2011

Vulnerabilities & Adaptations to Extreme Climatic Variability

North Saskatchewan River Watershed

An analysis of socio-economic vulnerabilities to drought and excessive moisture events in the North Saskatchewan River Watershed

Lyle Thomson P.Ag
Thomson Agri-Environmental
7/22/2011

Contents

Description of the North Saskatchewan River Watershed

Overview

The North Saskatchewan River Watershed (NSRW) covers a total of 41,000 km^2, taking in 51 rural municipalities. The watershed borders the central portion of the Province of Alberta and meanders through central Saskatchewan until it meets up with the South Saskatchewan River east of Prince Albert. The watersheds major industries include agriculture, oil & gas, tourism & recreation and forestry; with each in varying proportions depending on the location. The NSRW was chosen for this study as it provides for a diverse group of stakeholders that have a lot to lose when considering droughts and extreme climatic events. The watershed has also has been subject to past extreme climatic events that have been well documented and can be referred to easily when conducting this study.

Figure 1. Location of NSRW in Canada

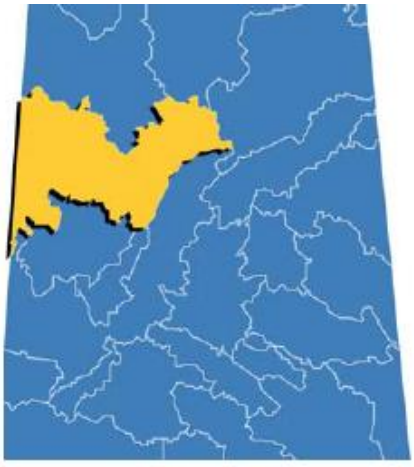

Figure 2. Location of NSRW in Saskatchewan

Socio-Economic Characteristics

For an analysis of 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 and economic drivers within the watershed. Urban municipalities include Lloydminster (Sask. side), Meota, Blaine Lake, Shellbrook, and Glaslyn; rural municipalities include Eldon #471, Canwood #494, Redberry #435, Senlac #411, and Wilton #472.

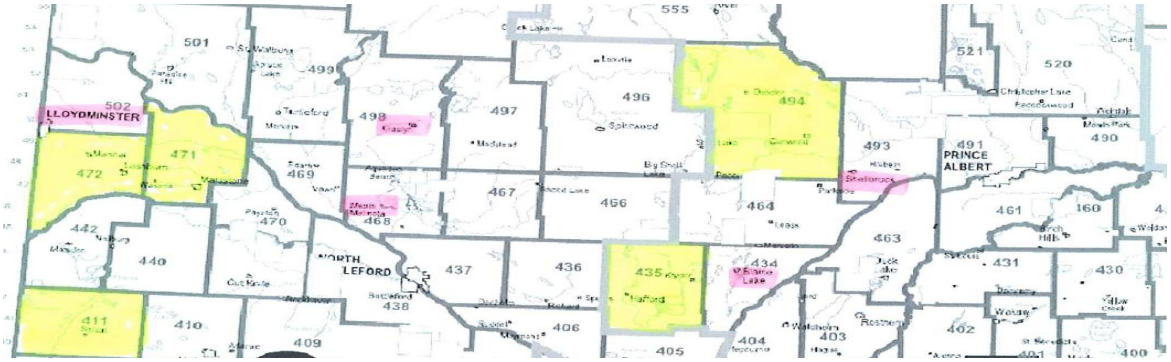

Figure 3. Location of Select Municipalities

Across the entire watershed, between 1996 and 2001, rural municipalities saw a total decline of 4%, while total populations increased from 116,003 to 116,512. Using the sample communities we can see that trend continuing into 2006 with rural declines of 6.55% and increases in urban areas of 1.74%. This data helps to show the outmigration of people, particularly young people when mentioned in the interviews, continues to be happening.

	Pop. 2006	Pop. 2001	% Change
Sample Rural Municipalities	4434	4745	-6.55%
Sample Urban Municipalities	10471	10292	1.74%

Table 1. Sample Municipalities Populations

Using the selected communities to show us trends in industries, it is easy to see that the watersheds economic driver is largely agricultural and resource based. There are, however sharp differences between the rural and urban settings. While nearly half of all the labour force in rural municipalities are employed, only 18% are employed in this sector amongst the select urban municipalities; a difference of 26%. Also notable is the strong diversification amongst urban municipalities divided up between construction, retail trade, and business services. When not factoring in agriculture, there is a strong reliance on the public sector for employment within rural municipalities than urban municipalities. The most alarming difference is the nearly $15,000 in median incomes. This reflects the common issue that was raised in many of the rural interviews, that there is just never enough cash flow or resources.

	Sample RM's		Sample Urban's		Difference between rural and urban in 2006
	Total	%	Total	%	
Total labour force 15 years and over	3080		6160		
Agriculture and other resource-based	1345	44%	1105	18%	26%
Construction	140	5%	590	10%	-5%
Manufacturing	165	5%	305	5%	0%
Wholesale trade	60	2%	320	5%	-3%
Retail trade	225	7%	855	14%	-7%
Finance and real estate	110	4%	215	3%	0%
Health care and social services	230	7%	565	9%	-2%
Educational services	175	6%	400	6%	-1%
Business services	350	11%	745	12%	-1%
Other services	300	10%	1040	17%	-7%
Median Earnings	$20,899.25		$35,151.25		-$14,252.00

Table 2. Select municipalities Industries

Water Resources

The NSRW is part of the Hudson Bay Drainage System. Melt water from the Columbia Ice fields in the Rocky Mountains provide the main source waters. Approximately 80,000 km2 of land in Alberta provides runoff through tributaries before the water even reaches Saskatchewan and the NSRW. Within

Saskatchewan, the North Saskatchewan River and the Battle River are the largest contributing tributaries of the watershed, although the Battle River only provides an additional 5% of total flow. The prairie portion of the Hudson Bay Drainage System contributes only 10 – 30mm of runoff, as compared to the mountain portion contributing over 500mm in a year. The flows from the prairie portion rivers and all other remaining tributaries, are primarily sourced from spring snowmelt; many of which at some point in the year will run dry.

There are a significant amount of lakes within the NSRW. Lakes within the watershed act much the same way that the waterways do, with high inflows from spring runoff. Lake levels typically drop throughout the late summer as evaporation rates exceed inflow rates.

Water wells in the watershed are highly variable in depth and diameter, depending on the depth of a suitable aquifer at any specific location. This variability results in roughly 50% of wells being bored and 50% being drilled. Bored wells are typically developed where aquifers are both shallow and low-yielding. To compensate for low-yielding aquifers, large diameter bored wells serve as storage reservoirs to provide water during periods of high demand. Smaller diameter drilled wells are more suitable for aquifers occurring at greater depths with high inflow rates.

Agriculture, recreation, municipalities, and oil & gas all heavily rely on the sustainability of these water resources. Water is not taken for granted as, for the most part, interview respondents acknowledge that without their available water source, their primary source of income would be affected.

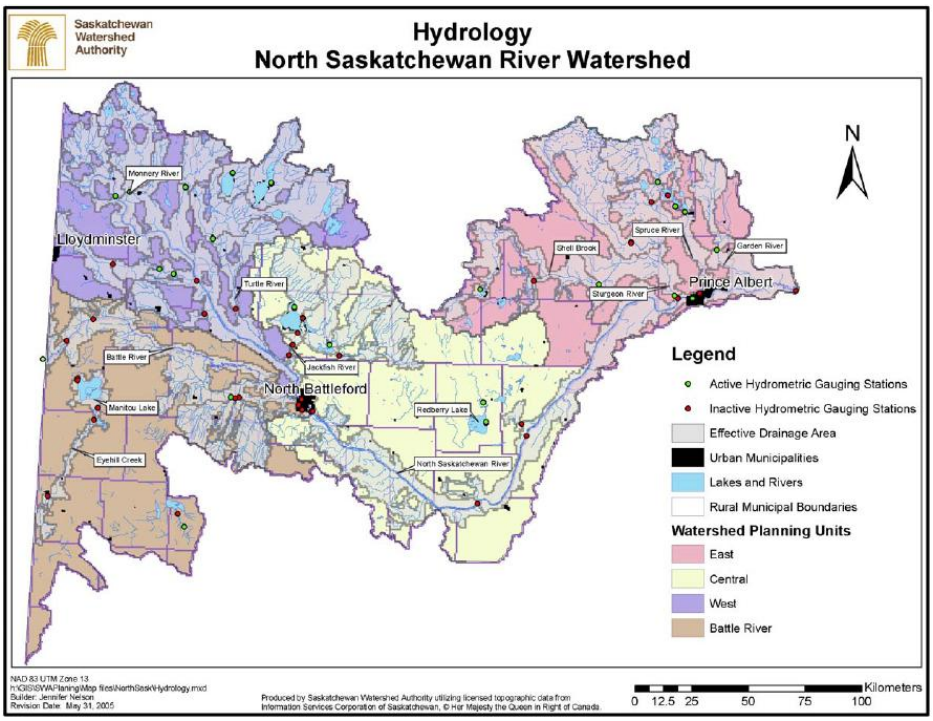

Figure 4 NSRW Hydrology

Climate

Much of the NSRW lies across several ecoregions in Saskatchewan transitioning from the northern mid-boreal uplands into the southern moist mixed grasslands. The physical geography mixes between Saskatchewan River Plains and Missouri Coteau Uplands.

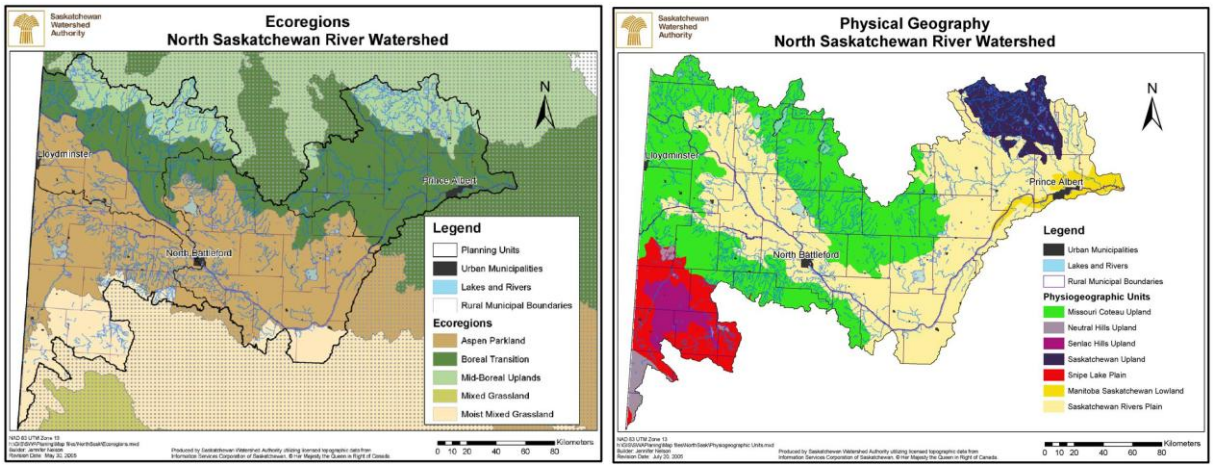

Figure 5 & 6. Ecoregions & Geography

From averaging the Lloydminster, North Battleford, and Prince Albert 1971 – 2000 climate normals, we can find the watersheds broader climatic trends. Using the averaged climatic normals, the NSRW receives an annual average daily temperature of 1.62°C and receives 407mm of precipitation per year. The watershed is characterized by heavy snowfall between November and March, followed by rainfalls beginning in April till October.

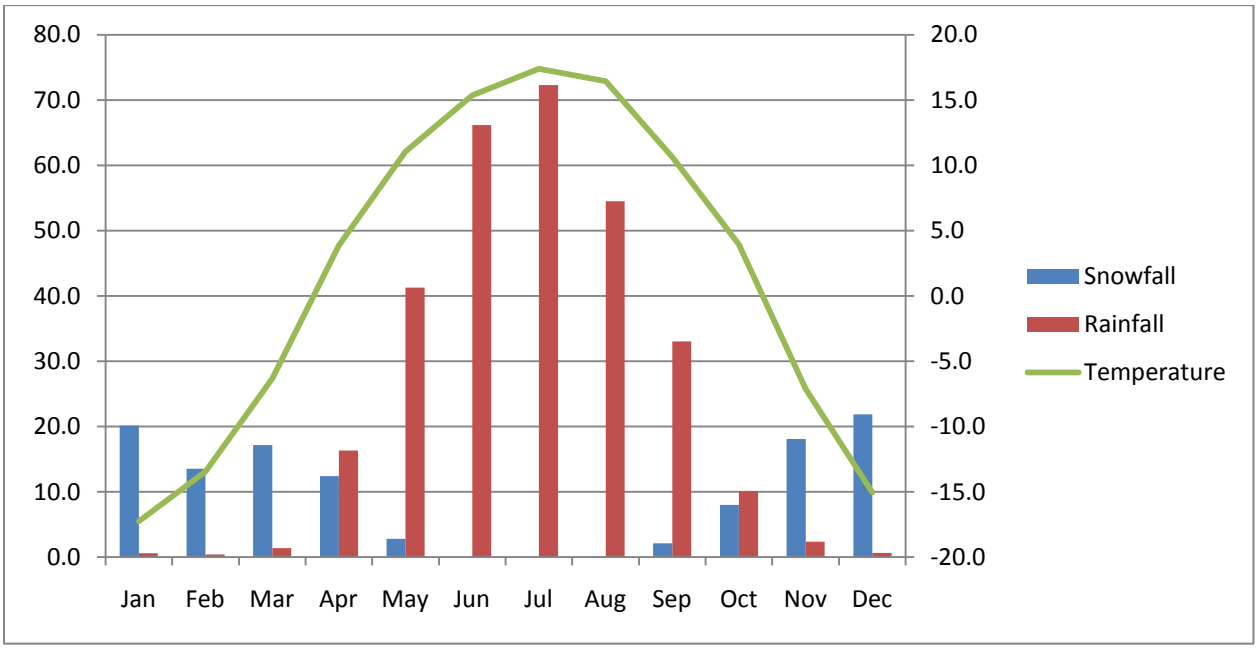

Table 3. NSRW Climate

The Watershed Assessment

Objective

The objective of the watershed assessment study is to gain insight into the socio-economic vulnerabilities to drought and excessive moisture events within the NSRW, 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, 40 face to face interviews were conducted with residents of the North Saskatchewan River Watershed. 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 were 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

Historically the climate in the North Saskatchewan River Watershed is wetter than other parts of Saskatchewan. Parts of this region throughout the 1930's were largely populated as an escape from the drought which predominated across SW Saskatchewan (Anderson, 2006). Particular droughts stand out amongst residents and producers because of their infrequent exposure towards these events. Droughts cited in the interviews include 1986-88, 1996, & 2001-02; with 2001-02 being the most mentioned amongst the respondents. 2001-02 was mentioned the most as it stands out as the most widespread and severe. From the fall of 2000 to the summer of 2002, eight consecutive seasons, the west central prairie provinces recorded precipitation levels of well below normal (Wittrock & Wheaton, 2007). These record setting consecutive seasons of droughts left producers with complete crop failures, and drastically reduced feed and water supplies for cattle.

"In pasture situations we rarely have had problems but in 2001 and 2002 those watering holes we depended on actually went dry." - Respondent

Municipalities were also dramatically affected; looking for new water supply sources after their prior ones had either dried up or had severally reduced quality. One situation, in response to the adjacent Jackfish Lake having reduced water supplies and a very high mineral content, the village of Meota and surrounding hamlets had to develop a pipeline to the North Saskatchewan River and install a treatment plant at a cost of 4.4 million.

Excessive moisture issues within the watershed were not as common of an issue amongst respondents. Typically drainage was described as very effective on lands. In certain situations, excessive rain during seeding, harvesting, and haying periods resulted in delays. These delays resulted in lower quality and yields for the crops and forages. These rains also resulted in rutting in fields and yards, making accessibility an issue. Accessibility was also an issue for other industries, including oil & gas and construction jobs. These workers noted that there is a perennial delay in the spring when access to sites is impossible, and if this is prolonged it can be a strain.

With high moisture amounts cattle health can be negatively impacted. Calves are extremely sensitive to exposure and wet conditions only exacerbate problems. One producer noted that early calving periods of February are easier rather than later, because he found that wet conditions negatively affect calves more than extreme colds. 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.

When excessive moisture issues were discussed, it provided for segue into issues of delays and the inevitable damaging effects of early frosts. This is not surprising as the shorter growing season and high moisture rates in this region of Saskatchewan make this a more prevalent, but generally accepted, issue. 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.

"Timing is crucial in the spring. A guy should be out there but then he is working with the cows. Things are going by when you should be seeding." - Respondent

On years with higher moisture amounts, the crops take longer to ripen. Regardless of if it were spring seeding delays or an unusually early frost occurring in August, some considered frost to be the most expensive climatic event over the last 100 years. 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 caused global warming theories, but many are finding that patterns or what were considered 'normal' is changing.

"That is what is stressful. Nothing is predictable anymore." – Respondent

With more erratic weather patterns, producers also felt that there is more severity to the weather. This severity was not necessarily felt on their own farms, but from what they hear and see through media and in conversation. This notion could also be attributed to the increase in monitoring and awareness through media of storms and extreme climatic conditions. In fact, many of the same respondents who noted an increase in weather severity also found that the severity of winters has decreased. 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 equipment, and cropping practices reducing blowing snow could all relate to this feeling of milder winters also.

Although hail has always been a concern across the prairies, it was rarely mentioned as an issue concerning weather and climatic events. 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 insurance is widely available, it's uptake amongst respondents was considerably low. Expansion of farm sizes, high rates versus low returns, and the absence of spot loss hail insurance option were the most cited reason for the lack of uptake. These reasons make hail a risk they are willing to take considering the costs of insurance.

From these larger weather and climatic concerns, resulting side-effects were also noted. Fires in 2002 impacted the communities of Holbein, Big River, and Prince Albert. These communities are along and within the boreal forest zone, creating an ever-present risk of fire, especially during times of drought. Although damage to infrastructure was negligible, considerable amounts of land were consumed by these fires. Also at this time, a decline in fisheries was found in both Jackfish Lake and Redberry Lake. Prior to 2001 there was a large commercial fish industry for white fish on Jackfish Lake. The effect that the drought had on the quality of water remaining in the lake is suspect. Insects in dry years are always very noticeable, especially with peas or lentils. Grasshoppers seem to go in cycles with two or three dry years peaking and then populations dropping back. Beavers have also been impacted the landscape

considerably, damming and flooding many hay flats and ultimately causing a decrease in the total available land for production.

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)[1], Net Income Stabalization Account (NISA)[2], and Agri-Stability[3] 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 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.

[1] 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).

[2] 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).

[3] 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.

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).

Social Exposures

The social dynamic occurring across the agricultural community within the NSRW 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 almost 7%. Many of the older respondents (50+) reported that there are not enough young laborers available because they are either moving to the city, or working on the nearby oil rigs. 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.

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?

Adaptation towards droughts within the watershed was frequently mentioned amongst respondents. Although the most recent significant drought occurred almost 10 years prior, it still seemed fresh in the mind of respondents. Details such as precipitation amounts, perceptible environmental impacts, and measures taken to alleviate impacts were readily accessible. Few, if any, respondents cited no significant impact from the 2001-02 drought.

Adaptations in Grain Production to Climate

The adaptation of grain production in the NSRW 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.

Early adopting producers reported switching to air delivered seeders and drills in the mid 1980's. These seeding implements allowed for producers to plant their crops without having to pre-work the soil to prepare their seed bed.

> *"We would cultivate the soil and then seed with a press drill. That was the normal. By the mid 80's we got an air seeder so we could seed without pre-working it. We really gained a lot there." - Respondent*

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 years 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.

Excessive moisture issues in grain production primarily affect timing within a growing year. Spring seeding delays are most commonly caused by excessive moisture both from snowmelt runoff and spring rains. With each farm's 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 issues stemming from excessive moisture were not extremely significant. That is not to say that gullying and slumping along waterways does not exist, but respondents did not report it as a significant issue. Land that is in annual crop production has for the most part been developed with water flows in mind. Ephemeral streams and seasonal tributaries have been left as grassed waterways rather than cultivated and seeded each spring. One producer felt that with the region having fairly reliable precipitation amounts year to year, the opportunity to seed many of these waterways has not existed. The potential for cultivation and reduction of soil stabilization from perennial vegetation along the waterways is modest.

Although commonly thought of as best practice, leaving stubble high so that it catches snow throughout the winter has been disregarded in efforts to minimize snow capture during extremely wet periods throughout the fall of 2010 & 2011. Producers within the Prince Albert region have found themselves working their land with cultivators to minimize the amount of stubble that will catch snow and to help dry out the land.

"We are pulling out cultivators that we haven't used for 20 years just to dry the land out." – Respondent

Adaptations in Cattle Production to Climate

The cattle sector across the NSRW has been significantly impacted by many recent extreme climatic events. 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 the drought of 2001-02, 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.

"There just wasn't any hay and after the frost there was all kinds of feed. $35-$40 a bale for it. It was expensive. Good feed but expensive." – Respondent

"Actually in 2002 was when they had the frosts here in the second of August so that basically saved our bacon as far as feed went, but it was terrifically expensive feed because there was none in the province anywhere." - Respondent

- 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, such as Swift Current. Producers felt as though they were being gouged with the costs of $40/bale + transportation.

- Moving cattle to areas where feed was available and have them custom fed.
  - Several producers reported shipping some or their entire cattle herd to the SE 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 who had 50 of his cows shipped to Yorkton for summer grazing actually sold them there too; they never came back. By 2002, after three really dry years in a row, it became apparent that their stocking rates were probably too high for their land and with the smaller cattle numbers their farm become much more manageable.
  - 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.

- 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.

Many respondents had deep water wells dug in 2002 to depths in excess of 300 feet. At this time federal and provincial funding was also available to producers to develop more secure, long term water supply sources. It is very clear from the interviews that the majority of these wells 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. As one producer put it, “We can never have too much rain”. 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.

One producer noted that he depends on hay flats to supply a significant amount of his winter feed. In times of high moisture amounts, those hay flats can flood and become inaccessible for the year. When this happens he runs into a shortfall of feed and has to look for those other sources. Large portions of land in low lying spots are depended upon as forage by a significant amount of producers across the province. It is expected that although only one producer in the interviews noted this as a significant issue, many more experienced the same situation.

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[4] 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.

"Our RM was actually included as a drought disaster area and that was the year our RM took off some of the best crops they've ever taken off in their lives... It's true to the west of us there was some drought like Maidstone and towards Lloydminster, But, yet, we ended up getting included in that and it was a bit of a joke." – Respondent

Past extreme climatic events in the watershed have had Ad Hoc programs developed to relieve their effects. Between the years 1986-88 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 Canada-Saskatchewan Livestock Drought Assistance Program, the Canada-Saskatchewan Crop Assistance Program, the Canada-Saskatchewan Green-feed Program, and the Emergency Water Supply Program.

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

[4] 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.

Title	Year	Amount	Amount with Inflation
Saskatchewan Livestock Drought Assistance	1988	$ 40,000,000.00	$ 67,943,661.97
Saskatchewan Greenfeed Program	1988	$ 20,000,000.00	$ 33,971,830.99
Emergency Water Supply Program	1988	$ 28,000,000.00	$ 47,560,563.38
Canadian Crop Drought Assistance	1988	$ 453,000,000.00	$ 769,461,971.83
Saskatchewan Crop Assistance Program	1989	$ 280,000,000.00	$ 452,654,155.50

Table 4 Ad Hoc Programs through 1988-89

Chart 5 details the amounts that Crop Insurance, Private Hail Insurance, and other payments[5] totaled from producer receipts in Saskatchewan at year end from 1971 – 2010[6]. The chart takes into account all funding sources regardless of whether it was federal, provincial, or combined funding source because it is just a tally from producer's receipts. Between 1986-88, when extensive drought and Ad Hoc programming was occurring, we see a significant decline in crop insurance payments and a sharp rise in Other (Ad Hoc) payments. From 1987-88 there was over 1.5 billion dollars expended through Ad Hoc payments while only 673 million dollars expended through crop insurance (which also included hail insurance at the time); a difference of over 800 million dollars. This shows that these Ad Hoc payments were coming to producers during the drought period, which differ significantly from crop insurance which shows a year's delay in payments. The drought of 1986-88 is primarily reflected in 1989 with 865 million dollars being expended.

"Talking to the guys that are enrolled, by the time they actually qualify, the need has already passed. What is the good from that program when it takes a year to get paid? You have either died or survived by then already. I know they don't like Ad Hoc payments, but those are the most effective." –Respondent

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 really prefer not to have to rely on payments during these years, it seems that 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.

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

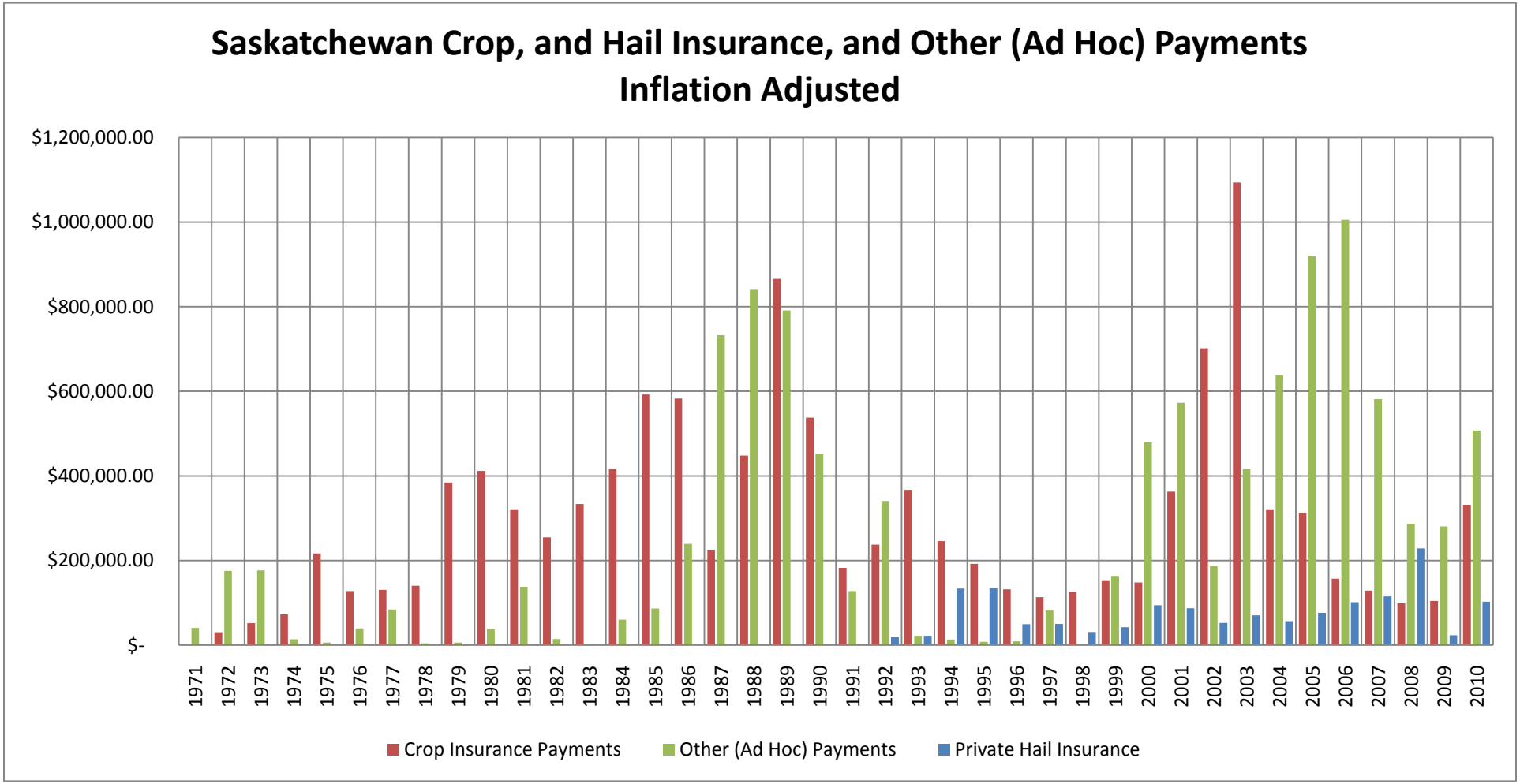

Chart 5 Saskatchewan Crop and Hail Insurance[7], and Other (Ad Hoc) Payments Inflation Adjusted[8]

[7] As of 1992, crop insurance payments no longer include payments under private hail insurance plans.
[8] 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. One such producer group exists in the northeast corner of the watershed in an area existing between Big River, Shell Lake and Prince Albert. This club formed out of several producers taking the same Holistic Management Course, It enables producers to share their experiences of what has worked and what hasn't.

"We try and think outside the box and look at different situations, and that's where our management group really comes in hand, where you get together with this close knit, where you feel safe and can say, "this is my problem" and look at it with a whole bunch of different eyes rather than one. Because you're, it's harder to see your own problems. So I think that's something, a tool, to use." – Respondent

- 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. Although in kind compensation has always been maintained in the past, 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. While in the past it was common to help another producer out through lending bales at times of need, they now felt that there was an increase in gouging. As it would be expected, when there is short supply of a product and it is in demand, the price of the product adjusts. This situation was well documented from the drought of 2002 when the entire North Sask River Watershed was inundated by drought and there were good feed supplies in the southern portion of the province. Although producers in the NSRW would normally sell hay for C$120/ton in a normal year to other regions, they were particularly unwilling to pay this same price plus transportation in 2002. Although some looked at this as a "shoe on the other foot" type of situations, politicians did view it as price gouging (Le Roy & Klein, 2003).

Despite these last few examples, agricultural productions 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 Hay West campaign. During the drought of 2002, the Hay West campaign began with a group of producers from Navan,

Ontario donating roughly 100,000 round bales to producers in the drought affected regions of the NSRW. Although the initiative displays the strong spirit and generosity shared amongst agricultural producers, shipping and fumigating costs ended up being two to three times the value of the hay. These costs (3.8 million) were paid through by the federal government. Recipients of the donated hay were selected through a lottery process, which is quite unusual (Le Roy & Klein, 2003).

Conclusions

The North Saskatchewan River Watershed has a number of exposures that are sensitive to extreme climatic variability's. It's the ability of production methods, institutions, and social networks to adapt towards these conditions that will dictate future sustainability. Respondents in the NSRW 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. 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 reported that they would really like to not have to rely on payments during these years, it sometimes seems 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.

Social networks play a primary role in the resiliency of producers. 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.

Bibliography

Agriculture and Agri-Food Canada. (2011, January 19). *Growing Forward*. Retrieved April 7, 2011, from AgriStability: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1291990433266&lang=eng

Anderson, A. (2006). *The Encyclopedia of Saskatchewan.* Canadian Plains Research Centre.

Diaz, H., Hurlbert, M., Corkal, D., & Warren, J. (2009, October). Saskatchewan Water Governance Assessment Final Report:. *Unit E1 Institutional Adaptation to Climate Change Project* .

Environment Canada. (2011, March 8). *Localizer.* Retrieved June 12, 2011, from Canadian Climate Change Scenarios Network: http://www.cccsn.ca/tools/viz-localizer/localizer.pl

Le Roy, D. G., & Klein, K. K. (2003, Spring). Say Hay and Hay West: Charity, Government and Farmer Responses. *Western Economics Forum* , 1-6.

Lisitza, L. (n.d.). Historic Overview of Safety Net and Support Programming. Policy Branch, Saskatchewan Ministry of Agriculture.

Pittman, J. (2008). *Institutional Adaptations to Climate Change Project: Report on the Community Vulnerability Assessment of Outlook, Saskatchewan.* Regina: Saskatchewan Watershed Authority.

Saskatchewan Ministry of Environment. (2011). *Adaptation Defined*. Retrieved June 6, 2011, from Climate Change Saskatchewan: http://www.climatechangesask.com/html/learn_more/Impact_Adaptation/Adaptation_defn/index.cfm

Ward, G. (2009, October 5). *2006 Census of Agriculture.* Retrieved June 5, 2011, from Statistics Canada: http://www.statcan.gc.ca/ca-ra2006/analysis-analyses/sask-eng.htm#r1

Wittrock, V., & Wheaton, E. (2007). *Towards Understanding the Adaptation Process for Drought in the Canadian Prairie Provinces: The Case of the 2001 to 2002 Drought and Agriculture.* Saskatoon, Saskatchewan: Saskatchewan Research Council.