	25.1	20.625	10.75	24.7	8	29.425	21.15	29.4	13	34.35	28.775
Shaunavon Study Area																				
RM of Lone Tree #18	21.8	?	30.0	?	21.5	?	35.1	?	25.8	?	19.8	?	16	?	26.3	?	29.7	?	37.2	18.7
RM of White Valley #49	21.1	11.8	33.4	23.1	24.1	7.8	33.3	17.2	29.1	18.3	20.5	?	21.9	12.1	24.4	?	32.0	?	34.5	28.0
RM of Auvergne #76	16.0	10.0	24.8	15.0	19.4	10.0	34.5	27.5	22.3	20.0	11.6	17.0	13.2	10.7	21.7	15.0	26.4	15.0	30.1	?
RM of Grassy Creek #78	21.0	?	24.5	17.8	24.3	13.9	35.6	26.3	30.0	22.2	19.9	8.0	22	13.0	27.6	12.5	31.7	23.5	26.1	?
RM of Arlington #79	18.9	15.9	27.8	14.8	24.4	15.5	34.6	28.9	27.4	21.1	15.7	?	25.7	19.5	25.4	?	31.0	35.7	28.7	22.7
RM of Bone Creek #108	18.7	9.3	26.4	20.5	28.8	12.7	36.8	27.2	40.1	24.1	23.9	18.1	23.4	16.0	33.4	27.2	33.5	37.5	32.8	26.3
Avg.	19.583	11.75	27.817	18.24	23.75	11.98	34.983	25.42	29.117	21.14	18.567	14.367	20.367	14.26	26.467	18.233	30.717	27.925	31.567	23.925
Coronach Study Area																				
RM of Hart Butte #11	24.2	13.2	22.6	?	19.9	7.2	26.5	23.9	24.5	20.0	15.7	9.0	23.1	11.3	24.1	?	30.3	?	26.2	31.5
Gravelbourg Study Area																				
RM of Gravelbourg #104	22.1	16.6	24.3	18.6	19.6	9.6	33.2	35.2	27.8	18.5	21.7	16.1	22.7	14.0	24.4	?	28.5	?	32.7	31.5
Kindersley Study Area																				
RM of Kindersley #290	15.1	8.7	9.6	?	22.0	16.4	35.4	28.9	41.1	32.3	28.7	22.1	28.7	16.6	32.8	34.1	30.3	24.4	35.5	34.9
Maidstone Study Area																				
RM of Eldon #471	30.7	24.6	8.7	16.9	17.8	14.4	41.6	28.2	45.2	35.6	40.1	32	40.3	31.4	44.2	36.7	45.8	34.4	43.2	29.1

* Indicates years of widespread drought in Saskatchewan.

** Indicates a year with widespread early killing frost (e.g., August 2004).

*** Indicates a widespread hot dry growing season with an early harvest.

? Indicates that the Saskatchewan Ministry of Agriculture did not report a figure because a) no canola was grown in the RM; or b) fewer than three producers grew canola and privacy might be compromised by reporting yields.

These observations were provided via e-mail correspondence with Ms Terry Bedard, Saskatchewan Ministry of Agriculture, March 13, 2012.

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IN THEIR OWN WORDS:

Comments from respondents interviewed for the RCAD project

One thing we always worry about is drought. That's one reason our methods of farming have improved so much. The goal has been to make use of every drop of rain. The big changes include going to these air drills and to continuous cropping.
A farmer from Shaunavon, Saskatchewan

We're always conscious of the things you need to do to conserve moisture in a dry country. But, at the end of the day we are still dependent on rain. If you don't get the rain there isn't much you can do. But I also believe we are less exposed to the impact of drought now than we were several years ago.
A farmer from the Aneroid area, Saskatchewan

Drought is just one of the hazards people face in agriculture. For example, we started farming in time to catch the high interest rates in the 1980s. They ran up to 27%, but somehow we're still here. So there are issues besides drought that can frustrate you.
A farmer from Bracken, Saskatchewan

Coping with drought is just one of many management problems you deal with running a farm. When prices are poor and costs are up, you have to be a good business and money manager, too.
A farmer from Shaunavon, Saskatchewan

I think agriculture is like life. You've got to look at it over a 20-year span. You don't wait until you're in the middle of a drought to worry about drought. Or wait until you're in the middle of a flood to worry about flooding. You never know what's coming next year. You have to make some plans and be ready for things. You can't simply look at average conditions and plan around that. An average gives you a flat line graph, and that's not what you get from year to year.
A farmer from Shaunavon, Saskatchewan