2011

Vulnerabilities & Adaptations to Extreme Climatic Variability

Old Wives Lake Watershed

An analysis of socio-economic vulnerabilities to drought and excessive moisture events in the Old Wives Lake Watershed.

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7/22/2011

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Description of the Old Wives Lake Watershed

Overview

The Old Wives Lake Watershed (OWLW) covers a total of 22,500 km2, taking in 23 rural municipalities. The watershed is situated in south central Saskatchewan, between the cities of Swift Current and Moose Jaw. The watershed's primary industry is agriculture. The OWLW was chosen for this study because it has been subject to many extreme drought and flood events.

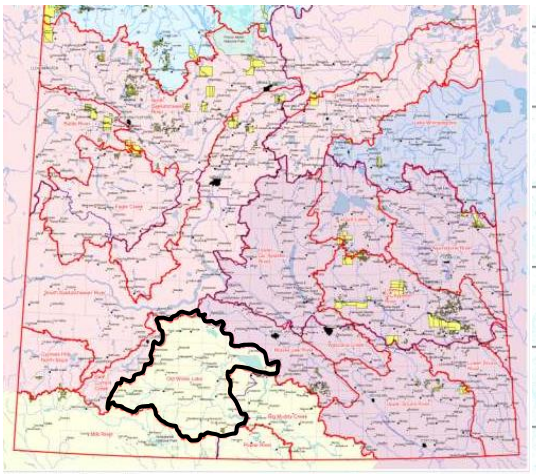

Figure 1. Location of OWLW in Saskatchewan

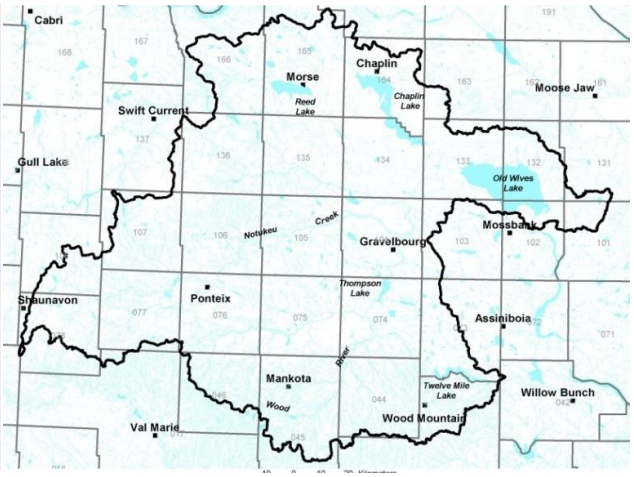

Figure 2. Location of Municipalities in OWLW

Socio-Economic Characteristics

When looking at population and employment statistics, several municipalities were chosen to provide a snapshot of what the most current data is showing for across the entire watershed. Municipalities were chosen based on their geographic location within the watershed, urban municipalities include Chaplin, Gravelbourg, Shaunavon, Mankota, and Hodgeville; rural municipalities include Mankota No. 45, Wise Creek No. 77, Gravelbourg No. 104, Coulee No. 135, and Chaplin No. 164.

	Pop. 2006	Pop. 2001	% Change
Sample Rural Municipalities	1580	1815	-13%
Sample Urban Municipalities	3395	3677	-8%

Table 1 Sample Municipalities Populations

Between 1996 and 2001 the sample municipalities showed declines in both rural and urban municipalities of 13% and 8% respectively. Participants of the interviews corroborate these statistics through the numerous citing of younger demographics out-migration to cities.

Industry within the OWLW is dominated by agriculture. People may be employed in the mineral and oil & gas industries, but extraction primarily takes place outside of the watershed boundaries. Although there is a difference of 38% between rural and urban municipalities employed within agriculture, the

rural municipalities act as service industries for the agricultural industry. Notable employment sectors include health care, educational services, retail trade, and business services. This diversification amongst industry sectors in the urban municipalities help to create a stark contrast in income; with urban municipality doubling rural municipality's median earnings.

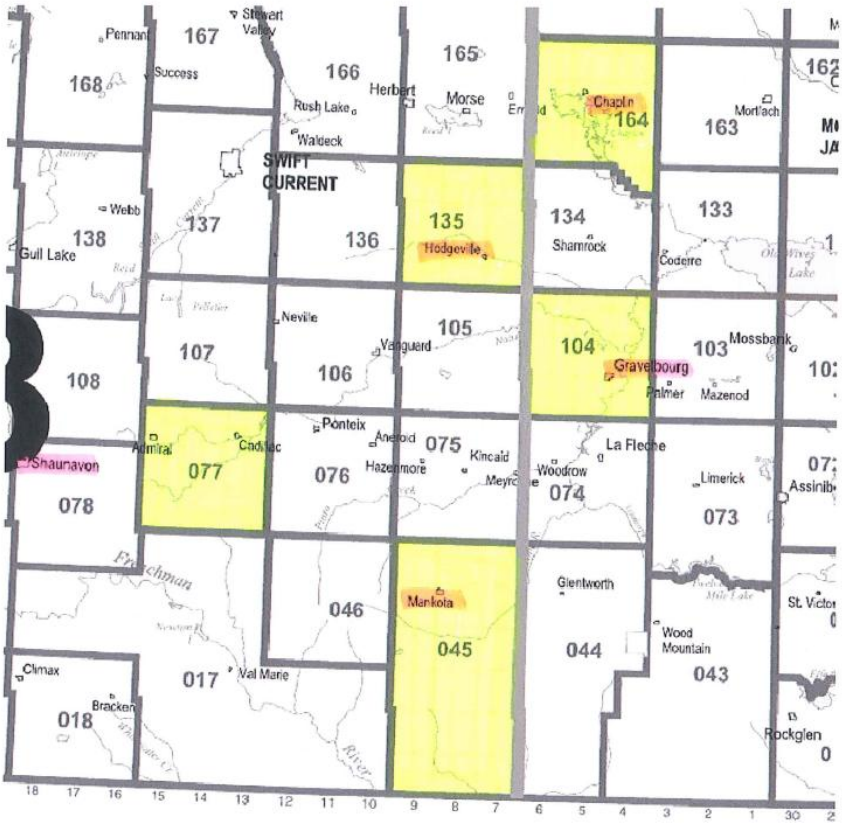

Figure 3 Location of Select Municipalities

	Sample RM's		Sample Urban's		Difference between rural and urban in 2006
	Total	%	Total	%	
Total labour force 15 years and over	1055		1660		
Agriculture and other resource-based	600	57%	305	18%	38%
Construction	55	5%	50	3%	2%
Manufacturing	20	2%	125	8%	-6%
Wholesale trade	20	2%	65	4%	-2%
Retail trade	35	3%	180	11%	-8%
Finance and real estate	30	3%	50	3%	0%
Health care and social services	90	9%	235	14%	-6%
Educational services	85	8%	155	9%	-1%
Business services	45	4%	190	11%	-7%
Other services	75	7%	265	16%	-9%
Median Earnings	$14,953.00		$32,364.00		-$17,411.00

Table 2 Select Municipalities Industries

Water Resources

The OWLW is unique in that it is internally drained. All water sources are contained within the watershed, and water only exits through evaporation and groundwater seepage. The watershed is sometimes included in the Missouri River Basin; if it were to flood significantly to an unprecedented level it would eventually drain south.

Primary source waters occur as springs and snowmelt along the southern border, dubbed 'the divide'. These waters eventually develop into the Wood River. Other major spring and snowmelt source waters develop in hills nearby Pambrun and Hodgeville, which help to create the Notukeu Creek. All major waterways eventually collect in the Old Wives Lake in the Northeast section of the watershed, where the only outflow occurs through a set of controlled canals running into Chaplin & Reed Lake to help service Saskminerals, sodium sulphate plant. Remaining water in the Old Wives Lake typically evaporates, leaving behind significant mudflats.

Major lakes within the OWLW are primarily saline; these include Reed Lake, Chaplin Lake, Old Wives Lake, and Twelve Mile Lake. These lakes are characterized by water source waters containing a high salt or minerals content. The water then evaporates, leaving behind any dissolved salts. Salt production occurs along the northern edge of Chaplin Lake. Water is diverted north from Old Wives Lake to Chaplin Lake so that it increases the available amount of salt to dissolve from the water. Ponds and gates are used to control this site in order to maximize the rate at which the water dissolves. Like agriculture, this industry is highly dependent on seasonal spring runoff.

Freshwater lakes within the watershed are developed from dam structures along major waterways like the Notukeu Creek and Wood River. These lakes are primarily used for irrigation, municipal drinking water, and recreation with several regional parks located adjacent to them.

Figure 4. OWLW Hydrology

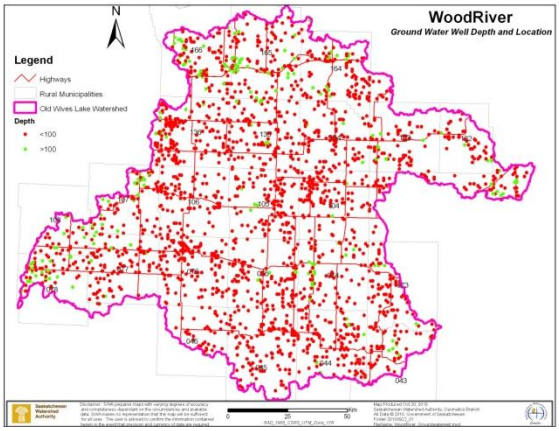

Figure 5. Location of wells in OWLW

Most farmyards and some municipalities rely on ground water wells for water supply. The quality and quantity of these wells are highly variable; this is verified by the interview participants. Participants reported the quality and quantity of wells to range from excellent and highly potable to undrinkable. In undrinkable situations, water was then either supplied from a pipeline or hauled in to a cistern for

consumption. As seen in Figure 5, most groundwater wells do not exceed 100 m and there is not a distinct pattern in the location of the wells. Wells that do exceed 100 m are more localized, occurring in regions to the north and the southwest. This may be attributed to regional geologic differences like the bearpaw formation (silt & clay aquitard) overlaying other surficial aquifers. This also may be attributed to municipally drilled wells drilling deeper to ensure supply water to several users along a buried pipeline.

Water resources in the OWLW have always been highly variable and acted as a limiting factor towards agricultural production. Both feedlot and irrigation development has been impacted in the past from a lack of available water resources. Significant improvements in water supplies have been made in the last 10 years with the development of the Farm & Ranch Water Infrastructure Program. The program was cited numerous times when talks centered around how participants got their water and how secure their water sources are.

Climate

The OWLW is situated in Saskatchewan's mixed grassland ecoregion. It is bordered to the northeast by the Missouri Couteau hills, and to the south and west by the Wood Mountain Uplands. These areas are predominately made up of pasture land for cattle grazing as their topography is unsuitable for conventional annual cropping. The majority of the area spreading across most of the interior of the watershed is used as annual cropland. When conducting interviews across the watershed, it was a point of emphasis to get strong representation from landowners and residents that live and work across all different areas of the watershed.

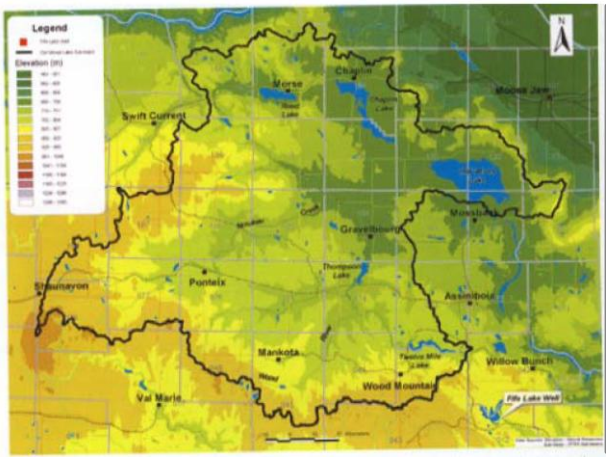

Figure 6. Elevation in OWLW

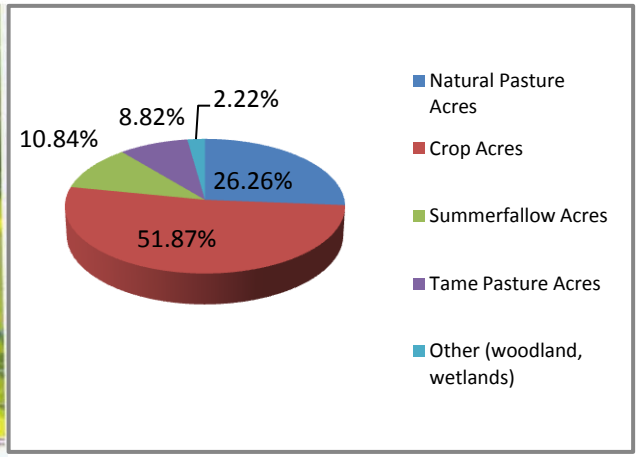

Figure 7. Land Use in OWLW

From averaging the Shaunavon, Chaplin, Gravelbourg, Mankota, & Assiniboia 1971 – 2000 climate normals, we can find the watersheds broader climatic trends. The OWLW receives an annual average daily temperature of 4^{o}C and receives 375mm of precipitation per year. The watershed is characterized by snowfall between November and March, followed by periodic rainfalls beginning in May until September. This type of climate is typical for dry grassland ecoregions, as it will primarily support only

smaller vegetation, rather than large tree stands. Bluffs of trees and shrubs are found in hilly, north facing slopes. The shade provides a cooler, wetter microclimate.

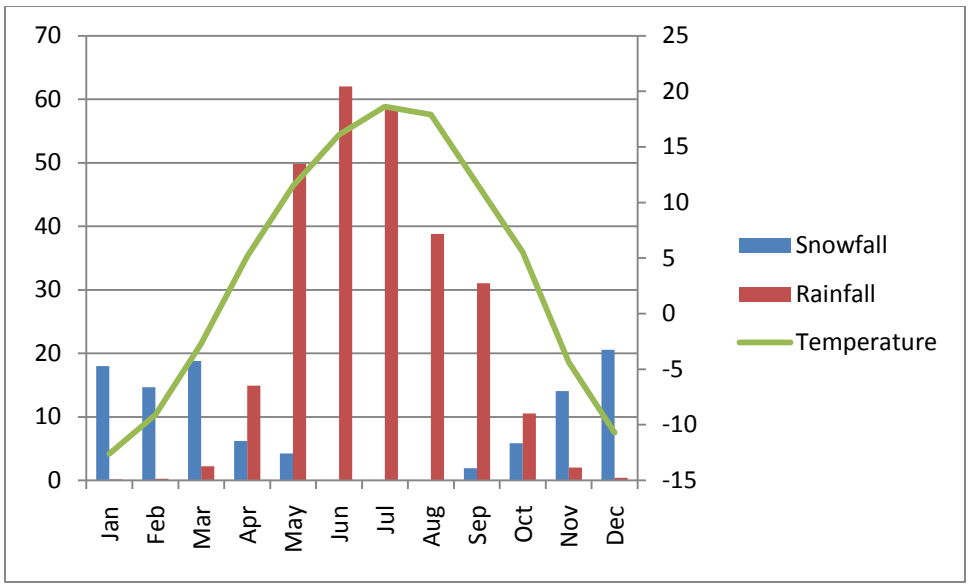

Chart 1 OWLW Climate

The Watershed Assessment

Objective

The objective of the watershed assessment study was to gain insight into the socio-economic vulnerabilities to drought and excessive moisture events within the OWLW, and how they're adapted upon. Specific exposures in the NSRW including agricultural production, institutional/financial, and social practices are all significantly impacted by these events. Agriculture is the primary driver of the economy in the region, and has a direct connection with climatic events, which makes it the main focus of concern within this report.

Procedure

Sources of information for the vulnerability assessments include census data, secondary watershed reports, past community vulnerability assessments, and most importantly, direct data gathered from interviews conducted with respondents across the watershed. The respondent's data contains information used to find trends in past exposures and vulnerabilities to climatic events, and how they have responded.

Over the course of October – December 2010, 60 face to face interviews were conducted with residents of the OWLW. A list of potential respondents was developed through contacting and interviewing local municipality administrators and regional government employees in the Agriculture sector. These initial contacts were seen as the 'gate keepers' of the region, helping to provide respondents that would provide positive feedback upon initial over the phone contact. They also provided general overviews of their respective regions dealing with past climatic issue occurrences, socio-economic issues faced at council tables, and current water resource availability.

Timing of these interviews was essential over this period as many of the respondents were agricultural producers and would be too busy at any other point of the year to conduct an interview. Many of the interviews were also conducted during the evening as it became more apparent during scheduling and the interviews that producers were busy with off farm jobs during the day.

"I think one of the biggest adaptive strategies is pretty much almost everybody working off the farm."
- Respondent

Most respondents contacted about an interview were extremely responsive, as they saw the importance of the project, as well as the unique opportunity to voice their concerns.

The interviews followed a semi-structured format based upon conversation rather than questions and answer. A list of essential information to collect at each interview was followed. All interviews were digitally recorded and transcribed. They were then coded using the qualitative analysis software package, NVivo. This software developed categories using quotes from all the transcriptions based on water use, vulnerabilities, etc.

Agricultural Production Exposures

The OWLW is part of an area in southern Saskatchewan that has been plagued by droughts ever since settlement in the late 1800's. From 1857-1859 John Palliser lead a survey expedition to Canada's west where he would discover an area stretching across southeast Alberta and southwest Saskatchewan was unsuitable for growing crops due to its dry nature (Anderson A. , 2006). Dubbed Palliser's triangle, the OWLW is entirely contained within the most extreme regions of this area. During the time Palliser explored Canada's west, the prairies and the OWLW, were engulfed in one of its many periodic droughts. Particular droughts that stand out amongst interview respondents include 1961 - 63, 1981, 1984 – 88, and 2004-08. Because the OWLW is quite large, many respondents listed different years that were impacted by drought. Based on where they lived many respondents would contradict others when citing bad years. However, all agreed that periods throughout the 1960's, 80's, and 2000's incurred droughts.

"To put this into perspective, in the Good Book when it rained for 40 days and 40 nights and Noah built his arc, we got a tenth of an inch here". – Respondent

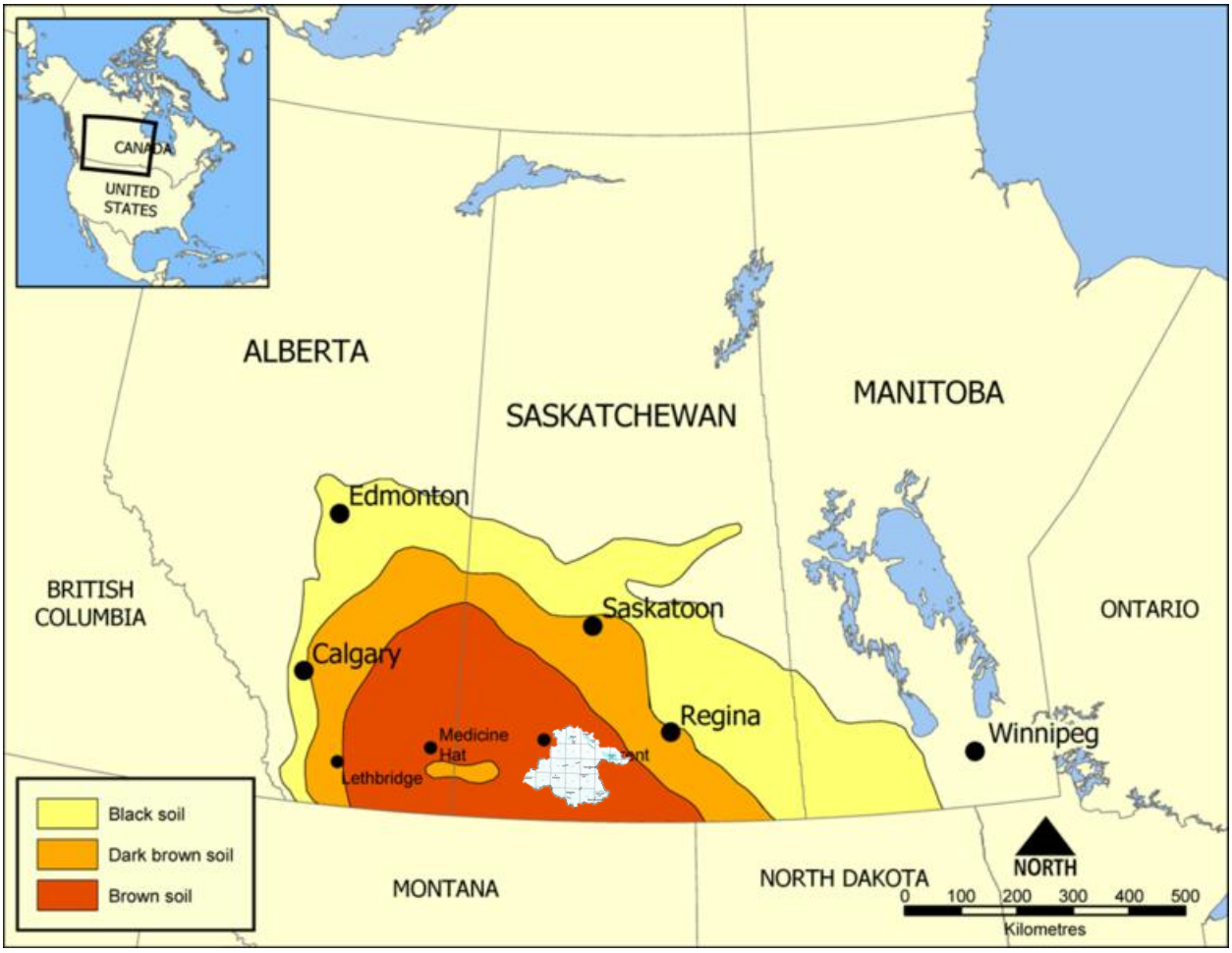

Figure 8 Palliser's Triangle

Respondents reported that 5 – 10 inches of rain throughout a growing season is necessary to receive a good production of forage and crops. Many placed 5 inches of rain as a dividing line between having poor and good production. This basis has many variables attached to it, including the timing of precipitation, the existing water table, the amount of runoff in the spring, and the amount of heat incurred throughout those seasons.

"But you know this country is sort of funny because if you can have a good reserve in the fall, you don't need that rain the next year in order to grow a half decent crop as long as the weather is not too hot, cools at night, and you get a lot of dew. The cool nights, we have seen that happen". – Respondent

Determining what these producers consider is a good production of forage and crop is also important as it helps to determine the perceptions of producers in the OWLW. Many respondents noted that 30 bushels/acre of spring wheat would be a successful crop while acknowledging that in other parts of the province that amount of yield would be considered a very poor crop. Essentially it comes down to whether the producer is getting a return which is greater than their inputs. Although their yields are much lower than other parts of the province, they also put fewer resources, such as time, seed, fertilizer, and chemical application rates. Investing less in their crops lowers the amount of risk that is associated with seeding the crop each year. Acknowledging this risk factor is important when examining the exposures associated with agricultural production and adaptation strategies to extreme climatic events.

"They are getting 2 to 3 times the rain we are. You get that kind of rain and you can put down that kind of fertilizer. How do you guess down here what year is going to bring what rain?" – Respondent

Fires in the OWLW were once very common as a natural occurrence within grassland biomes. It has now been relegated to more southern parts of the watershed as most areas are cultivated and annually cropped, leaving little tinder and groundcover to catch fire. In years where there is good forage growth followed by a dry harvest period, fires can become an issue. Dry storms with lightning but without rain are the primary cause. Although they can range in sizes up to square miles and consume significant amounts of forage that would have otherwise been grazed, they are largely not an issue for producer's bottom line. No respondents were able to specify a fire which created a safety concern.

Richardson's ground squirrels and insects also seem to be a side effect of droughts. Many producers viewed an increased prevalence of these pests during dry periods and that they have a much more damaging effect during those years. The evidence of population increases during dry years may be due to less mortality from drowning and a reduced amount of foraging materials outside of crop and pastureland. These pests can have a significant impact on many producers' lands with entire crops being ruined from their foraging. There is a strong desire for control on gophers through strychnine despite its ill repute from the general public. Grasshoppers and other smaller pests are controlled through insecticide, which is generally applied upon identification during midseason crop growth. These are all costs borne by the producer.

Excessive moisture concerns amongst respondents within the OWLW are largely marginalized in comparison to drought; despite the recent excessive precipitation which occurred during the

interviewing period. At times, excessive rain during seeding, harvesting, and haying periods results in delays. These delays result in lower quality and yields for the crops and forages. These rains also result in rutting in fields and yards, making accessibility an issue. Respondents also noted that after significant high rainfall years the water table was drawn up significantly, allowing for capillary action[1] to draw salts to the surface and create salinity issues in soils.

With high moisture amounts cattle health can be negatively impacted. Calves are extremely sensitive to exposure and wet conditions only exacerbate problems. During calving periods producers do their best to keep their calving facilities warm and dry. Doing this increases the amount of hay necessary for bedding, as well as all associated costs involved with keeping livestock within confined facilities. Wet conditions can also affect the health of full grown livestock. Poor nutrition results from forages rotting or carrying moisture related diseases, as well as footrot developing from livestock being subject to continual hoof saturation as a result of excess water in pastures.

Erosion issues stemming from excessive moisture have become a very significant issue as of late. Throughout the spring of 2011 numerous gully's developed in annual cropland where some washouts amounted to length in excess of 800 m and depths and widths in excess of 1.8 m. These gullies, if not re-sloped and seeded to perennial forage, can become increasingly larger with subsequent runoff events; scarring producer's fields and inconveniencing them through making more turns and losing more land. These gullies also significantly affect the watercourse they runoff into by depositing enough sediment at times to completely dam off the watercourse.

When excessive moisture issues were discussed, it provided segue into issues of delays and the inevitable damaging effects of early frosts. Some producers, primarily mixed, noted an emerging trend on their farms where they are finding that in spring they are shorter on time than ever before. This trend relates strongly to the shortage of workers now being found on farms.

On years with higher moisture amounts, the crops take longer to ripen. Whether it were spring seeding delays or an unusually early frost occurring in August, some considered frost to be almost as devastating as drought has been throughout the history of the region. The continual degradation of crops year over year puts a significant impact on the bottom line of producers.

Particular interest during the interviews was paid towards climatic variability and global warming theories. There was a strong aversion amongst respondents towards the notion of human cause global warming theories, but many are finding that patterns or what were considered 'normal' is changing. One respondent felt that the weather patterns seemed to be behind a month from what he used to remember as a kid. This month's delay has been resulting crops being seeded later in spring and harvest occurring later on as well into late October and even November. The result is a significant decrease in quality.

Respondents felt that the number of cold weather days and the amounts of snow has decreased. Although respondent's assertion may be correct, improvements in road networks, snow plow

[1] Capillary action is the ability of a liquid to flow against gravity through adhesion.

equipment, and cropping practices reducing blowing snow could all relate to this feeling of milder winters also.

Hail seemed to be a key extreme climatic event amongst many producers in the OWLW. Hail can be a disastrous weather event that can potentially ruin enormous swaths of cropland by damaging and breaking the heads and stalks of most cereal crops. Although the absence of spot loss for hail insurance does detract many from carrying hail insurance, many still seemed to purchase the coverage. Uptake seemed to be primarily driven by the current year's climatic trends. If the year seemed to be a wetter, stormier year, they would opt for the coverage. On drier years there would be less uptake. Purchasing hail insurance is not automatically assumed to take place each year amongst respondents, contrasting crop insurance.

Institutional Financial Exposures

Agricultural Safety Net Programs are largely shared between federal and provincial governments. They have had many different names attached to them with the changes in governments, but all with similar intentions. Programming has been in place since the 1950's to help with situations that are burdening producers and are beyond their control. Situations can include low commodity prices, sudden increases in expenses, and extreme climatic activities; all resulting in a decrease in net income. Programs like Crop Insurance (Agri-Insurance)[2], Net Income Stabilization Account (NISA)[3], and Agri-Stability[4] have all provided producers with long term programming to help ensure income stabilization during disaster periods. These programs all require that producers enroll in the programming prior to any situation, which involves financial obligations.

Crop insurance, developed in 1961, has stood out in particular as the main program developed for producers to help deal with uncontrollable natural hazards like drought, excessive rain, hail, and wildlife. Losses that are controllable or could have been prevented with sound farm management practices are not covered. Crop insurance is based on average yields calculated over the entire acreage of a farm. Yields must be 50 – 80% (depending on premiums paid) below this average for the entire farm in order to receive a payout. The program has had enormous uptake, making it the norm for producers to have

[2] Crop Insurance, largely administered on a provincial basis, provides producers with coverage based on yields. This provides security for producers on years when their yields may not meet there average yields. Producer acceptance to this program is very large in Saskatchewan. In 2001 about 74% of crop area in Saskatchewan carried some level of crop insurance coverage (Lisitza).

[3] The Net Income Stabilization Account (NISA) program was an individual whole farm that was intended to assist agricultural producers in achieving long –term income stability. Producers made deposits to individual accounts equal to a set percentage of their annual eligible net sales. These deposits were matched by contributions from the federal and provincial governments. The opportunity to make an account withdrawal was triggered when individual incomes fell below a threshold or ENS for the year fell below average (Lisitza).

[4] Agri-Stability provides support when producers experience a large margin decline. Producers may be able to receive an Agri-Stability payment when their current year program margin falls below 85% of their reference margin (Agriculture and Agri-Food Canada, 2011). There is much confusion surrounding this programming from producers, with many noting that they feel there is "no rhyme or reason" to how one producer receives payment while another doesn't.

for their farm. Throughout the interviews respondents did however criticize the program for its increases in premiums and decreases in coverage to the point where it may not even sufficiently cover the costs of production anymore. The overall land base and production costs for the average producer has significantly increased while the total amount of farm operations has been reduced. This has led to fewer participants being enrolled in the crop insurance program, and having to make up for that reduction through paying higher premiums. The larger average land base per farm in some ways acts as insurance for many producers because while some areas may experience below average yields, other areas may not because of production variability's. A payout through crop insurance may not be triggered in an event like this, as the average yield is based on the farms entire acreage.

Crop insurance can also be purchased for the establishment and production of hay crops and forage for grazing. Most respondents did not insure these types of production as they felt the value of the crops were too low to necessitate paying the premiums for insurance. The causes of loss to trigger a payment are the same as for annual cropland. There are also many private insurers that will cover mortalities in livestock herds. The crux seems to be that with drought events forage for livestock may be available but healthy secure drinking water may not; there is no way to insure a dugout or well.

Spot loss hail insurance was available as a part of crop insurance to provide coverage on different sections of a farm that were damaged by hail. Rather than it being treated as a loss that reduced the yield percentage for your farm, it was separated so the portion of hail damaged crop would be compensated for regardless of your other crops. Spot loss coverage was eliminated in 2002 and was then being treated the same as damages from droughts or excessive moisture. If average yields remain above the insurance margins on a farm after a growing season, any hail that destroyed crop on that farm will not be paid out. As farms increase in size, the percentage of the area affected by hail may not reduce the overall average yield, but can still impact significant portions of crop that have had all expenses incurred to produce it. The current administration and application of crop insurance does not coalesce with the increase in farm sizes coupled with the increased variability and magnitude of storms reported by respondents across the watershed (Pittman, 2008).

"I mean for us we buy crop insurance but we really look at crop insurance as a liability because we rarely benefit from it. We feel we need to have it in place because of our banking arrangements. They want to see that you have it". - Respondent

Social Exposures

The social dynamic occurring across the agricultural community within the OWLW is similar to all other areas of the province; faced with an aging population and net outmigration of workers. As outlined in the socio-economic characteristics of the watershed, from 2001-06 we see a rural population decline of 13%. Many of the older respondents (50+) reported that there are not enough young laborers available because they are either moving to the city, and/or working on oil rigs outside of the watershed. Many of these potential laborers are even the children of the respondents. They do not blame them for making those decisions, and in many cases, were pushed in the direction of getting off the farm. This was often done subtly as children's involvement in farm operations is less than it was with prior generations, making them less likely to be involved through adulthood. Farms are increasing in size and it would

seem as though labor employment would be crucial for these operations. This is not necessarily the case because quite often gains in efficiency, through necessity, using larger implements on the land make getting the work done that much quicker.

There are bright spots within the social network however where new young families are moving in. Although land costs have risen significantly in the last 10 years, they are still significantly lower than Alberta, where a few families reported moving from. Most families had a connection with the area through relatives living or having lived in the area. However, at this point the trend is not significant enough to ease the reduced and aging population in the watershed.

A decreasing and aging population diminishes the availability of essential services. Education, health care, and emergency protection all have a reduced capacity because of their inherent financial burdens. Adapting to these challenges may be the most crucial for the watershed's future.

"What would make the difference is where you are as far as your debt load is concerned, where you are in your life, like if your just a young farmer starting out and you had a year drought where you didn't get a crop well you know the bank still wants their money for the most part, you would handle less than somebody who's established, has no debt, probably has some money in the bank" - Respondent

Exposure Adaptations

In response to the vulnerabilities and exposures detailed above, this section provides a detail of how interview participants dealt with those situations both in the past and present. As with most of this report, the agricultural community is the primary focus of this section as they are the most vulnerable to climatic changes and extreme weather events.

Agricultural Production Adaptations

Production adaptations are the way that people react and respond to the variability's seen in climatic patterns. A key question to address is how producers in the watershed respond to specific environmental stimuli so that they can not only survive but thrive. The actions taken to adjust to current climatic impacts involve minimizing the negative impacts, and taking advantage of new opportunities presented. Average weather conditions, as well as the frequency and magnitude of severe weather such as droughts and floods, are all included in specific stimuli that require adaptation (Saskatchewan Ministry of Environment, 2011). Quite literally, how were respondents able to weather the storm?

The most prominent adaptations within the OWLW towards extreme climatic activity have dealt with drought as it has always been the most recurring issue. These adaptations have enabled producers to withstand more recent droughts that have surpassed the climatic magnitude of the dirty 30's. Some producers within this region seem to have contempt for other regions that have not experienced as significant of droughts, and are also gratified by their own ability to cope.

"South western Saskatchewan switching to different cropping methods; I think the highs and the lows have really been, really been leveled out. They aren't nearly as prone to seeing a major drought". - Respondent

Adaptations in Grain Production to Climate

The origination of many adaptations towards drought within grain production have stemmed from the OWLW region. Technological, biological, and operational innovations that have been developed from research at the Semiarid Prairie Agricultural Research Centre (SPARC) in Swift Current, SK have been adopted by the producers within this region and grown from there.

The adaptation of grain production in the OWLW to drought has primarily taken place through technological innovation. Producers have made a considerable shift from 50/50 rest rotation practices common in the 1930's to having 100% of land in production each year. It is now uncommon to see any land being left fallow for a year, unless conditions existed during the time of seeding that made the land unable to seed. Technology within the last 30 years has enabled producers to decrease moisture robbing tillage practices, maintain significant ground cover across their land, and control perennial weedy species within crops all while increasing production yields and acreages. There are still many pockets where 50/50 rest rotations are practiced. Reasons cited included primarily the costs associated with upgrading equipment.

Early adopting producers reported switching to air delivered seeders and drills in the late 1970's. These seeding implements allowed for producers to plant their crops without having to pre-work the soil to prepare their seed bed.

More recently the advent of Global Positioning System (GPS) technologies has allowed for producer to accurately operate their machinery, reducing overlap of seed, as well as fuel costs. GPS systems have also been integrated with Smart Hitch technologies that allow for seeding implements to adjust its frame position by inches on-the-fly according to where standing stubble is, allowing for seeding to occur in-between last year's stubble rows.

Normally when producers pre-worked their land for seedbed preparation it also doubled as a control for their weeds at this point. Continuing with the advent of low or no till practices, producers have shifted removing weedy species by tilling soils to the application of chemical herbicides for control. This enables producers to keep stubble in place while the current year's crop grows, with less soil disturbance. With the advent of new technologies enabling producers to seed their land earlier, pre-emergent herbicide application is also being seen less. Producers are now more commonly applying herbicides during the post emergent stages of crop production using high clearance sprayers. These sprayers use narrow tires and very large booms to lessen the ground impact that they have on the crop. Richardson's ground squirrels were also controlled through pre-working the land as their burrows were caved in. Depending on the location in question, this issue has either been resolved or not. It seems to take a concerted effort across the landscape to control gopher. Control is primarily achieved with poisons delivered through bait stations, and shooting with rifles to some extent.

"And in farming more of the direct seeding and you know there are still farmers around here that farm basically 50/50 every year. There are more of those in the last two years basically because the market wasn't there for the crops so they are managing their risk". - Respondent

Excessive moisture issues in grain production primarily effects timing within a growing year. Spring seeding delays are most commonly caused by excessive moisture both from snowmelt runoff and spring rains. With each farms size growing in production acres (Ward, 2009), making use of the narrow seeding window is becoming much more crucial. Air seeders, which are also an adaptation to drought conditions, allow producers to seed their land in roughly half the time as pre-working is not necessary. Erosion stemming from excessive moisture is also curbed through minimum till air seeders/drills.

Adaptations in Cattle Production to Climate

"You can change your cattle operation more than your grain operation. With grain, your inputs are basically bought before you go on the field. You pre-buy chemical, you book your fertilizer". - Respondent

The cattle sector across the OWLW has also always had to deal with extreme climatic activity, most significantly drought. Respondents even went as far as to say that just getting into cattle production is a direct adaptation towards drought, rather than having land in grain production. It is worthwhile to note that the cattle sector is different from grain production when climatic events such as drought occur. A grain producer's limitations is that their production is quite literally attached the land. The mobility of cattle results in many different adaptation options. From focusing in on past droughts from the 1980's

and 2000's, it was quite clear that adaptations amongst cattle producers was extremely varied based on the following factors; available forage, available drinking water, or both. When forage was lacking, short term solutions included:

- Salvaging failed annual crops through baling or grazing.
    - Salvaging crops was the most common adaptation amongst cattle and mixed producers in the survey. Many mentioned that leeway was provided by Saskatchewan Crop Insurance when determining whether a crop should be written off or harvested. It was beneficial for producers to have crop insurance claims provide coverage so that insurance would be paid out and whatever salvageable crop was there could be grazed or baled rather than harvested. The costs associated with harvesting the crop far outweighed the yields that would come out of it. Mixed producers were fortunate because of the availability of the grains from their own farms. Strictly cattle producers had to rely on social networks to provide this option.
    - Early frosts provided relief for many livestock producers because it degraded annual crops. These crops would have otherwise gone into the bin to feed grade qualities that was cut and baled and used for livestock feed. This helped for feed but did not satisfy hay requirements.

- Having straw and feed shipped or hauled back to the farm, or purchasing standing hay to cut, bale, and ship back.
    - Producers reported being short of straw but not feed because of available crops that had been written off. Straw bales were trucked in from areas that were in a position to sell some excess straw.

- Moving cattle to areas where feed was available and have them custom fed.
    - Several producers reported having to ship some or their entire cattle herd to wetter portion of the province. They believe that when factoring in time, machinery operating costs, and shipping, that this was a much more economical route rather than to have feed supplied and brought back from the SE portion of the province.
    - One producer reported having to ship all of his cows North of Regina in 2004 because after the lack of a spring runoff all of his dugouts for cattle were dry. He believes that this was the right decision as he knew the producer that he was shipping them to and he could focus on other work at the time to recoup the costs.
    - Downsides reported to having cattle shipped and custom fed, besides the upfront costs of shipping and management, is that sometimes they didn't know what they were getting their cattle into. Cattle herds become fairly accustomed to certain ways of management, as well as the forage that they are consuming. Any drastic changes to these can impact the shape and health of the cattle. A cow that grazes each year on drier forages in SW Saskatchewan will not perform well on much thicker, heavier grasses in Manitoba.

- Reducing herd size.

  - Selling a large portion of the herd (50 – 75%) was reported several times. This was not common with younger producers but was almost a catalyst for older producers looking to either slow down or get out of the business completely.
  - Culling the herd early and selling off calves in August rather than October was common as pastureland was depleted from the prior year.

- Finding locally available sources
  - Cutting ditches and dried up sloughs for hay, collecting chaff behind crops that were harvested, and accessing public lands (Ducks Unlimited, PFRA pastures, SWA lands) provided additional feed that might not have otherwise been available.

When drinking water was lacking producers took a similar, yet varied approach depending on their situation. Hauling water to the pastures from the yard was quite common. Yard sites typically are built where the most accessible or dependable water supplies are available. Hauling water from the yard to their pastures was a solution when dugouts or other water sources were drying up in the pastures. Although this solution has significant fuel and time costs, it is effective in the short term.

Developing newer, larger water sources becomes a priority for producers within the OWLW during or after drought periods. After a drought a producer has the ability to know exactly where their shortfalls will be for the next drought that occurs. Developing these sources while the assistance is available is not taken for granted. It is very clear from the interviews that the majority of these water sources were partially government funded. The wells helped supply buried pasture pipelines that could provide water for cattle in pastures, rather than rely on dugouts that would quite often dry up. Where dugouts were being used as a watering source, many producers developed systems to pump the water out and into a trough, rather than having the cattle access the dugout directly. This helped secure the quality of water that remained in dugouts for continual use.

The timing of seeding and harvest are not issues that largely affect the cattle industry. That is not to say that excessive moisture does not affect the cattle industry, but respondents indicated that their level of exposure is moderate compared to the highly effected grain sector. Perennial forages establish themselves each spring and for the most part are harvested through grazing or haying through several parts of the year. When excessive moisture affected feed qualities by making swaths to damp to bale and it ended up rotting in the field, producers used similar adaptation strategies as they would use for drought. More often than not acquiring alternative feed sources were not difficult as during times of drought because of the more localized nature of excessive moisture.

Health concerns surrounding excessive moisture usually results in efforts to keep cattle dry. This involves increased hay demands for bedding, as well as off-site watering to avoid cattle lingering in saturated areas. Both of these examples result in increased costs, but are not issues that came up often in interviews; the producers seemed to have a handle on it.

Institutional Financial Adaptations

Governments have had to develop Ad Hoc[5] programming as an adaptation partially due to political pressure and to the shortfalls within crop insurance. Extreme climatic events have been the primary impetus for Ad Hoc Programming in Saskatchewan. The ability of safety net programming, such as crop insurance, to provide coverage during these events is largely felt to be ineffective due to the extremity and timing of any event.

Ad Hoc programming available to producers in Saskatchewan, throughout the past, has been delivered through payments based on acreages or productions. This style of delivery has been criticized that it results in large landowners and large producers receiving most of the assistance. The basis for the delivery has occurred both provincially wide with every producer being eligible, and on a regional basis, with only producers in a certain area being eligible. With the regional scale of extreme climatic activity, program delivery has occurred through financial transfers based on climatic severity in local districts (Le Roy & Klein, 2003). Although producers in the watershed felt that delivery of programming on regional levels is more effective, it does create situations where some are left out while still needing the help and others quite the opposite.

"The government responds to things and maybe they miss a few pockets of stuff that isn't normal, we were in worse shape than a lot of the drought regions and that's what happens when you draw lines on a map". - Respondent

Past extreme climatic events in the watershed have had Ad Hoc programs developed to relieve their effects. Between the years 1984-86 respondents reported a significant drought in the watershed. At this time there was the development of several programs in response to the current drought including: the Prairie Livestock Drought Assistance, Coverage Restoration, and Prairie Crop Drought Assistance Program

Table 4 depicts the approximate amount that the programs expended and also the amounts adjusted for inflations. The Prairie Crop Drought Assistance Program dollar figures are for the entire country, while the others provide expenses within Saskatchewan.

Title	Year	Amount	Amount with Inflation
Prairie Livestock Drought Assistance	1984	$ 28,700,000.00	$ 57,495,348.84
Prairie Livestock Drought Assistance	1985	$ 60,400,000.00	$ 116,176,076.56
Coverage Restoration	1985	$ 20,000,000.00	$ 38,468,899.52
Prairie Crop Drought Assistance Program	1985	$ 108,800,000.00	$ 209,270,813.40

Table 4 Ad Hoc Programs through 1984-85

[5] Ad Hoc, a Latin phrase meaning "for this", is used by governments to designate programming that has been designed as a solution for a specific problem, and not intended to be adapted to other purposes.

Chart 2 details the amounts that Crop Insurance, Private Hail Insurance, and other payments[6] totalled from producer receipts in Saskatchewan at year end from 1971 – 2010[7]. The chart takes into account all funding sources regardless of whether it was federal, provincial, or combined funding source because it is a tally from producer's receipts. Between 2004 and 2008 when drought reported by the respondents were occurring there was a significant decline in crop insurance payments and a sharp increase from Other (Ad Hoc) Payments. From 2004 – 2008 there was nearly 3.5 billion dollars expended through Ad Hoc payments while only 1.5 billion expended through crop and hail insurance, a difference of roughly 2 billion dollars. The Ad Hoc spending during this time primarily occurred through programs aimed at emergency water supplies for drought affected areas, and emergency aid relief funding. The payments make up for shortfalls that occur in crop insurance when they do not address the immediate needs of producers in a region.

Through analyzing available programming data and respondent interviews, the ability for institutional adaptation is large. Programming during periods of extreme climatic activity enable producers to operate and continue on with their livelihood until insurance and other safety net programming becomes available. Although producers reported that they would prefer not to have to rely on payments during these years, it seems, at times there may be no other option as their industry has been reduced to a 2 year timeline to either make it or break it. The Ad Hoc programming's ability to sustain producers through these periods has proven significant.

[6] Other Payments primarily makes up for all Ad Hoc programming payments.
[7] Figure were adjusted for inflation to enable comparison from year to year.

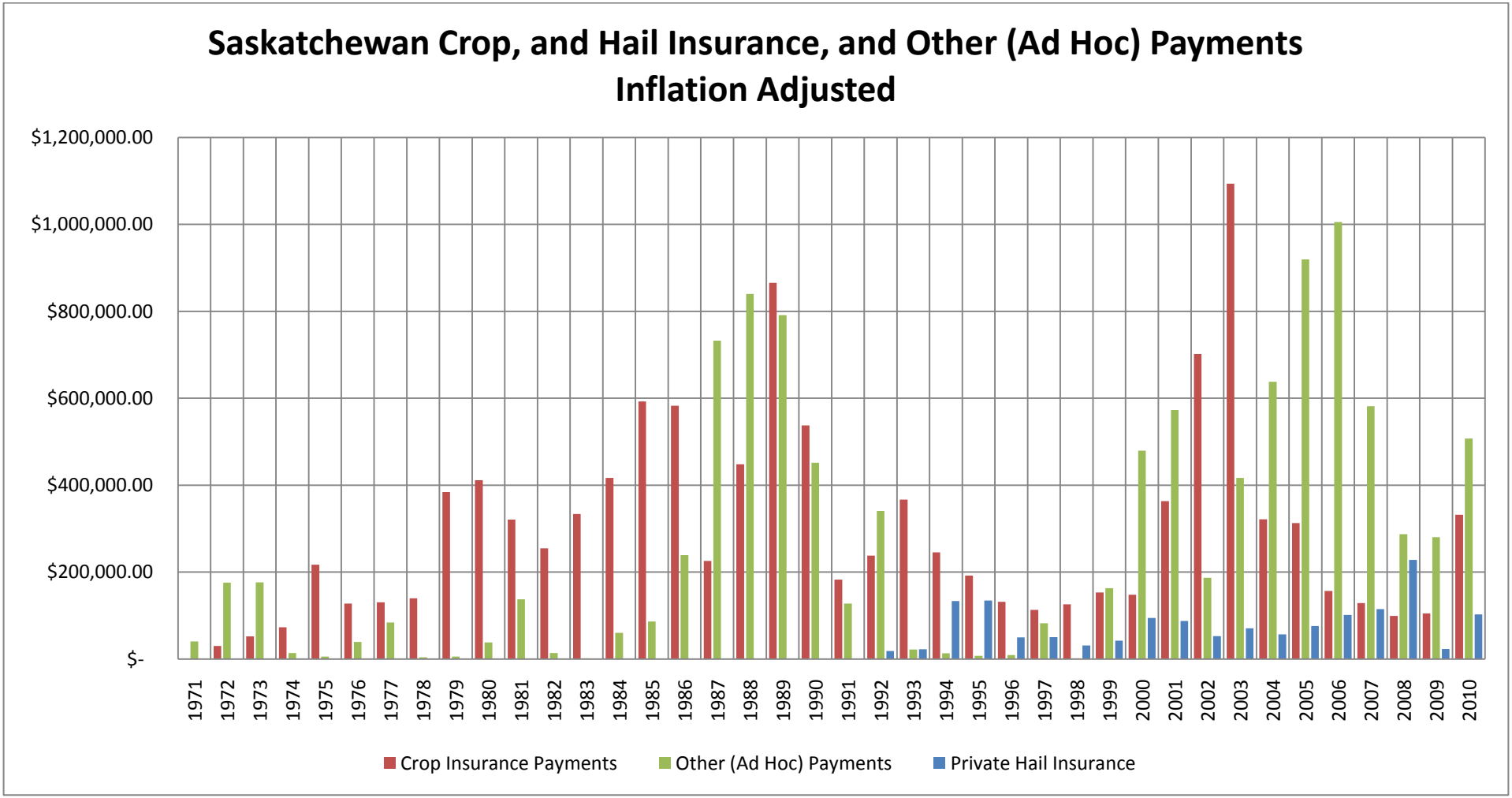

Chart 2 Saskatchewan Crop and Hail Insurance[8], and Other (Ad Hoc) Payments Inflation Adjusted[9]

[8] As of 1992, crop insurance payments no longer include payments under private hail insurance plans.
[9] Dollars are X 1000 to reflect actual amounts. For example. Crop Insurance payments in 1991 were roughly $182 million.

Social Adaptations

Exposures are exacerbated during periods of extreme climatic activity, making adaptation even more important. A reduced and aging population makes the development of social networks between people that are there increasingly important. These networks develop either formally or informally with the same intentions of providing information and developing solutions to current trends affecting the watershed.

Formal Organizations cited by respondents include the following:

- Holistic management organizations: Holistic management is a whole-farm planning system that benefits the land, animals, and people. The system incorporates values-based goal setting, the appropriate use of tools as well as financial, land, and biological planning and monitoring (Holistic Management international, 2011). Many of the theories and practices that have been adopted by producers in these organizations have come out of research and extension work from provincial and federal governments. It is on the shoulders of the producers to develop and organize their own club, if they so choose. Although uptake of this type of management is common in the OWLW, there is no existence of a formal organized contained within the watershed.

- Livestock associations & co-ops: These organizations exist to help provide entry into the beef and livestock sector. A group of at least 6 members work together through pooling funds to help with accessing insured loans at a discounted interest rate, as well as increase their ability to purchase wholesale. The members of the organization also have insurance in case they go broke as part of the pooled funds is earmarked for helping out for those situations. Knowing the members involved and having credit checks are important for this reason. This is not a new type of organization but it is still extremely valuable to the respondents that mentioned it.

- Rural municipal councils: Many respondents reported being active on RM councils currently or in the past. Although they sit on the council to represent the ratepayers of the municipality and to decide how to spend rate payer's tax dollars, the meetings also provide producers with opportunities to network, discuss issues, and find solutions to issues they are facing on their own farms.

Informal Organizations cited by respondents include the following:

- Family operations. Running a farming business through a family operation has and still is the common way to operate for producers. The independence associated with this organization continues to be valued highly. This independence can also detract from the regions ability to come together and adapt to exposures that has made some of the other organizations listed successful through increased purchasing power and networking opportunities

- Neighbors: Although the value of independence is high on family farms, most producers do keep ties or relationships open with their neighbors. Through working with neighbors, operating

efficiencies are significantly increased and expenses can be saved. By utilizing machinery and equipment across numerous farms that would otherwise be underutilized on a single producer's farm, the costs of owning that piece of equipment become much less onerous. Some grain farm respondents noted that lending a hand to another producer and operating equipment for them at no charge is not done as much as prior generations. Dollar and time margins are so tight on one's own farm that to expend resources on another's without compensation of some kind is required. Financial compensation is becoming much more frequent. Custom farming operations allow producers to justify the costs of purchasing new large equipment. For those producers with large land holdings, it provides them with the ability to have their crops seeded, sprayed, and harvested within a narrow timeframe while not having to employ full-time or seasonal staff. Livestock farms (or the livestock portion of a farm) reported more informal business transactions than grain farming. Ranchers commonly work together to help each other out without any compensation expected. Many chores and events including branding and calving make having extra help on hand necessary. A social aspect also revolves around these sorts of events making them much less informal.

These networks have been developed out of necessity resulting from the isolation that is associated with rural areas. The net migration and aging population only serves to exacerbate this issue. Many producers responded that their closest neighbors are now much further away, or that their areas are becoming increasingly foreign; they no longer know their neighbors because the land has been recently sold and the new owners only sporadically appear to tend to the work. Producers also responded that when drought and excessive moisture issues resulted in them being short in feed, they were viewed as an opportunity from other regions. Price gouging for feed and hay were common complaints.

Despite these last few examples, agricultural production has always had a comradery towards itself unlike any other industry. The social networks play a significant role in ensuring viability through extreme climatic events. An example of this comradery was displayed through the Southwest Drought Disaster Committee. The committee, representing 45 rural municipalities across southwest, was formed following the droughts of 2004 & 05 and during the droughts of 2006 & 07 as a way to send a message to governments to provide support for the area (Anderson S. , 2007). This also came in response to the $25.00/animal unit payments provided to the northwestern region of the province that suffered from droughts in 2002 (Alcorn, 2002), and the $50/acre payments provided to the northeastern region of the province that suffered from flooding. These payments resulted in strong resentment towards both government and the producers receiving the aid, as they felt that producers in southwest Saskatchewan and the OWLW were largely ignored. Large rallies formed by producers of the affected region were held across the area and in Regina in front of the legislative buildings. From this committee came the development of the Farm and Ranch Water Infrastructure Program. This program helps aid producers in developing water supplies for livestock and farmyards with 65% cost sharing incentives. Many wells, dugouts, and pipelines were and continue to be built because of this program.

"And that's where the Farm and Ranch program was spawned. You know, hundreds of dugouts and wells have been put in… We've got a lot more capacity for water largely because of that Farm and Ranch program in the last two years". - Respondent

Conclusions

The Old Wives Lake Watershed has a number of exposures to extreme climatic variability's, with drought being the primary perennial issue. It's the ability of production methods, institutions, and social networks to adapt towards these conditions that will dictate future sustainability. Respondents in the OWLW have had significant setbacks in the last half century that show there is significant ability for responding to exposures.

The ability for adaptations in agricultural production methods is extremely high. Producers have time and again shown their ability to cope and manage significant setbacks. Production methods and technological innovations have significantly changed in the last 30 years to manage those climatic variability's. Producers are used to significant droughts in the region and, although not unaffected, producers know how to react . Many producers are finding it hard to see what more they could do to safeguard their farms while maintaining their production rates and lifestyle. This reflects the common responses for what more could be done to safeguard from climatic variability's, including the development of new varieties of crops and an increase in large scale water infrastructure. Both of these developments are beyond producer's control, but if given the opportunity, they have proven they will take whatever innovations are presented and run with them.

Through analyzing available programming data and respondent interviews, the ability for institutional adaptation is large. Programming during periods of extreme climatic activity enable producers to operate and continue on with their livelihood until insurance and other safety net programming becomes available. Although producers asserted that they do not rely on or immediately expect compensation Ad Hoc programming during climatic event periods, some feel that it is very necessary to sustain production capacities across the watershed. The respondents note that during those climatic event years, decisions are made focusing on short term sustainability, such as selling parts of herds, summer fallowing land, and overgrazing land, while acknowledging that those decisions dig themselves into a financial and management hole. The Ad Hoc programming provides relief so that many of those decisions made on the farm can stay focused on the long term, like financial support per acre coupled with water development through the Farm and Ranch Water Infrastructure Program.

Social networks play a primary role in the resiliency of producers. Producers in the OWLW can be quite motivated when they feel their livelihoods are at a considerable threat. This motivation is directed towards banding together to achieve results, for instance, the formation of the Southwest Drought Disaster Committee. Respondents who were involved in some capacity with an agricultural or social organization seemed to be much more aware of opportunities where technical assistance and funding may be available. Those involved also seemed to be more progressive and adaptive towards their farms management; actively seeking options and new methods of production when an exposure warranted.

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