

Assiniboine Watershed Stewardship Association



Drought and Excessive Moisture Preparedness Plan

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Table of Contents

1.0 Yorkton Creek Sub-basin Drought and Excessive Moisture Preparedness Plan	1
1.1 Assiniboine River Watershed Overview	1
1.2 What is Drought?	3
1.3 What is Excessive Moisture?	3
1.4 About this Plan	4
1.5 Planning Approach	4
2.0 Vulnerability Assessment	6
2.1 Participatory Mapping	7
2.2 Timeline	. 10
2.3 Drought and Excessive Moisture Characterization for the Assiniboine River Watershed	. 11
2.4 Scenario Planning	. 14
2.5 Information Requirements	. 18
3.0 Adaptation Planning and Actions	.21
4.0 Future Refinements	.24
List of Figures	
Figure 1. Yorkton Creek Sub-basin.	
Figure 2. Assiniboine River Watershed Advisory Committees	2
Figure 3. Preparedness Planning Approach	5
Figure 4. Yorkton Creek Sub-basin Participatory Mapping Exercise, November 22, 2010	8
Figure 5. Comparison of Assiniboine River Watershed PDSI Wettest Year (1954) and Driest Year (1961	-
and SPI Wettest Month (April 1975) and Driest Month (May 1971)	
Figure 6. Scenario Assessment Discussion Questions	. 15
Figure 7. Representative User Groups Present (Workshop Two) within the Yorkton Creek Sub-basin,	
January 19, 2011	
$ \label{thm:comparison} \textbf{Figure 8. Comparison of Preferred Information Requirements Among Various User Groups within the } \\$	
Yorkton Creek Sub-basin, January 19, 2011	. 19
List of Tables	^
Table 1. Participatory Mapping Exercise of Yorkton Creek Sub-basin, November 22, 2010	
Table 2. Timeline of Events in the Yorkton Creek Sub-basin 1920-2010	. 10
Table 3. Top 10 Extreme Years. Palmer Drought Severity Index (PDSI) and Standardized Precipitation	11
Index (SPI) for the Assiniboine River Watershed (1901-2005 Agriculture Year)	
Table 4. Scenario One, Scenario Two, Scenario Three	. 16

Table 5. Comparison of Pr	referred Information Requirements of Each User Group within t	he Yorkton
Creek Sub-basin		20
Table 6. Key Municipal, Ed	ducational, Channel Maintenance and Aquifer Protection Issues	Affecting the
Yorkton Creek Sub-basin		22
	List of Appendices	
Appendix I. Glossary of Te	erms	25
Appendix II. Resources		27
Appendix III. Saskatchewa	nn Association of Watersheds Drought Preparedness Meeting	35
Appendix IV. Information	Requirements Questionnaire	37
Appendix V. Yorkton Cree	k Sub-basin Adaptation Planning (Issues) Template	39
Appendix VI. Bibliography	·	41

Yorkton Creek Sub-basin Drought and Excessive Moisture Preparedness Plan

Drought and Excessive Moisture events across the Canadian prairies are becoming more common. In 2010, the Saskatchewan Watershed Authority (SWA) initiated drought and excessive moisture preparedness planning workshops to be delivered through four pilot watersheds across the province. The Assiniboine Watershed Stewardship Association (AWSA) was chosen as one of the four Watersheds to develop a Drought and Excessive Moisture Preparedness Plan for the Yorkton Creek sub-basin within

Assiniboine River Watershed.

1.1 Assiniboine River **Watershed Overview**

The Assiniboine River Watershed is comprised of the Assiniboine River and multiple tributaries located in eastern Saskatchewan and western Manitoba. The Saskatchewan area of the Assiniboine River Watershed covers approximately 17,300 km² (ARWAC and SWA, 2006). The located headwaters are approximately 50 km northwest of Preeceville, Saskatchewan in the Porcupine Hills (ARWAC and which feeds into the Assiniboine River near Kamsack, is the Whitesand River, which originates in the Beaver Hills. Yorkton Creek, Kamsack Creek, Lilian River, Smith Creek, Crescent Creek, Willow Brook and Wallace Creek are part of the Assiniboine River Watershed's tributaries (ARWAC and SWA, 2006). The Assiniboine River continues approximately 45 km southeast from Kamsack before joining the Lake of the Prairies which is a 56 km man-made reservoir that straddles the Saskatchewan

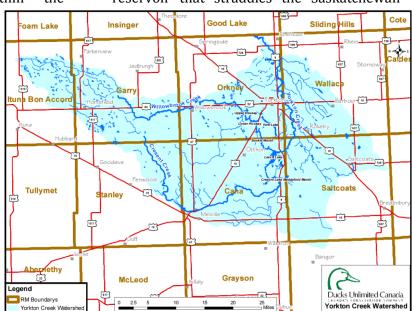


Figure 1. Yorkton Creek Sub-basin (Source: Assiniboine Watershed Stewardship Association, 2010)

SWA, 2006) (Figure 1). A major tributary,

and Manitoba border (ARWAC and SWA, 2006).

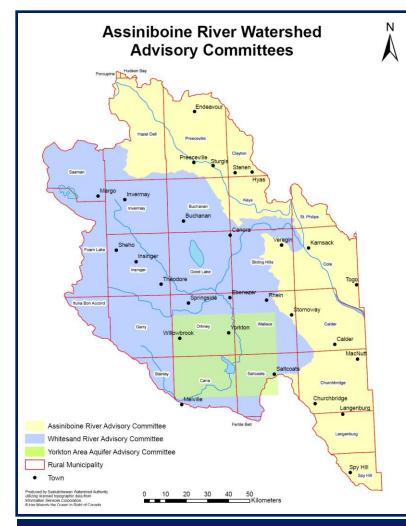


Figure 2. Assiniboine River Watershed Advisory Committees (Source: Assiniboine Watershed Stewardship Association, 2010)

The Assiniboine River Watershed is divided into three Watershed Advisory Committees – the Whitesand River Advisory Committee, The Assiniboine River Advisory Committee, and the Yorkton Area Aquifers Advisory Committee (Figure 2).

The Assiniboine River Watershed is unique in that approximately 90% of residents within the watershed rely on groundwater opposed to surface water as their source of drinking water (ARWAC and SWA, 2006). Generally, groundwater supply is more stable than

surface water; however, defining available groundwater supply is difficult and costly (ARWAC and SWA, 2006).

Yorkton Area Aquifers provide the water supply for virtually all the City of Yorkton and surrounding area (AWSA, 2008). Yorkton Area provide Aquifer's water agriculture, industry, municipal supplies and drinking water (YAAAC and SWA, 2006). Source water protection planning, and aquifer protection from extreme drought or excessive moisture events, is crucial in this area in order to manage and prepare for potential threats to the quantity and quality of groundwater. The area's water quality and supply is threatened by external factors including climate change, waterdemand growth, extended hydrological droughts, and excessive moisture events.

There is a broad consensus that global temperatures are rising (SWA, 2005). The implications for Saskatchewan are not yet well

understood – however, warmer winters, increased drought risk, and more extreme precipitation and temperature events are expected (Sauchyn and Kulshreshtha, 2008). Water supplies may be affected resulting in reduced summer flow, increase in frequency and magnitude of flooding and drought, and changes to groundwater recharge and discharge (SWA, 2005).

1.2 What is Drought?

Drought is considered to be one of the most complex, and subsequently, least understood of all natural hazards, affecting more people than any other hazard (Sivakumar Wilhite n.d., as cited in Hagman, 1984). Drought originates from a reduction in the amount of precipitation over an extended period of time, resulting in a water shortage, usually a season or more in length (Sivakumar and Wilhite, n.d.). Droughts are unique in their intensity, duration and spatial extent (Wilhite and Knutson, n.d.). Drought is a slow-onset, creeping natural hazard that is a normal part of climate; it results in economic, social and environmental impacts (Sivakumar and Wilhite, n.d., as cited in Wilhite, 2000).

The onset and cessation of drought is difficult to predict, as is the severity of a drought. Human activities and a specific area's water supply characteristics influence sensitivities to drought in a given watershed. Droughts can be categorized as meteorological, hydrological, agricultural or socioeconomic, each of which results in different impacts (Wilhite, 1996; V. Wittrock, personal communication. Ianuary 12. 2011). Appendix I. describes each type of drought in detail.

The greatest natural disasters in Canada (in terms of economic costs) have been attributed to drought, specifically the 1930s drought and 1999-2004 drought. The 2001-2002 drought, which largely occurred in Saskatchewan and Alberta, resulted in a national loss of \$6 billion in GDP and the loss of 41,000 jobs (Wheaton *et al.*, 2008).

Drought conditions can impact communities and individuals in a variety of ways. In the

Assiniboine River Watershed drought-related impacts include land degradation, water shortages and irrigation deficits, feed shortages, unstable economics (lower crop yields, crop damage/failure), soil moisture shortages and increased stress.

Effective drought management has three major components (Sivakumar and Wilhite, n.d.):

- Monitoring and early warning,
- Risk and vulnerability assessment, and;
- Preparedness, response, and recovery

Previous attempts to manage drought have been borne from a reactive, crisis-management approach which inherently results in costly remedies (Wilhite and Knutson, n.d.). The goal is to reduce drought vulnerability by identifying relevant impacts and assess their underlying causes.

1.3 What is Excessive Moisture?

Too little water can be just as damaging as too much water, which may negatively impact water supplies, agriculture and ecosystems (SWA, 2010). Increased variability and changes in the frequency and severity of extreme events such as droughts and floods is occurring. A broad suite of management practices is required in preparing for such extreme events (Pittman, 2010a).

Heavy precipitation events result in crop damage, soil erosion, and the inability to cultivate land. Excessive moisture can adversely affect the quality of surface and groundwater as well as contaminate water supplies.

1.4 About This Plan

The Assiniboine Watershed Stewardship Association (AWSA) held two workshops facilitated by Saskatchewan Watershed Authority and the AWSA on November 22 2010, and January 19, 2011. The goal was to identify the vulnerability and resilience of various watershed stakeholders through numerous workshop activities, including highest mapping areas of concern, construction of timelines showing drought and excessive moisture events adaptations, scenario-based discussion, and adaptation planning. The workshops' are an important element in preparedness, response, and recovery planning which will help to increase the Yorkton Creek Subbasin's capacity to deal with drought and excessive moisture events, and lead to more resilient urban and rural communities.

This plan involves identifying issues and action items within the Yorkton Creek Subbasin, then prioritizing each issue. The purpose of the plan is to provide a strategic plan in dealing with Drought and Excessive Moisture for the Yorkton Creek area and offer a starting point for engagement throughout federal and provincial agencies.

1.5 Planning Approach

Representatives from local governments, individual licensees and users, agricultural producers, and urban and rural municipalities participated in the AWSA workshops. The goal of the workshops was to share ideas, information and knowledge across multiple stakeholder groups to develop a preparedness plan for the watershed. Various workshop activities were

undertaken to facilitate vulnerability assessment and adaptation planning (Figure 3). Ideas and knowledge obtained from the workshops were ultimately incorporated into the plan.

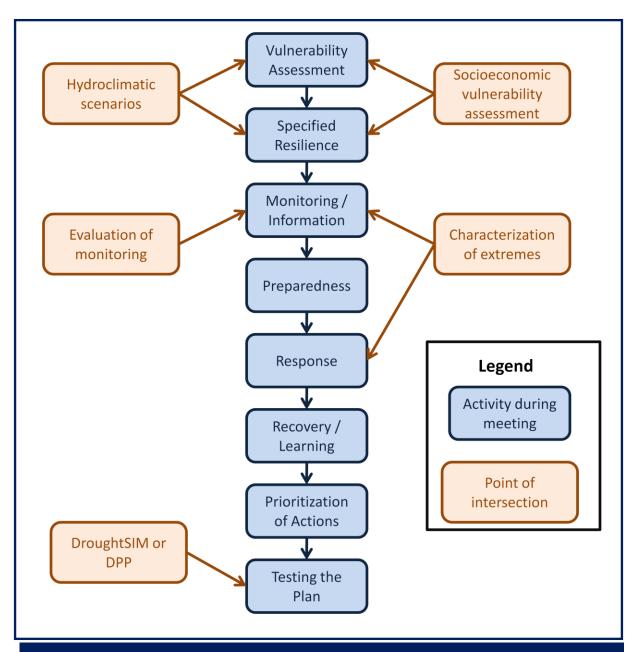


Figure 3. Preparedness Planning Approach

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Vulnerability Assessment

Preparing for drought and excessive moisture events involves looking at the past and understanding where vulnerabilities lie. Preparing for such events involves discussion during normal conditions, rather than at the onset of drought and excessive moisture events.

The vulnerability of any system is a function of an area's exposure, sensitivity and adaptive capacity to an event, such as drought and excessive moisture, and its' capacity to cope, adapt, or recover from the impacts (Pittman *et al.*, 2010; ICLEI 2010; Ford and Smit, 2004; Smit and Wandel, 2006). Understanding the Yorkton Creek Sub-basin's vulnerabilities will help decision makers in developing suitable adaptation actions (ICLEI, 2010).

Exposure and sensitivity of a system are virtually inseparable and are one component in assessing vulnerability (ICLEI, 2010; Smit and Wandel, 2006). Determining the Yorkton Creek Sub-basins' exposure-sensitivity involves asking questions to understand whether the area is subject to any existing stress and whether a drought or excessive moisture event will exacerbate that stress (ICLEI, 2010).

Adaptive capacity refers to a system or community's potential or ability to plan for,

cope, and adjust to changes and stresses with minimal disruption or additional cost (ICLEI, 2010; Ford and Smit, 2004; Smit and Wandel, 2006). The ability to undertake adaptations is influenced by economic wealth, technology, equity of access to resources, knowledge and skills, and social capital and institutions (Pittman *et al.*, 2010; ICLEI, 2010; Smit and Wandel, 2006; Ford and Smit, 2004). Adaptive capacity varies from country to country and community to community (Smit and Wandel, 2006).

The Yorkton Creek Sub-basin's capacity to cope with drought and excessive moisture event's, varies over time in response to social, economic, political and future environmental changes (Ford and Smit, 2004). An increase in the frequency of event's, near the upper limit of the coping range, may decrease a system's adaptive capacity and inhibit coping ability, adaptation or recovery of that system (Smit and Wandel, 2006).

By increasing the Yorkton Creek Sub-basins' adaptive capacity, it's vulnerability to current and future drought and excessive moisture events will be reduced (ICLEI, 2010). The goal of this analysis is to identify current and past exposures and sensitivities that the Yorkton Creek Sub-basin has experienced. Once these conditions have been identified,

analyst's and decision-makers can identify potential future exposures and sensitivities, and plan for, or respond to these conditions (Smit and Wandel, 2006).

The following section features current vulnerabilities experienced within the Yorkton Creek Sub-basin, and are separated into five subsections: (1) participatory mapping; (2) timeline; (3) drought and excessive moisture characterization; (4) scenario planning; and (5) information requirements of stakeholders.

2.1 Participatory Mapping

Maps and diagrams are an important part of any planning activity (IIED, 1991). Participatory mapping is the creation of maps by local communities and stakeholders, with the involvement of organizations such as government, universities, and nongovernment organizations (IFAD, 2009). Generally, mapping and timeline initiatives are conducted by outsider groups and the maps created contribute to an outsider's agenda (IFAD, 2009).

Participatory mapping provides valuable visual representation of what stakeholders perceive as its place, and features they feel are significant (i.e. beaver dams, culverts, flooding activities, washouts etc.) (IFAD, 2009; IIED, 1991). The process of contributes participatory mapping community cohesion, and may stimulate stakeholders to engage in land and resourcerelated decision-making. This process raises awareness of land-related issues and ultimately empowers local communities and stakeholders (IFAD, 2009).

Participatory mapping has proved to be an effective way for communities to demonstrate

to external agencies what the community values, and the communities' relationship and interactions with the landscape (IFAD, 2009).

During the mapping exercise with the Yorkton Creek Sub-basin, participants were grouped and asked to identify areas and infrastructure previously affected by flooding and drought, and delegate areas of highest concern for future events. Figure 4. identifies areas throughout the watershed that stakeholders have identified are of concern, or particular importance.

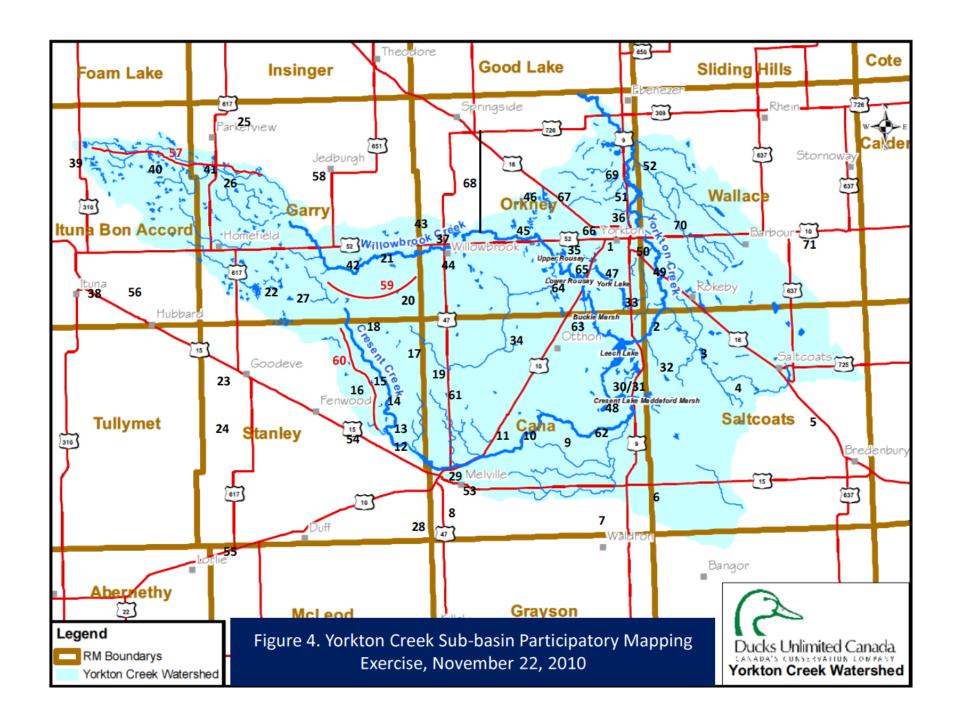


	Table 1. Participatory Map	ping	Exercise of Yorkton Creek Sul	o-ba	asin, November 22, 2010
1	Yorkton flooding 2010	26	Community pasture, holds lots of water	51	Flood 2010
2	Heavy rainfall 2010	27	Road washed out	52	Road under water
3	Beavers in the area	28	Dam overflowing since May (2010)	53	Open water, flowing "rapids"
4	Water quality issues	29	Dry (1988-1989)	54	Water up to shoulder of road
5	Lack of water in 2009	30	1995 and 2002 Flash flood. Changes in water quality, color, hardness, turbidity.	55	Stillborn's slough - when dry it is very dry in the area (1988-1989)
6	Well (2009)	31	Maddaford Marsh - DUC control structures have made things much better.	56	R.M Beaver Bounty \$10/tail
7	Flooding drainage - Well dry 2009-2010	32	Historically - flooding towards Saltcoats	57	Beaver dams every 40 feet
8	Area flooded	33	Dam	58	Potential to seed to perennial cover to rest soil
9	Trapping beaver in the area	34	Drought in 1960's - could walk across the lake	59	Beaver dams
10	Dugout dry (2009)	35	Cattle operation - requires lots of water	60	Beaver dams
11	Sloughs drying up in the area (2009)	36	Area severely at risk (Bottlenecked)	61	No new drainage since 1980's - 1800, open wells in this area, approximately 15 feet to water
12	Melville reservoir	37	Flooding prior to Yorkton Creek Drainage Project	62	Landowner wells not tested as much as city wells
13	Low water levels	38	Scott's Lake flooded cropland (2006)	63	Wellhead flooding
14	Bridge	39	Culvert level with road (2010)	64	Flooding (2010)
15	Low water levels	40	Flooded pasture	65	Yorkton golf course - pump water into York Lake - hasn't been used.
16	Beavers	41	Need to address culvert issues (2011)	66	Yorkton flooding (2010). New treatment plant has not been used yet.
17	Basin	42	Culvert (2010)	67	May be better to have a catch basin on East side of City. Currently catch basin is in the middle of the city.
18	Drainage, water quality, contamination issues	43	Road under water 2010	68	Outlet to Whitesand not used in 2010
19	Artesian well	44	1975, 1957, 2010 Willowbrook flooded	69	Flooded in 2010 - still under water
20	Artesian wells	45	Flooded crops and pasture (2010)	70	Low-level crossing on dirt road - flooded now (November 2010)
21	Bridge/culverts installed (2010)	46	Shallow wells, prone to drought	71	Barbour - lots of storage capacity (sloughs). Dry dugouts throughout 1980's.
22	Drainage	47	Drought low levels 1940's and 1950's		
23	Roads flooding	48	Flooding (1975)		
24	Pig barn	49	Low-level crossing (2010)		
25	Low lying area - very susceptible to flooding	50	Road flooded (2010)		

Areas identified on the Yorkton Creek Subbasin watershed map include frequently flooded areas such as roads, pastures, and low-lying areas (Table 1). Many areas within the watershed have been affected by drought in the past. Beaver dams and beaver activity (No. 57, 59 and 60) were identified throughout the area as problematic (Table 1).

discussion, to document past impacts from, and adaptation to, these events (Table 2).

2.2 Timeline

A timeline of drought and excessive moisture events was constructed through group

Table 2.	Timeline of Events in the Yorkton Creek Sub-Basin 1920 to 2010					
1922	Record flood, Yorkton Creek Watershed.					
1954	High water levels. Highest record rainfall since 2010.					
1960	1960 Widespread drought. Low lake levels, water supplies low. Wetlands dry.					
1975	1975 High water levels, agricultural land flooded. Lots of agricultural land impacted.					
1979	Dry years observed on air photos. SWA air photos show very dry conditions.					
1980s	People farmed through water runs. Drainages backed up with sediment. Conservation and drainage ditches - People could farm acres that weren't farmed before.					
1983	Flooding and impacts to houses.					
1987-1988	City of Melville's reservoir went dry - Crescent Creek.					
1989-1992	RM of Garry - Well dropped four feet.					
1992	Severe drought east of Yorkton. Aquifer level dropped several feet.					
1995	Record flood. Peak flows, culverts destroyed due to fast spring thaw.					
2002	Flash flooding - large changes in water quality, hardness and turbidity.					
2009	Fall was very dry, dugouts were dry and sloughs dried up.					
2010	May - Dam was overflowing.					
2010	Roads flooded in Ituna.					
2010	RM of Orkney - Road flooded north of Highway 52, west of Willowbrook.					
2010	Water reached the top of Willowbrook bridge.					
2010	RM of Garry - Pasture and cropland flooded.					
2010	RM of Wallace - Many secondary roads flooded.					
2010	Beaver dams are observed every forty feet in some areas of the watershed.					
2010	Many roads and culverts washed out.					
2010	Discussions with elders say 2010 was worse than the 1954 flooding.					

2.3 Drought and Excessive Moisture Characterization for the Assiniboine River Watershed

Virginia Wittrock from the Saskatchewan Research Council (SRC) provided information to help characterize drought and excessive moisture events within the Assiniboine River Watershed. Work done through SRC attempts to compare and contrast dry and wet patterns within the Assiniboine River Watershed to aid in risk management and planning strategies for future extreme events. Table 3. compares the top ten extreme drought and excessive moisture events within the Assiniboine River Watershed between 1901 to 2005 using both the Palmer Drought Severity Index (PDSI) and the Standard Precipitation Index (SPI).

The Palmer Drought Severity Index (PDSI) is primarily a hydrological drought index which is used to quantify excessive moisture and drought. Values are calculated based on soil water content, temperature data and daily/monthly precipitation information. PDSI values are beneficial as the values have a "long-term memory" built into the model and are helpful when looking at long-term trends (Wittrock *et al.*, 2010).

The Standard Precipitation Index (SPI) quantifies meteorological drought and is valuable in identifying emerging droughts earlier than the PDSI index, as previous moisture conditions are not taken into account. SPI is generally used in short-term, month-to-month analysis. SPI does not incorporate temperature, which is critical agricultural drought when monitoring (Wittrock et. al., 2010). PDSI values range from \leq -5 (Exceptionally Dry) to \geq 5 (Exceptionally Wet). SPI values range from ≤-2.5 (Exceptionally Dry) to \geq 2.5 (Exceptionally Wet).

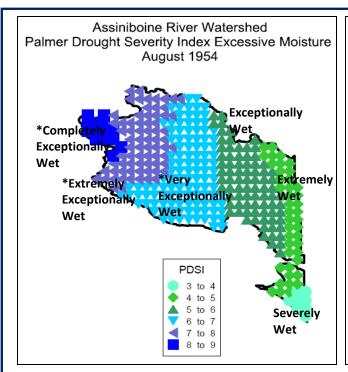
Table 3. Top 10 Extreme Years. Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) for the Assiniboine River Watershed (1901-2005 Agriculture Year)

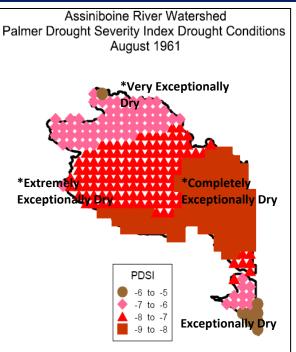
Palmer Drou	ght Seve (PDSI)	erity Index	Standardized Precipitation Index (One Month Extremes)							
Drought	_	essive pisture		Drought Excessive Moisture			sture			
Year Value	Year	Value	Year	Month	Value	Year	Month	Value		
1961 -8.7	1954	8.4	1971	May	-4.5	1975	April	3.2		
1941 -7.0	1995	6.1	1980	April	-4.0	1996	July	3.2		
1958 -5.8	1996	5.9	1961	August	-4.0	1983	July	2.9		
1984 -5.8	1993	5.6	1924	May	-3.9	1995	August	2.9		
1915 -5.7	2005	5.5	1913	Dec	-3.9	2002	August	2.9		
1959 -5.6	1953	5.3	1973	Jan	-3.7	1969	Sept	2.9		
1937 -5.5	1950	5.3	1992	Mar	-3.5	1965	Sept	2.9		
1931 -5.4	1994	5.1	1981	Nov	-3.4	1909	July	2.8		
1944 -5.3	1942	5.0	1925	Dec	-3.4	1926	Oct	2.8		
1934 -5.2	1966	4.8	1985	July	-3.2	1970	Oct	2.7		

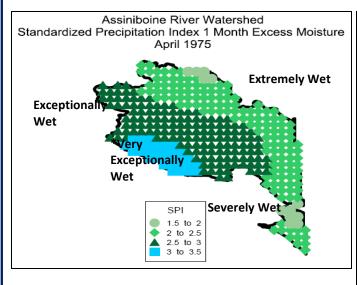
Wittrock *et al.* (2011) incorporated new categories, (categories and values beyond the current PDSI and SPI scale) for extreme events within the Assiniboine River Watershed, as such extreme values were not represented in the current model. Additional categories included were (see Figure 5):

- PDSI 6.0 to 7.0 (Very Exceptionally Wet)
- PDSI 7.0 to 8.0 (Extremely Exceptionally Wet)
- PDSI 8.0 to 9.0 (Completely Exceptionally Wet)
- PDSI -6.0 to -7.0 (Very Exceptionally Dry)
- PDSI -7.0 to -8.0 (Extremely Exceptionally Dry)
- PDSI -8.0 to -9.0 (Completely Exceptionally Dry)
- SPI 3.0 to 3.5 (Very Exceptionally Wet)
- SPI -3.0 to -3.5 (Very Exceptionally Dry)
- SPI -3.5 to -4.0 (Extremely Exceptionally Dry)
- SPI -4.0 to -4.5 (Completely Exceptionally Dry)

Figure 5. compares the wettest year (1954) and driest year (1961) within the Assiniboine River Watershed using the PDSI method. The wettest month (April 1975) was compared to the driest month (May 1971) using the SPI index. Wittrock *et al.'s* (2011) additional PDSI and SPI categories were overlaid on the Assiniboine River Watershed map (Figure 5).







Note: Areas marked with an asterisk "*" are categories arbitrarily created by the author.

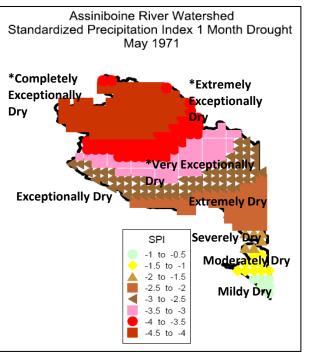


Figure 5. Comparison of Assiniboine River Watershed PDSI Wettest Year (1954) and Driest Year (1961) and SPI Wettest Month (April 1975) and Driest Month (May 1971)

These maps (Figure 5) indicate the spatial variability within the watershed. The PDSI excessive moisture map shows that the "completely exceptional" region is in the northwest portion of the watershed while the southern portion is categorized as "severe" conditions. The PDSI drought conditions map illustrate that the central portion of the watershed was under "completely exceptional" drought conditions while the northern and southern corners of the watershed were experiencing "exceptional and very exceptional" drought conditions.

The one month SPI excessive moisture month (April 1975) illustrates the lower southwest area of the watershed was dealing with "very exceptional" conditions. The one month SPI drought of 1971 illustrates the variability that can occur during a drought event. The northern portion of the watershed was under "completely exceptional" to exceptional" drought conditions while the southern quarter of the watershed varied from "mildly dry," in the southern tip, to "exceptional" conditions. This illustrates the potential impacts of the drought may have been greater in the northern portion, than the southern region of the watershed. A more comprehensive analysis of the watershed can be found in Wittrock et al., 2011.

2.4 Scenario Planning

Scenario planning is a method used for imagining possible futures by considering various uncertainties (Peterson *et al.*, 2003; Schoemaker, 1995). The purpose of scenario planning is to improve a community's ability to quickly respond to a variety of futures and avoid potential traps and benefit from potential opportunities (Peterson *et al.*, 2003). Generally, there are two common errors in decision making – underprediction and overprediction of change – scenario planning attempts to compensate for this, and allows us to chart a middle ground (Shoemaker, 1995).

Building scenarios involves anchoring each scenario in the past, and determining what issues may significantly affect the area including economic, political, technological and industry factors (Schoemaker, 1995). Scenario planning provides a forum for policy creation and evaluation, when stakeholders are involved in the process (Peterson *et al.*, 2003). Scenario planning is an effective coping method when control is difficult and uncertainty is high, factors which are evident in managing drought and excessive moisture events within the watershed.

During the first workshop on November 22, 2010, various issues affecting the Yorkton Creek Subbasin were identified through mapping and timeline exercises. Following the mapping and timeline exercises, stakeholders were separated into two breakout groups to discuss three scenarios which could potentially affect the sub-basin (Figure 6).

- Scenario 1 What would happen if a wet year like 2010 happened twice in 5 years?
 - O What would the impacts be?
 - O Who would be most vulnerable? And why?
 - What could be done to prepare for this scenario?
- Scenario 2 What would happen if a long-term drought (lasting longer than previously experienced) occurred?
 - O What would the impacts be?
 - O Who would be most vulnerable? And why?
 - What could be done to prepare for this scenario?
- Scenario 3 What would happen if it switched back and forth from wet to dry years very quickly?
 - O What would the impacts be?
 - O Who would be most vulnerable? And why?
 - O What could be done to prepare for this scenario?

Figure 6. Scenario Assessment Discussion Questions

Table 4. Scenario One	Vulnerability	Adaptation
What would happen if a wet year like 2010 happened twice in 5 years?	 Inundation Approximately 3 years for area to dry out Poor quality grass would result in lighter cattle High salinity Roads/infrastructure would be devastated Resorts (i.e. Good Spirit) Zoning costs Social/psychological effects on community members Day to day - businesses affected Student jobs No production of crops – economy impacted Increase in taxes Property loss Local library at risk Producers (Farmers and Ranchers) exit industry Insurance industry Lack of storage capacity Yard sites heavily impacted when dealing with consecutive events in such a short time frame Infrastructure not designed to withstand such events Lower socio-economic groups Industry (i.e. Dealerships) Fertilizer leaching into runoff Surficial aquifers 	 Storm sewer upgrade Crop insurance – apply for more Insurance industry has changed policies in regards to flooding (i.e. weeping tile and sump pumps are now required to get a lower premium) Sand bag now Build reservoirs Awareness, education Plant different crops Channel maintenance, investigate new methods for de-vegetating channels Protect/flood proof major wells Apply for increased government funding for R.M.s to address infrastructure Educate people on benefits of beavers – provide water storage Large industrial rooftops to create storage reservoirs Consult engineer regarding storm drainage channel using Yorkton Creek Design and build storm water retention ponds

Table 4 cont'd. Scenario Two	Vulnerability	Adaptation
What would happen if a long-term drought (lasting longer than previously experienced) occurred?	 Farmers and ranchers (loss of farms) Less acute, similar impacts Dust storms Immediate impacts to water usage/treatment Aquifer's dry Few urban issues unless aquifer goes dry, lawns may not be green Similar vulnerability as excessive moisture Algae issues affect tourism/resort industry York Lake "park" recreational park would close as visitors and residents would look at a dry slough Loss of production, less crops, higher prices, changes to economy Depends on time, after a flood it would be welcomed Melville may be able to handle a 3 year drought, Yorkton is unsure Five year drought vs. Five year flooding – flooding more devastating R.M. of Garry – Crops grow well during drought years due to clay soils People would become lackadaisical on channel maintenance, when flooding events occurred, the impact would be even greater Drought has less impact on R.M. infrastructure 	 Dig deeper wells Conservation tillage – "no-till" practiced in area Don't farm marginal land Pasture management Design dugouts for four year storage instead of 1-2 years Apply for grants for water development More dams Pipeline to Lake of the Prairies Dredge York Lake – more storage/capacity
Scenario Three	Vulnerability	Adaptation
What would happen if drought and excessive moisture events switched back and forth from wet to dry years very quickly?	 High cost to infrastructure Unrealistic – will not dry out that quickly; but may occur over 2-3 years in the future with climate change Stress on farmers and ranchers Balancing water Urban people not as affected as quickly Forage acres would be most impacted by fluctuations Would greatly affect producer's ability to adjust – difficult to plan for such variability Agriculture seems to be better tailored to dry conditions rather than wet conditions May be a good thing as drought would increase storage 	 Larger dugouts with 5 year supply Proper grazing management Vaccinate against anthrax Grasses for each (flood/drought tolerant) or both Change farming practices In terms of "adaptive infrastructure" our group says flooding is much more of an issue and would cause more "reaction to action"

The scenario planning exercise identified vulnerabilities associated with each potential scenario and possible adaptations stakeholders could foresee to mitigate impacts of such events (Table 4).

2.5 Information Requirements

During the second workshop, participants were asked to complete a questionnaire to help decision makers understand the diversity of groups and what information may be valuable to them (Appendix IV).

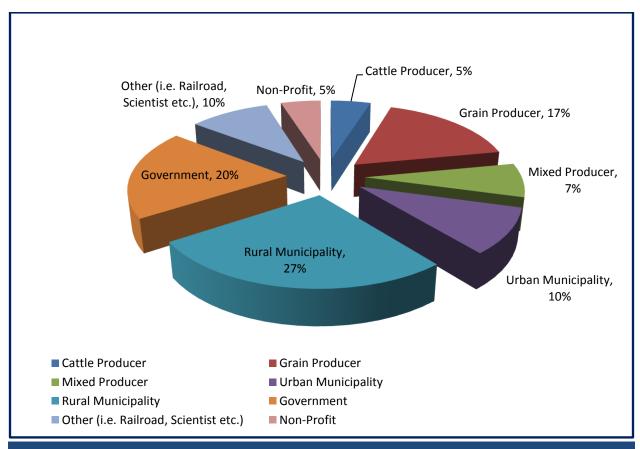


Figure 7. Representative User Groups Present (Workshop Two) within the Yorkton Creek Sub-basin, January 19, 2011

The majority of the representative user groups present within the Yorkton Creek Sub-basin were Rural Municipalities (27%), Government (20%) and Grain Producers (17%), (Figure 7).

The Yorkton Creek Sub-basin workshop attendees were asked to identify what information may be beneficial to them. Figure 8. compares preferred information requirements among all user groups within the AWSA.

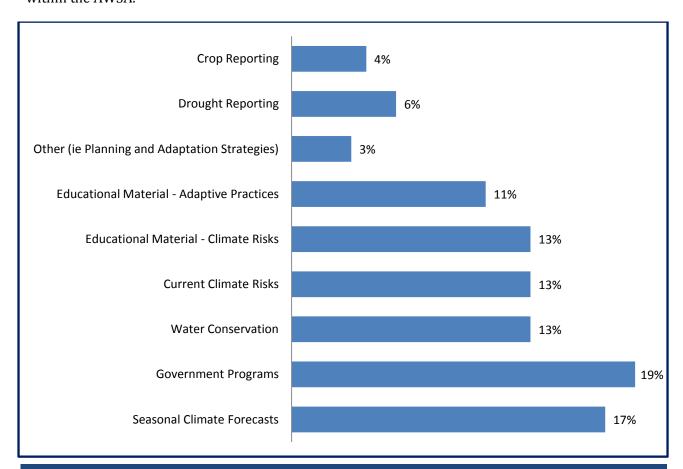


Figure 8. Comparison of Preferred Information Requirements among User Groups within the Yorkton Creek Sub-basin, January 19, 2011

User groups identified Government Programs (19%) as the most important information requirement followed by Seasonal Climate Forecasts (17%) and Information Concerning Current Climate Risks, Educational Material on Current Climate Risks and Water Conservation (each 13% respectively) (Figure 8).

Table 5. compares preferred information requirements from each user group within the AWSA.

Table 5. Comparison of Preferred Information Requirements of Each User Group within the Yorkton Creek Sub-basin January 19, 2011

	USER GROUP								
INFORMATION REQUIREMENTS	Cattle Producer	Grain Producer	Mixed Producer	Urban Municipality	Rural Municipality	Government	Non-Profit	Other	
Information on Government Programs	25%	30%	18%	24%	26%	16%	25%	19%	
Information on Water Conservation	0%	4%	12%	18%	9%	16%	25%	19%	
Seasonal Climate Forecasts	25%	26%	18%	24%	23%	16%	13%	19%	
Information on Current Climate Risks	13%	13%	18%	12%	14%	20%	13%	13%	
Educational Materials (EM) on Climate Risks	13%	9%	18%	18%	12%	16%	13%	13%	
Educational Materials (EM) on Adaptive Practices	25%	17%	18%	6%	16%	8%	13%	6%	
Other (ie. Flood/Drought Forecasting, Projected Precipitation for each Drainage Basin, Interactive Maps for Runoff)	0%	0%	0%	0%	0%	8%	0%	13%	
Total	100%	100%	100%	100%	100%	100%	100%	100%	

Cattle Producers identified educational materials on adaptive practices, government programs, and seasonal climate forecasts as preferred information (25% each respectively); while Grain Producers and Rural Municipalities expressed a high interest in the need for information on government programs. Mixed Producer's, Government, Non-Profit and Other groups had a broader interest in all information requirements (Table 5).



Adaptation Planning and Actions

Adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as "an adjustment in natural or human systems in response to actual or expected climatic stimuli (variability, extremes, and changes) or their effects, which moderates harm or exploits beneficial opportunities" (UKCIP, n.d., as cited in IPCC TAR, 2001).

Good adaptation practices are founded on the engagement of informed stakeholders and community, with the willingness and ability to adapt (UKCIP, n.d.).

Within the Yorkton Creek Sub-basin the process of building adaptive capacity involves understanding the nature of issues and risks within the Sub-basin, (which were identified by the community and stakeholders during the vulnerability exercises), then assessing the situation (coping capacities and thresholds), and finally identifying potential adaptive responses (UKCIP, n.d.).

Participants were organized into two breakout groups during workshop two, and discussed four vulnerability issues within the Yorkton Creek Sub-basin (Table 6):

- Municipal Preparedness
- Awareness/Education on benefits of being proactive

- Aquifer Protection; and
- Channel Maintenance

Table 6. Key Municipal, Educational, Channel Maintenance and Aquifer							
Pro	tection Issues Affecting the Yorkton Creek Sub-	-basir	1				
	Issue		Priority	,			
Action Item #	Municipal	Low	Medium	High	Preparedness	Response	Recovery
1	Tourism industry – Flooding of tourist areas (i.e. Good Spirit Lake)				х	х	
2	Equipment sharing agreements between R.M.'s				Х	Х	
3	Agreements with R.M.'s regarding detour options during flooding events				х	х	
4	Delineate high concern areas for future flooding events				Х	Х	
5	Theft/vandalism of signs – purchase more signs prior to events				х	х	
6	Sandbag availability – where to purchase/stockpile etc.				Х	Х	
7	Culvert maintenance – GPS locations, culvert handbooks				Х	Х	Х
8	R.M.'s - Build priority models for ambulance, essential services and review emergency preparedness				х	х	
9	Weather station reporting, two-way communication				Х	Х	
10	Winter snowpack surveys				Х		
11	Assess beaver dams (Dec/Jan time frame)				Х	Х	
12	Culvert preparation prior to spring thaw (i.e. steaming)				Х		
13	Public Alert Notifications – Radio, T.V – continuity for all R.M.'s				х	х	Х
14	Status of Well/Aquifer levels – aids in preparation for water rationing				х	х	х
	Issue						
	Proactive Education			T			
15	Radio station advertising/local newspapers				Х	X	Х
16	Education on beavers in the area				X	X	
17	Changes to school curriculums regarding environmental education for children				v	V	v
	Workshops/ meetings featuring people with experience with				Х	Х	Х
18	such issues				Х	Х	X
	Issue						
	Aquifer Protection	l					
20	High levels of nitrates in water is affecting aquifers				Х	Х	Х
21	Need public health information regarding aquifers				Х	Х	Х
22	Education on aquifers - school trips to aquifers, signage in aquifer locations, video tour of Yorkton aquifer (i.e. spreading manure on land affects aquifers)				v	v	v
23	Provide public with information on aquifer locations				X	X	X
	BMP's and programs in place for aquifer protection but there				Х	Х	Х
24	needs to be continuous advertising and education – people forget				х	Х	Х

	Table 6. Cont'd. Key Municipal, Educational, Channel Maintenance and Aquifer Protection Issues Affecting the Yorkton Creek Sub-basin							
	Issue		Priority					
Action Item #	Aquifer Protection	Low	Medium	High	Preparedness	Response	Recovery	
25	Monitoring of groundwater in high risk areas (i.e. garbage dumps, mines, gravel pits)				х	х	x	
26	New regulations/options for landfills in small communities (cost is an issue)				х	х	х	
27	Maintenance/monitoring/guidelines for gravel pits				Х			
	Issue		Priority					
Action item #	Channel Maintenance	Low	Medium	High	Preparedness	Response	Recovery	
28	Conservation and drainage ditches – more grant money	_	_		X	X	_	
29	Beaver control (need consistency across R.M.'s)				Х			
30	Options for dealing with sedimentation issues and debris				х	х	х	
31	Assessment of existing channels, landowner monitoring stations				х			
32	Increase funding for channel cleaning programs				Х			
33	Arrange dedicated contractors for scheduled channel maintenance				х	х		
34	Coordinate channel maintenance across municipalities				Х	х		
	Channel capacity issues. Need some control of what is				Х	Х		
35	being released into channels							
35	Prior to channel construction there needs to be studies done on impacts upstream and downstream prior to channel development				X	х		

This portion of the plan attempts to rate potential adaptations (action items) identified by stakeholders during the discussion sessions, as low (green), medium (yellow), or high (red) priority. The adaptations outlined in Table 6 were then recognized as part of a preparedness, response or recovery item in the occurrence of a potential drought or excessive moisture event.

IV

Future Refinements

Adaptation will involve a mixture of response strategies which may require a 'sequential approach': building climatic resilience; increased preparedness and planning (living with the potential risks); and to a certain extent - some acceptance of loss (UKCIP, n.d.).

The goal of this plan was to identify current and past exposures and sensitivities that people within the Yorkton Creek Sub-basin encounter, examine how the community deals with these conditions or risks, and identify processes and factors which may constrain their choices (Smit and Wandel, 2006). Once these conditions are identified, analysts and policy makers can help the Sub-basin plan-for (preparedness), and respond-to (response), these conditions and potentially determine future vulnerability (Smit and Wandel, 2006).

Adaptation must evolve with internal and external circumstances in order for adaptation to be continually effective. The viability of the Watershed's adaptive responses will be challenged - as climate, technological innovations, increased scientific understanding, and socio-economic's are constantly changing. As such, adaptive planning and responses will need to be reassessed periodically within the Sub-basin.

By adopting a continuous improvement approach and incorporating lessons-learned from previous adaptation efforts - the Yorkton Creek Sub-basin will be better prepared in the event of future drought or excessive moisture events.

Appendix I Glossary of Terms

Definitions for terms used in this plan are included below. Many of the terms used in the plan have a variety of definitions, depending on the discipline used; however, for the purpose of this plan, the definitions have been adapted to the natural hazard of drought and excessive moisture.

Adaptation: "an adjustment in natural or human systems in response to actual or expected climatic stimuli (variability, extremes, and changes) or their effects, which moderates harm or exploits beneficial opportunities" (UKCIP, n.d., as cited in IPCC TAR, 2001).

Adaptive Capacity: refers to a system or community's potential or ability to plan for, cope, and adjust to changes and stresses with minimal disruption or additional cost (ICLEI, 2010; Ford and Smit, 2004; Smit and Wandel, 2006).

Agricultural Drought: characterized by a lack of water to grow a particular type of crop or support livestock. Defining factors include not only the amount of precipitation received, but the correct use of available water. Agricultural drought generally occurs after a meteorological drought and before a hydrological drought (Econnics, 2010).

Drought: drought originates from a reduction in the amount of precipitation over an extended period of time, resulting in a water shortage, usually a season or more in length. Droughts differ in intensity, duration and spatial extent (Knutson *et al.*, 1998).

Excessive Moisture: periods of flooding due to heavy precipitation events or spring runoff which may disrupt social and environmental systems (Pittman, 2010b).

Hydrological Drought: occurs when low precipitation results in low water levels in lakes, rivers, reservoirs and aquifers. Generally, a hydrological drought follows a meteorological drought. Water uses that depend on ground and surface water levels such as urban water use, recreational and industrial water use, and ecosystems are affected by hydrological droughts (Econnics, 2010).

Meteorological Drought: occurs when precipitation in a certain area, within a particular time period, is compared to the average rainfall for that same area. Soil moisture is depleted during a meteorological drought and impacts crop production (Econnics, 2010).

Preparedness: process of performing pre-disaster activities to ensure a level of readiness to respond in the event of a drought or excessive moisture emergency (Knutson *et al.*, 1998).

Recovery: activities undertaken to promote the rebound of social and environmental systems following an extreme event (Pittman, 2010b).

Response: activities undertaken to reduce the negative consequence of the impacts from drought and excessive moisture events (Pittman, 2010b).

Risk: the possibility of adverse effects as a result of drought or excessive moisture events based on the temporal and spatial severity of the event and one's corresponding vulnerability (Knutson *et al.*, 1998).

Socio-economic Drought: occurs when a weather-related shortfall in water supply results in the inability to meet the demand for economic goods. The severity and impact of Socio Economic Drought is affected by water demand (Econnics, 2010).

Vulnerability: the susceptibility of a population or the environment in the event of drought or excessive moisture (Knutson *et al.*, 1998).

Vulnerability Assessment: framework for identifying a population or environments' susceptibility and the underlying causes of drought-related impacts (Knutson *et al.*, 1998).

Appendix II Resources

Provincial Government Resource Websites



<u>Farm and Ranch Water Infrastructure (Government of Saskatchewan)</u>

A province-wide Farm and Ranch Water Infrastructure Program will support the development of secure water sources in Saskatchewan to expand the livestock industry, encourage rural economic activity and mitigate the effects of future drought. http://www.agriculture.gov.sk.ca/FRWIP 2009



<u>Provincial Disaster Assistance Program (PDAP)</u> (Government of Saskatchewan)

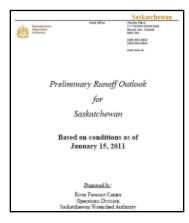
Provides financial assistance in certain circumstances where there has been a natural disaster, such as flooding, tornadoes, plow winds and severe weather.

http://www.cpsp.gov.sk.ca/Default.aspx?DN=4c191c20-5666-48fd-b412-979717005ef2



Free testing of flood-impacted drinking water wells (Saskatchewan Watershed Authority)

Offers free testing of drinking water wells affected by flooding. http://www.gov.sk.ca/news?newsId=503d61fe-9281-4b4b-b582-a6fcdb23c452



2011 Preliminary Spring Runoff Outlook (Saskatchewan Watershed Authority)

SWA has compiled detailed information on potential spring runoff conditions for the province.

 $\frac{http://www.swa.ca/WaterManagement/Documents/ProvincialForec}{ast2011Jan15th.pdf}$



<u>Stream Flows and Lake Levels (Saskatchewan Watershed Authority)</u>

Real-time information on stream flow and water level data is collected at hydrometric stations throughout the province of Saskatchewan to monitor water conditions in Saskatchewan. http://www.swa.ca/WaterManagement/StreamFlowsAndLakeLevels.asp



Flooding Preparedness (Government of Saskatchewan)

Documents and related links to assist homeowners in flood preparation, disaster cleanup, emergency measures and disaster assistance. http://www.health.gov.sk.ca/flooding-preparedness



Crop Reporter (Government of Saskatchewan)

Volunteer Crop Reporters fill out a weekly online summary and report crop conditions and precipitation for their areas. Reporting begins April $1^{\rm st}$ and runs for approximately 27 weeks. A regional crop report is released weekly.

http://www.agriculture.gov.sk.ca/Crop-Report





Current News/Information (Government of Saskatchewan)

- Strong Uptake for Emergency Flood Damage Reduction Program http://www.gov.sk.ca/news?newsId=efd27cc6-9f3f-4228-9d91-0e223e8e7ea7
- Province Releases Details of \$22 Million Emergency
 Flood Damage Reduction Program

http://www.gov.sk.ca/news?newsId=a21f4d25-0afc-4561-9e1c-e02c2156d7c1

Federal Government Resource Websites



Real-time Hydrometric Data (Environment Canada)

This site provides public access to real-time hydrometric (water level and streamflow) data collected at over 1700 locations in Canada.

http://www.wateroffice.ec.gc.ca/text search/search e.html?sear ch by=p®ion=SK



The Weather Office (Environment Canada)

Provides historical, current conditions and forecasts. http://www.weatheroffice.gc.ca/canada_e.html



AESB Water Supply and Drought Monitoring - Drought Watch (Agriculture and Agri-Food Canada)

http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1256658312655&lang=eng

Information and maps which provide users with an overview of the risk of drought in Canada.



<u>Drought Management Information (Agriculture and Agri-Food Canada)</u>

Extensive information on managing drought in regards to crops, livestock, pests, pasture management and water.

http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1256665877504&lang=eng



Managing Wet Soils (Agriculture and Agri-Food Canada)

This webpage, located on Agriculture and Agri-Food Canada's Internet site provides information on Impacts of Excess Soil Moisture and Cover Crops.

http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1195497988026&lang=eng



Environment Canada Seasonal Forecast (Environment Canada)

Provides monthly and seasonal forecasts, information on El Nino and La Nina, climatology of temperature and precipitation. http://www.weatheroffice.gc.ca/saisons/index_e.html



Snow Water Equivalent Mapping (Natural Resources Canada)

Displays recent information of snow cover across Canada and North America.

http://atlas.nrcan.gc.ca/auth/english/maps/environment/climate/snowcover/snowdepth

Additional Resources



Irrigation Saskatchewan

Provides links to three websites - Irrigation Crop Diversification Corporation, Saskatchewan Ministry of Agriculture and Saskatchewan Irrigation Projects Association – which provide information on irrigation systems, scheduling, crop varieties and news and events.

http://www.irrigationsaskatchewan.com/ICDC/icdc index..htm



Drought Research Initiative (DRI)

The Drought Research Initiative was a five year program (2005-2010) to coordinate and integrate drought research in Canada through combining university and provincial/federal government researchers with expertise in various aspects of droughts including atmospheric, hydrologic, land surface and predictive aspects. http://www.drinetwork.ca/



<u>National Drought Mitigation Center (NDMC) University of Nebraska – Lincoln</u>

The NDMC employs preparation and risk management rather than crisis management in helping people and institutions deal with drought. The NDMC site provides information on monitoring, drought planning, and impacts and mitigation. http://www.drought.unl.edu/



National Integrated Drought Information System (NIDIS) U.S. Drought Portal

The U.S. Drought Portal is a system used to provide early warning data on drought and help individuals and organizations to plan and manage for the impacts of drought. The system also provides agencies and stakeholders with information on potential risks, impacts and comparison models for previous and potential droughts.

http://www.drought.gov/portal/server.pt/community/drought_gov/202;jsessionid=0559F10E8EC21CA540B604A9F2BEF6E1



Weatherfarm

Provides online information for Western Canadian producers providing real-time weather and farm-management information. http://www.cwb.ca/public/en/farmers/weather/stations/



Weatherbug

Provides online information for current weather and local forecast.

http://weather.ca.weatherbug.com/SK/Regina-weather.html?zcode=z6286&lang_id=en-ca



ICLEI Adaptation Handbook - Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation

ICLEI is an international association of local governments that provide technical consulting, training and information which work towards sustainable development at the local level. http://www.iclei.org/index.php?id=10832



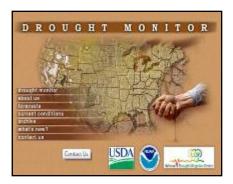
<u>SaskAdapt - Saskatchewan's Climate Change Impacts and Adaptation Information Center (Prairie Adaptation Research Collaborative)</u>

Provides the latest Saskatchewan and Prairie-specific science and information to help residents, government and business organizations make decisions on adapting to climate change. http://www.parc.ca/saskadapt/introduction



<u>Drought Preparedness Planning: The Ten Step Process</u> (2007 National Drought Mitigation Center)

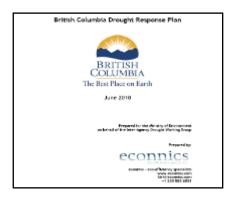
A ten step process which provides a checklist of key elements of a drought plan. http://www.p2pays.org/ref/50/49988.pdf



<u>University of Nebraska-Lincoln - Drought Monitor</u>

Provides forecasts, current conditions and drought monitoring within the United States.

http://www.drought.unl.edu/dm/index.html



British Columbia Drought Response Plan

Drought response plan which addresses preparedness, response and recovery for the province of British Columbia.

http://www.env.gov.bc.ca/wsd/public safety/drought info/cabi net/bc drought response plan june-2010.pdf



Living with Drought (Australian Government)

Australian weather, seasonal climate information, climate data, information on living with drought.

http://www.bom.gov.au/climate/drought/livedrought.shtml

Appendix III Saskatchewan Association of Watersheds Drought Preparedness Meeting

Saskatchewan Association of Watersheds

Drought Preparedness Breakout Summary

April 12-13, 2010, iPlex, Swift Current, SK

Perceptions of drought

As is apparent from the breakout sessions, drought means different things to different people in different places at different times. There was, however, a **reoccurring theme** in the discussion groups that drought is a dry, stressful period with negative implications for farms, families, businesses, communities wildlife and watersheds, but can also present certain opportunities.

Coping with drought

Past management strategies:

Stock pile hay/feed, increase well/dugout supply capabilities, improve water-use efficiency, conserve
and ration water, manage pastures to have carry-over, employ conservation tillage practices, xeroscaping, grow drought tolerant crop and forage varieties, carry crop insurance, use continuous cropping rotations, maintain stubble/trash cover on cropland, and adjust herd size.

Preparing for the future...

There were numerous strategies for improving drought preparedness identified by workshop participants. The following is a brief summary of these strategies:

Education/Awareness:

- Communicate the benefits of proactive approaches, such as conservation and using water efficiently, to all stakeholders.
- Address 'water abuse' issues by debunking the 'myth of abundance'.
- Engage existing communication pathways and networks to disseminate new technologies and ideas.
- Promote the watershed approach and encourage networking and collaboration between all stakeholders.

Soft Strategies:

- Mange excessive moisture as an opportunity to increase preparedness for the next drought.
- Develop water use monitoring programs that can be used to track water use over time.
- Rethink 'wastewater' and identify potential ways of using it as an opportunity.
- Encourage innovation in water and land management.

Planned Adaptation:

- Ensure water security by exploring potential sources and augmenting existing storage capacities and supplies.
- Develop research projects that improve our knowledge of drought preparedness in agricultural and urban settings.
- Shift the focus from managing drought impacts to building drought preparedness.

Appendix IV Information Requirements Questionnaire

Information Requirements Questionnaire

1.	Which	group(s) do you represent? (Please choose all that apply)
	a.	Cattle producer
	b.	Grain producer
	c.	Mixed producer
	d.	Urban municipality
	e.	Rural municipality
	f.	Government
	g.	Other:
2.	What i	nformation would be valuable to you? (Please choose all that apply)
	a.	Information on government programs
	b.	Information on water conservation
	C.	Seasonal climate forecasts
	d.	Information on current climate risks
	e.	Educational materials on climate risks
	f.	Educational materials on agronomic
		practices
	g.	Other:
	h.	Other:
	i.	Other:
	j.	Other:
	k.	Other:
3.	Are vo	u interested in the following: (Please choose all that apply)
		Volunteer crop/climate reporting
	b.	Volunteer drought and other
		climate impact reporting

Appendix V Yorkton Creek Sub-basin Adaptation Planning (Issues) Template

How can we address the issues?

	Issue:									
	Action items	Priority (high, medium, low)	Who should work on this?							
1										
2										
3										
4										
5										
6										
7										

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