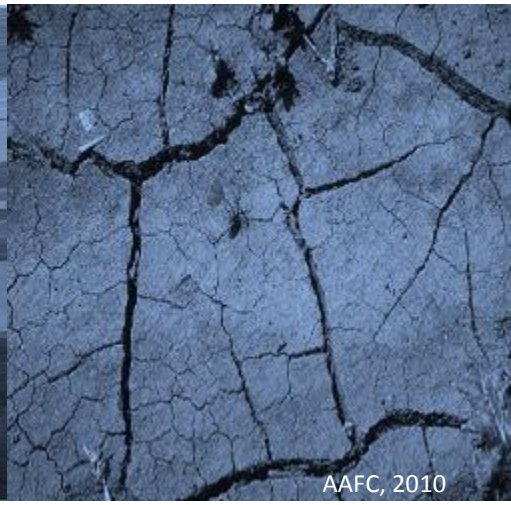
OWWA
Old Wives Watershed Association

Old Wives Lake Watershed


SWA, 2010


AAFC, 2010

Drought and Excessive Moisture Preparedness Plan

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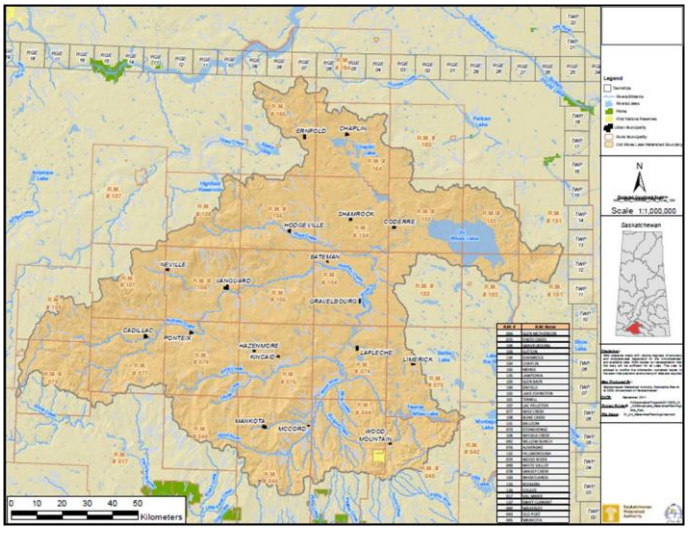
Old Wives Lake Watershed Drought and Excessive Moisture Preparedness Plan

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 and completed plans in four pilot watersheds. In 2011, SWA initiated drought and excessive moisture preparedness planning in two additional watersheds, by partnering with local non-profit stewardship agencies. The Old Wives Watershed Association was selected as one of the stewardship agencies to develop a Drought and Excessive Moisture Preparedness Plan for the Old Wives Lake Watershed.

1.1 Old Wives Lake Watershed Overview

The Old Wives Lake Watershed is approximately 16,850 km^2 (Figure 1) and is situated in the south central portion of the province (M. Almas, personal communication, January 11, 2012). The watershed is a closed basin, meaning there is no outflow. The largest water bodies in the watershed are primarily saline and include Old Wives Lake, the Chaplin Lakes and Twelve Mile Lake (SaskWater, 1994). Thomson Lake is a non-saline manmade reservoir which supplies Gravelbourg and Lafleche with potable water (SaskWater, 1994). The Wood River is the principal watercourse and hydrometric records show that the river's flow resembles that of a typical prairie stream, which derive their flow from snowmelt and rainfall (SaskWater, 1994). This relationship results in a range of extremes from high flow to low or no flow years. Additional watercourses which have been altered by weir and reservoir projects include Coderre, Vanguard and Lawson weirs, and the Admiral, Braddock, Cadillac, Gouverneur, Russell Creek, Summercove, and Semereua reservoirs (SaskWater, 1994).

Figure 1. Old Wives Lake Watershed



There is a broad consensus that global temperatures are rising. 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 but least understood of all natural hazards, affecting more people than any other hazard (Sivakumar and 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. 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, January 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 Old Wives Lake 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 much water can be just as damaging as too little water, which may negatively impact water supplies, agriculture and ecosystems (SWA, 2010). 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.

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).

1.4 About This Plan

Two workshops were held in the Old Wives Lake Watershed facilitated by Saskatchewan Watershed Authority and the Old Wives Watershed Association on November 17, 2011, and December 7, 2011. The goal was to identify the vulnerability and resilience of various watershed stakeholders through numerous workshop activities, including mapping areas of highest concern, construction of timelines showing drought and excessive moisture events and 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 Old Wives Lake Watershed'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 watershed, then prioritizing each issue. The purpose of the plan is to provide a strategic plan in dealing with Drought and Excessive Moisture for the Old Wives Lake Watershed 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 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 2). Ideas and knowledge obtained from the workshops were ultimately incorporated into the plan.

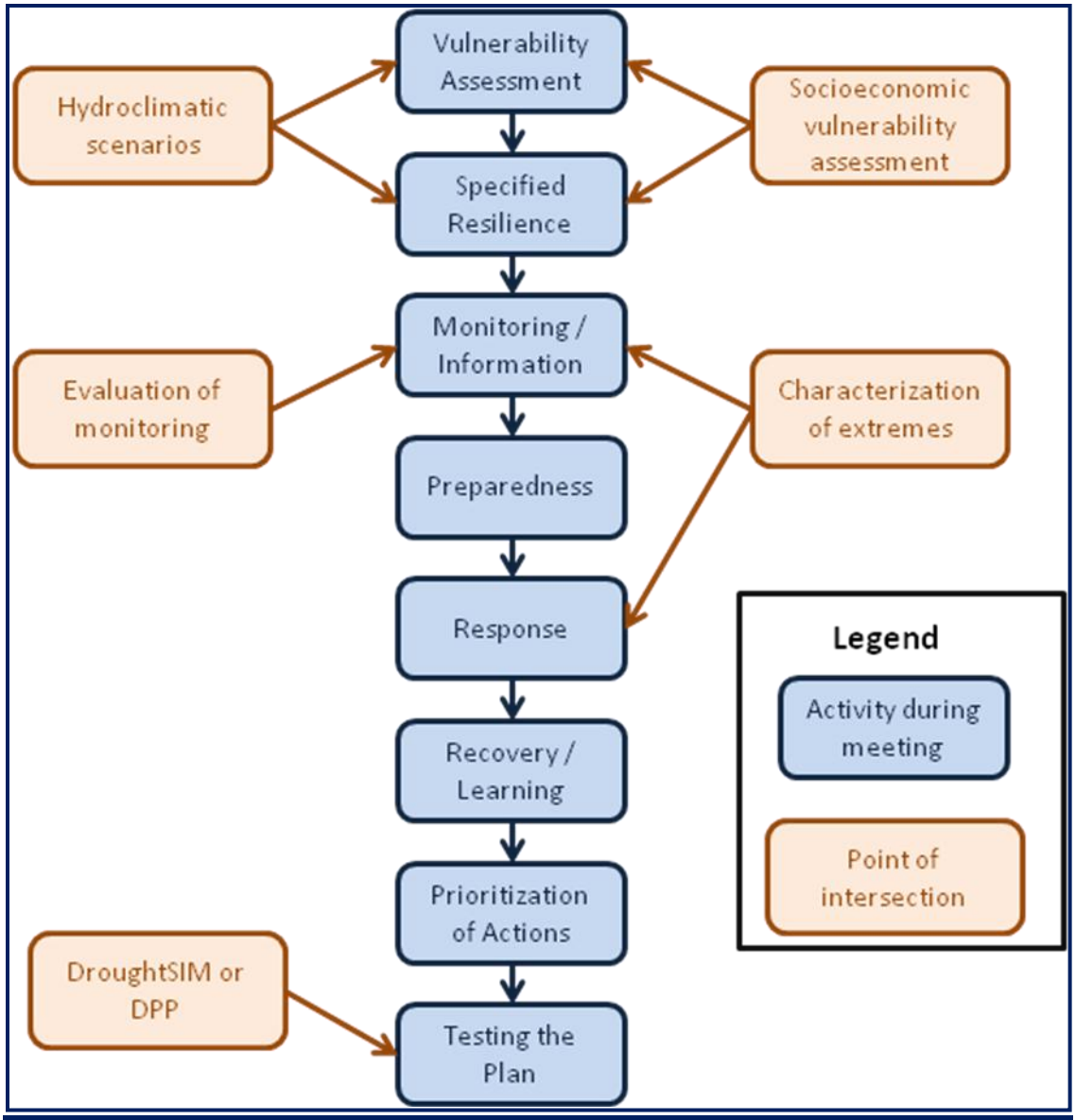


Figure 2. Preparedness Planning Approach

II

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 Old Wives Lake Watershed 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 Old Wives Lake Watershed 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 Old Wives Lake Watershed'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 events, 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 Old Wives Lake Watershed 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 Old Wives Lake Watershed has experienced. Once these conditions have been identified,

analysts 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 Old Wives Lake Watershed, 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 non-government 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 participatory mapping contributes to community cohesion, and may stimulate stakeholders to engage in land and resource-related 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 Old Wives Lake Watershed, 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 3 identifies areas throughout the watershed that stakeholders have identified are of concern, or particular importance.

Areas identified on the Old Wives Lake Watershed map include frequently flooded areas, dams and areas previously affected by drought (Table 1).

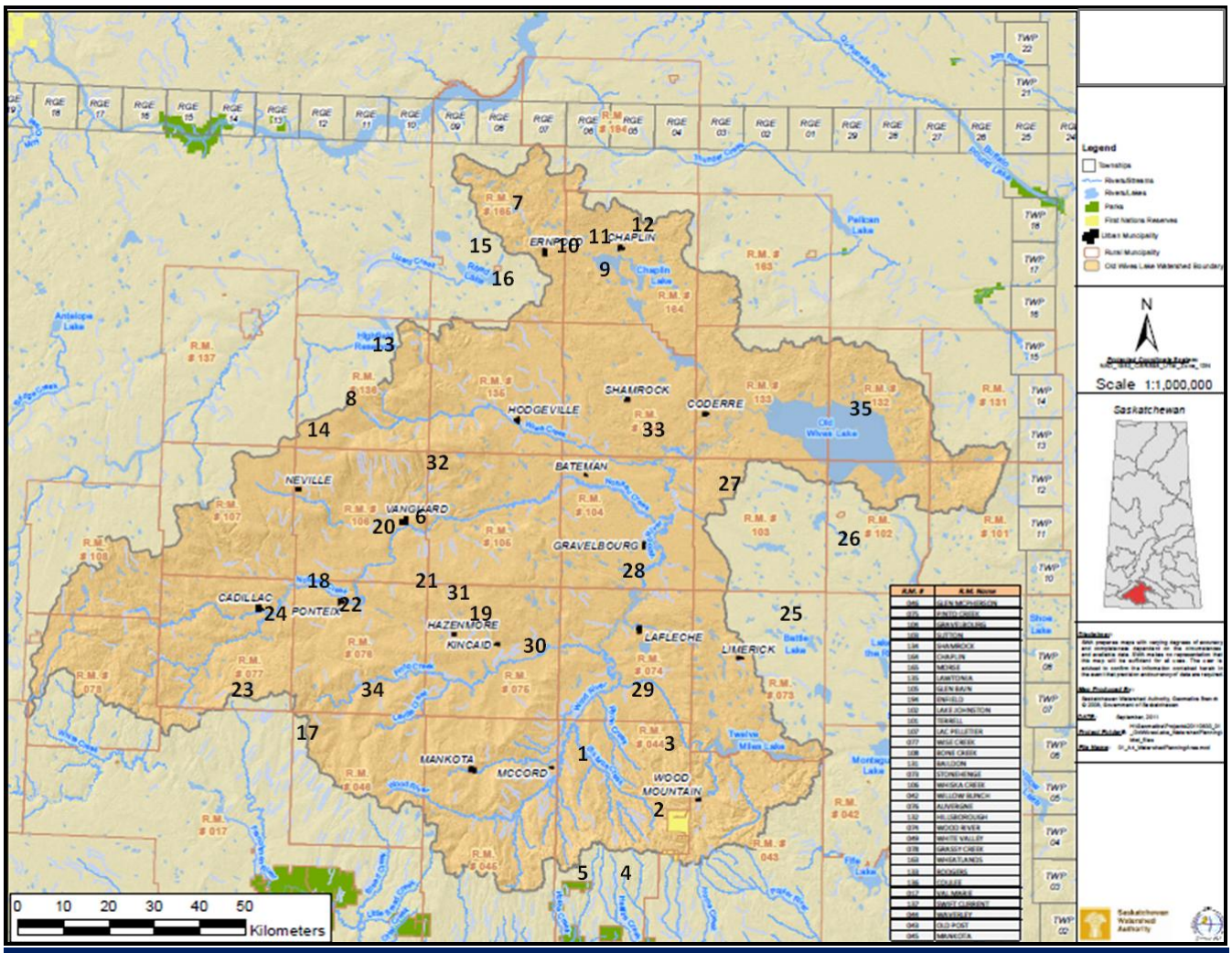


Figure 3. Old Wives Lake Watershed Participatory Mapping Exercise November 17, 2011

Table 1. Participatory Mapping Exercise Old Wives Lake Watershed November 17, 2011

1	1997 spring flood	18	Prairie fire 2011
2	Seven day storm in February 1978	19	June 2011 rain resulting in a flash flood
3	Periods of drought in 2001-03 and early 1980's	20	April 2011 flood Notukeu Creek overflow, sandbagged water treatment plant in Vanguard. South town access was flooded
4	Large snow pack in 2009-10 and 2010-11	21	1997 Spring flood in RMs 106, 105, 76 and 75
5	Prairie fires in August 2005 (roughly 3000 acres burnt over 2 weeks)	22	2000 flood
6	Huge flood – Vanguard July 3rd 2000 336-375 mm in 8 hour period	23	Widespread drought in the south west portion of the watershed in 2004 and 2009
7	Wells dry in 2007 and 2008	24	1952-53 flood washed out Gouverneur dam
8	Approximately 25 inches of rain in 1991	25	Huge snowfall in the 1970's
9	Flood prone area typically floods every year	26	Approximately 7 inches of rain over 12 hours in 2011
10	Flood prone area typically floods every year	27	Unable to seed in 2010 due to excess moisture
11	Flood prone area typically floods every year	28	Channel erosion, river changed course River bridge underwater for roughly 2 months
12	Wells dug in May 2011	29	Significant infrastructure damage due to high runoff event in 1997
13	9 inches of rain in 2011 over two weeks	30	Backflood structure damaged in 1997 and decommissioned
14	Plow wind and rain in 2005	31	1985 and 1988 droughts
15	Lake dry in 1998 and 2007	32	Sudden runoff in 1999 led to erosion issues
16	Lake full in 1991 and 2011 Road under water in 1991 and nearly in 2011 Culverts washed out in 2011 Could potentially lose road in 2012	33	Highway 58 washout in 2011
		34	Flooded acres throughout watershed in 2011
17	Prairie fire 1990	35	Old Wives Lake went dry in 1988 and salt blowing

2.2 Timeline

A timeline of drought and excessive moisture events was constructed through group discussion to document past impacts from past impacts and adaptation to these events (Table 2).

Table 2. Timeline of Events in the Old Wives Lake Watershed 1930 to 2011

1930s	Old Wives Lake dry.
1952-54	Very wet. Crops rusted out. Major damage to spillways.
1960-62	Severe drought. One of the hardest farming years.
1964	Very wet.
1974	Widespread flooding.
1977	most snow ever in Chaplin
1978	5 day blizzard in Gravelbourg and Chaplin.
1985	Drought year. Crops were very thin.
1988	Old Wives Lake - westerly winds moved lake water east and it didn't return. Lake was blowing salt.
1988	Old Wives Lake dried up. Found root structures in dried out lake bed.
1997	Very wet. Spring runoff overall basin 1:100 with localized 1:200 events. Severe infrastructure damage. Drained Thomson Reservoir but it filled right back up.
1997	Fast spring melt. Lots of damage in Gravelbourg.
2000	Huge flood in Vanguard due to spring rainfall (1:500 event*). Rail beds washed out due to flood waters. Needed to shock chlorination numerous wells.
2001	Widespread drought.
2002	Very wet. 2001-2, two very difficult years for agriculture.
2004-09	RMs 76, 106 and south. Very dry. Little record.
2007-09	2007-09 drought events likely each in the 1:100 or higher. 2009 is the driest winter period on record.
2010	Ground was saturated going into winter.
2011	Fortunate for the slow spring melt. Damage could have been much more severe. Spring runoff events in the 1:50 with localized 1:100 events.
2011	Releases from Thomson Reservoir cleared potential ice jams and saved Gravelbourg in the spring.
2011	7" in rain in the Mossbank area over 10 hours.
2011	10 bushels per acre around Chaplin.

*A 1:500 event is used to explain the event in terms of its occurrence. An event of this size is likely to occur only once in 500 years.

2.3 Drought and Excessive Moisture Characterization

Virginia Wittrock from the Saskatchewan Research Council (SRC) presented information to help characterize drought and excessive moisture events within the Old Wives Lake Watershed. Work done through SRC attempts to compare and contrast dry and wet patterns within the 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 Old Wives Lake 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 meteorological 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.,* 2011).

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 when monitoring agricultural drought (Wittrock *et al*., 2011). PDSI values range from ≤ -5 (Exceptionally Dry) to ≥5 (Exceptionally Wet). SPI values range from ≤-2.5 (Exceptionally Dry) to ≥ 2.5 (Exceptionally Wet).

Table 3. Top 10 Extreme Years. Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) for the Old Wives Lake Watershed (1901-2005 Agriculture (September to August) Year)

Palmer Drought Severity Index (PDSI)				Standardized Precipitation Index (One Month Extremes)					
Drought		Excessive Moisture		Drought			Excessive Moisture		
Year	Value	Year	Value	Year	Month	Value	Year	Month	Value
1988	-6.4	1907	8.5	1974	6	-3.5	1993	7	3.4
1937	-6.4	1909	7.2	1968	3	-3.5	1975	3	3.3
1931	-6.0	1954	7.1	1973	1	-3.4	1998	10	3.2
1961	-5.9	1955	6.8	2005	2	-3.3	1904	3	3.0
1919	-5.4	1966	6.2	1959	12	-3.3	1927	5	3.0
1929	-5.3	1991	6.1	1985	6	-3.3	1986	9	3.0
1984	-5.3	2004	5.9	1917	5	-3.3	1967	3	2.9
1946	-5.3	1951	5.5	1967	6	-3.2	1971	1	2.9
1981	-5.2	1974	5.5	1978	3	-3.2	1978	9	2.8
1959	-5.1	1916	5.4	1961	8	-3.1	1955	7	2.8

Wittrock and Wheaton (2011) incorporated new categories for extreme events within the Old Wives Lake Watershed, as such extreme values were not represented in the current model. Additional categories included were (see Figure 4):

- 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)

- SPI 3.0 to 3.5
  (Very Exceptionally Wet)

- SPI -3.0 to -3.5
  (Very Exceptionally Dry)

Figure 4 compares the wettest year (1907) and driest year (1988) within the Old Wives Lake Watershed using the PDSI method. The wettest month (July 1993) was compared to the driest month (June 1974) using the SPI index. Wittrock and Wheaton (2011) additional PDSI and SPI categories were overlaid on the Old Wives Lake Watershed map (Figure 4).

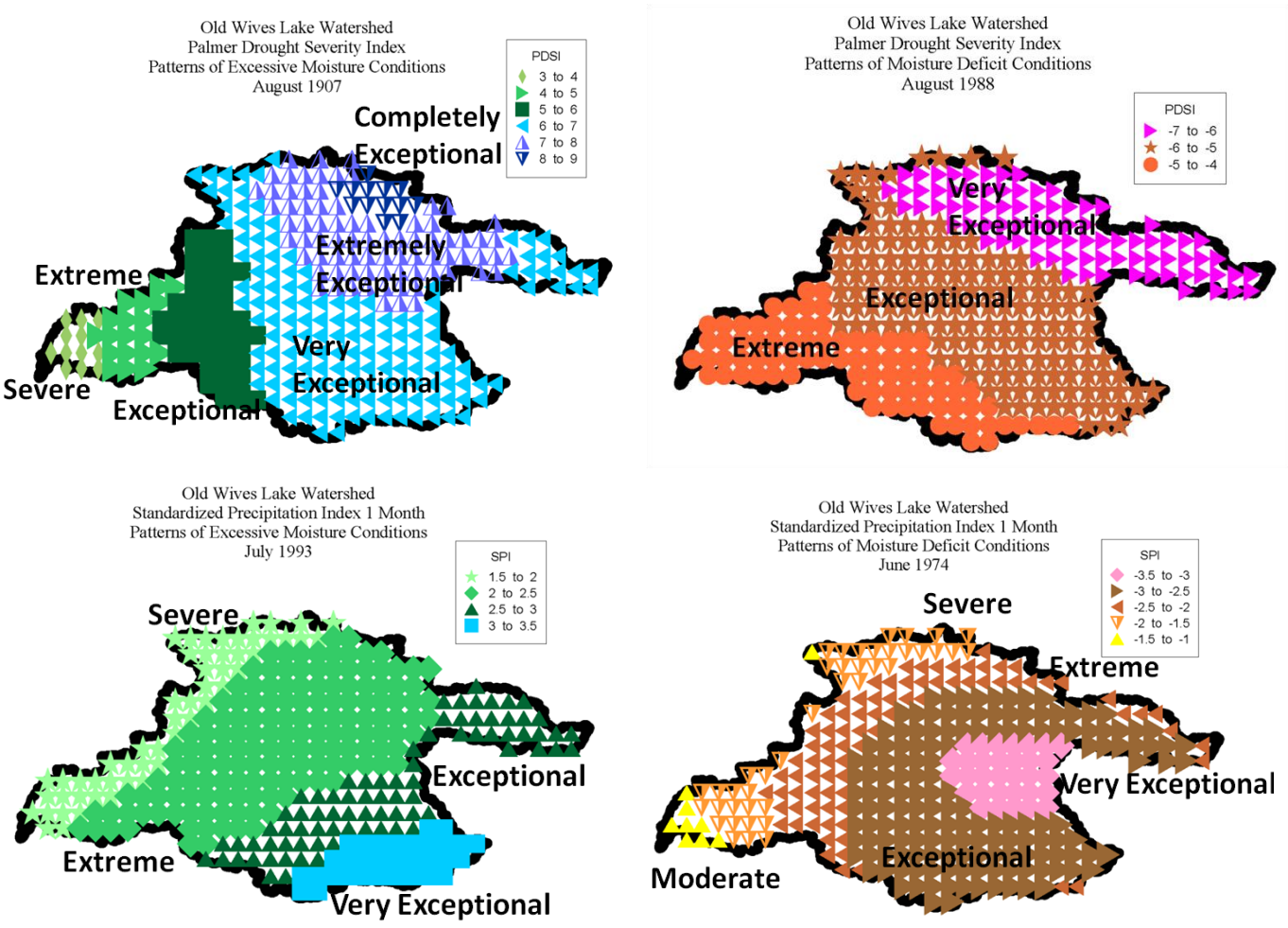


Figure 4. Comparison of Old Wives Lake PDSI Wettest Year (1907) and Driest Year (1988) and SPI Wettest Month (July 1993) and Driest Month (June 1974)

These maps indicate the spatial variability within the watershed. The PDSI excessive moisture map shows that the "completely exceptional" region is in the northeastern portion of the watershed while the southwest is categorized as "extreme" and "severe" in the far southwest. The PDSI drought conditions map illustrate that the northeastern portion of the watershed was under "very exceptional" drought conditions, while the southwestern region was under "extreme" conditions.

The one month SPI excessive moisture month illustrates the entire watershed was coping with excess moisture conditions, with the southeastern corner dealing with "very exceptional" conditions. The one month SPI drought of 1974 illustrates the variability that can occur during a drought event. The east central section of the watershed was under "very exceptional" drought conditions while the western region of the watershed was under "moderate" and "severe" conditions. This illustrates the potential impacts of the drought may have been greater in the east central portion than the western region of the watershed. A more comprehensive analysis of the watershed can be found in Wittrock and Wheaton, 2012.

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 second workshop on December 7, 2011, various issues affecting the Old Wives Lake Watershed were identified through mapping and timeline exercises. Participants were separated into two breakout groups and discussed three scenarios which could potentially affect the Old Wives Lake Watershed (Figure 5 and Table 4).

- **Scenario 1 – What would happen if a wet year like 2010 happened twice in 5 years?**
  - What would the impacts be?
  - 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?**
  - What would the impacts be?
  - 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?**
  - What would the impacts be?
  - Who would be most vulnerable? And why?
  - What could be done to prepare for this scenario?

Figure 5. Scenario Assessment Discussion Questions

Table 4. Scenario One	Impacts and Vulnerabilities	Adaptation
What would happen if a wet year like 2010 happened twice in 5 years?	• Infrastructure damage • Human health threats associated with household flooding (mould exposure, short term stress, etc) • Contamination of source waters by increased run off • Reduced quality of source water • Inability to seed land • Poor crop yields (crop rust) • Un-seeded acres • Limited access to grain storage • Lost grain • Instability in the agricultural sector (equipment sales,) • Loss of income/livelihood • Cattle sickness and disease • Copper deficiencies in livestock • Increase in bugs and pests • Increases in insurance payments • Erosion on sensitive areas • Sedimentation on low lying areas • Salinization from high water table • Pressure on operational budgets and capital spending • Displacement/loss of property • Loss of habitat and fragmentation • Weed infestation • Producers (crop/livestock) increased cost of rehabilitation of impacted areas • People in low lying areas and along creeks • Urban areas developed near rivers or flood plains • Agricultural dependent local business • Municipal resources • Transportation businesses (those industries dependent on rural road networks)	• Dyking and berming of flood prone areas • Seed low lying land to grass • Adjust agricultural operations (moving grain bins) • Zoning to ensure development does not take place in flood plains • Develop or update local emergency preparedness plans • Establish partnerships to share equipment • Rehabilitate gullies • Re-establish and protect riparian areas • Enhanced weather monitoring • Identifying potential ice jams along watercourse • Utilization of on farm planning programs such as the environmental farm plan initiative • Zero-till, and continuous no-till to reduce erosion potential

Table 4 cont'd. Scenario Two	Impacts and Vulnerabilities	Adaptation
What would happen if a long-term drought (lasting longer than previously experienced) occurred?	• Loss of income/livelihood • Long-term drought would have a greater economic impact than scenario one • Loss of feed and grain yields • Increased operation costs such as hauling feed and water • Increased presence of pests	• Drill water wells • Water rationing, restrictions and prioritization of use • Water re-use • Water conservation education • Adjust dugout design • Utilize drought resistant crops

	• Increased fire risk • Limited potable water/water shortages • Lower quality of water • Shorebird habitat loss • Reduced tourism and recreation opportunities • A two year drought would be devastating • A ten year drought may cause a complete collapse • Low income families • Reduced capacity of municipal taxes to ensure services are provided • Agriculturally related business • Municipalities (deteriorating roads, fire risk) • Industries relying on large volumes of water	• Adjusting stocking rates • Stockpile grain and grass • Limit hunting utilizing vehicles as they are a fire threat • Develop local emergency preparedness plans • Development of rural water infrastructure (increased storage capacity) • Proper design of rural water supplies can alleviate or limit the effects of drought • Promote xeriscaping in urban communities • Proactive government programs
Table 4 cont'd. Scenario Three	**Impacts and Vulnerabilities**	**Adaptation**
What would happen if drought and excessive moisture events switched back and forth from wet to dry years very quickly?	• Difficulty knowing what to plan for • Potential for poor management decisions • Loss of agricultural inputs • High fire risk if a dry year follows a wet year (lots of fuel for a fire) • Potentially lower stress and lower economic impacts than scenario two • Erosion and environmental damage increases (gullying and wind erosion) • Reduced tourism and recreation opportunities • Less opportunities for government programming as the programs may not be able to adapt quickly enough • Significant market vulnerabilities • Inability of municipalities to target resources • Less preparedness capacity • Municipalities may not be able to proactively invest in infrastructure. There may be more "knee jerk" reactions	• Increased communication of forecasting • Availability of secondary water sources • Temporary water sources • Regional planning and cooperation between municipalities

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 first 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).

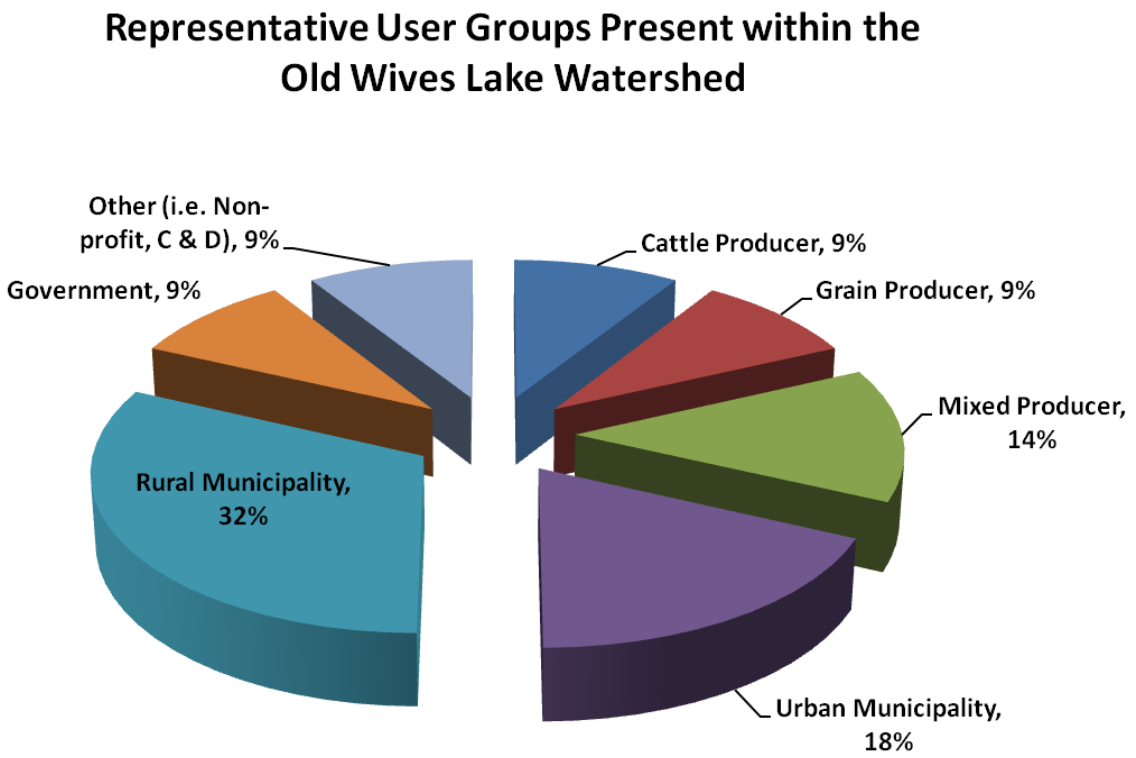


Figure 6. Representative User Groups Present (Workshop One) within the Old Wives Lake Watershed, November 17, 2011

The majority of the representative user groups present within the Old Wives Lake Watershed were Rural (32%), Urban (18%) and Mixed Producers (14%), (Figure 6).

The Old Wives Lake Watershed workshop attendees were asked to identify what information may be beneficial to them (Appendix IV). Figure 7 compares preferred information requirements from all user groups within the Old Wives Lake Watershed.

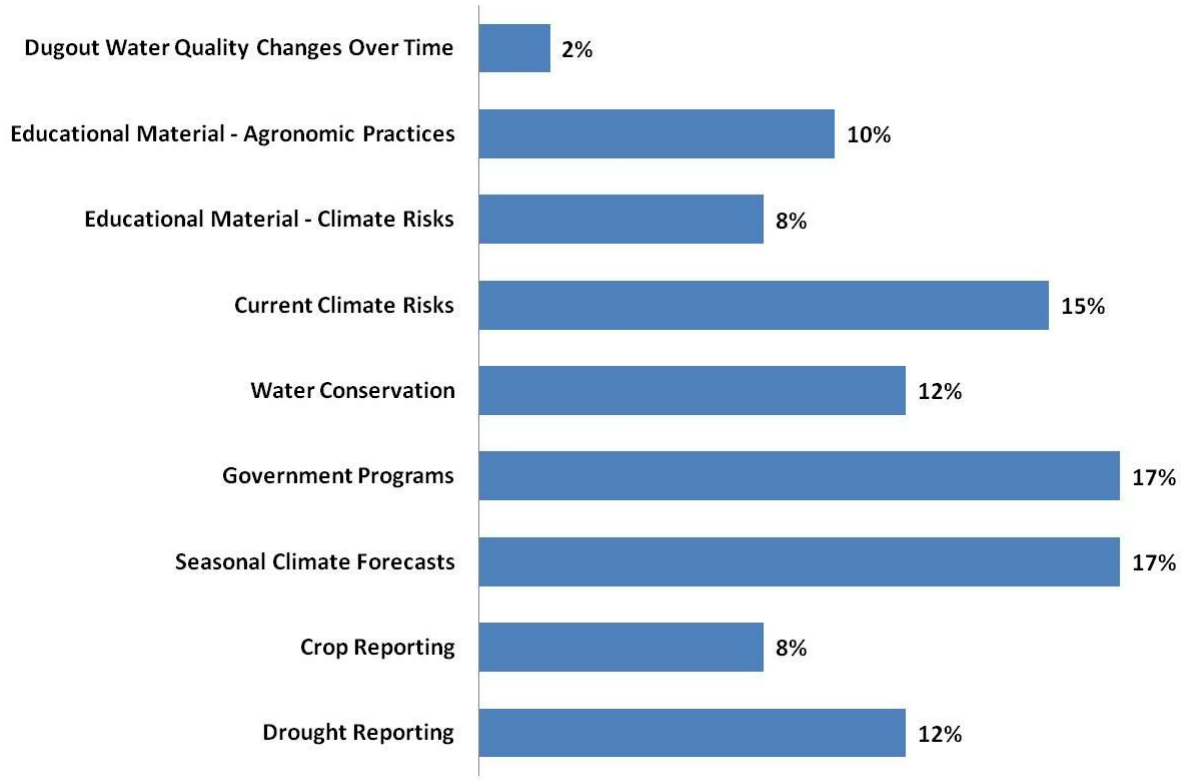


Figure 7. Comparison of Preferred Information Requirements for All User Groups within the Old Wives Lake Watershed November 17, 2011

User groups identified information regarding seasonal climate forecasts and government programs as the most important information requirements, followed by information concerning current climate risks, water conservation and drought reporting (Figure 7).

Table 5 compares preferred information requirements from each user group within the Old Wives Lake Watershed.

Table 5. Comparison of Preferred Information Requirements of Each User Group within the Old Wives Lake Watershed

	USER GROUP						
INFORMATION REQUIREMENTS	Cattle Producer	Grain Producer	Mixed Producer	Urban Municipality	Rural Municipality	Government	Other
Information on Government Programs	13%	33%	13%	17%	27%	13%	13%
Information on Water Conservation	13%	33%	13%	11%	14%	13%	13%
Seasonal Climate Forecasts	25%	0%	25%	23%	23%	25%	13%
Information on Current Climate Risks	25%	17%	25%	23%	23%	13%	13%
Educational Materials (EM) on Climate Risks	13%	0%	0%	14%	9%	13%	13%
Educational Materials (EM) on Agronomic Practices	13%	17%	13%	11%	5%	13%	25%
Other	0%	0%	13%	0%	0%	13%	13%
Total	100%	100%	100%	100%	100%	100%	100%

Cattle and mixed producers, rural and urban municipalities, and government identified seasonal climate forecasts and information on current climate risks, while grain producers expressed an interest in government programs and water conservation, and non-profit groups expressed interest in educational materials on agronomic practices.

III

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 Old Wives Lake Watershed the process of building adaptive capacity involves understanding the nature of issues and risks within the watershed, (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 Old Wives Lake Watershed (Table 6):

- Rural and Municipal Planning;
- Watershed Infrastructure;
- Agriculture and Land Management; and
- Communication.

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

Table 6. Issues Affecting the Old Wives Lake Watershed

Action Item #	Issue Rural and Municipal Planning	Priority Low	Medium	High	Preparedness	Response	Recovery
1	Municipalities should renew or establish local emergency response plans to ensure roles and responsibilities are understood in the event of a flood.				X		
2	Municipalities should implement a zoning bylaw or update the current bylaw to ensure zoning reflects drought and excessive moisture preparedness				X		
3	Municipalities should seek opportunities to conduct regional planning between RMs and establish mutual aid agreements to share resources during drought and excessive moisture events				X		
4	Municipalities and landowners should categorize excessive moisture and drought risks				X	X	
5	Municipalities should investigate options for water pricing structures to create an incentive to conserve water				X	X	
6	Municipalities should develop a plan to ration water during periods of drought				X	X	
7	Municipalities should work with stewardship agencies to administer local water conservation projects such as the promotion of water re-use technology and xeriscaping				X	X	X
8	Municipalities should develop a bylaw to limit hunting by vehicle during periods of drought as they are a fire threat				X	X	
9	Municipalities should evaluate their primary water storage capacity and enhance their understanding of secondary or temporary water sources				X		
Action Item #	Issue Watershed Infrastructure	Priority Low	Medium	High	Preparedness	Response	Recovery
10	Municipalities should identify locations of potential ice jams and monitor these areas during spring thaw				X	X	
11	Municipalities should work with partner agencies to cooperate the clearing ice and manage other spring runoff risks				X	X	
12	Municipalities should ensure infrastructure is designed for 1 in 500 year events				X	X	
13	Municipalities and Conservation and Development Areas should assess the operation and effectiveness of current water infrastructure				X		

Table 6 cont'd. Issues Affecting the Old Wives Lake Watershed

Action item #	Issue Agriculture and Land Management	Priority Low	Medium	High	Preparedness	Response	Recovery
14	Municipalities should work with stewardship agencies to access multi government level funding opportunities to address preparedness projects				X	X	X
15	Municipalities should work with stewardship agencies to re-establish riparian area buffers and to rehabilitate identified gullies				X	X	X
16	Producers should identify secondary feed access				X	X	
17	Producers should be encouraged to assess their water storage capacity and increase storage capacity if it is not sufficient to endure a drought				X		
18	The development of dugouts should be designed to reduce evaporation (long, narrow and deep dugouts are less susceptible to evaporation				X		
19	Municipalities and landowners should identify flood prone lands and ensure these areas are seeded to permanent cover				X	X	X
20	Municipalities should encourage landowners to utilizing continuous cropping and zero till practices to reduce soil erosion during high runoff years				X		
Action item #	Issue Communication	Priority Low	Medium	High	Preparedness	Response	Recovery
21	Municipalities and Conservation and Development Areas should enhance communication of water management with downstream users				X	X	X
22	Municipalities, Conservation and Development Areas and stewardship agencies should host joint workshops promoting inter-agency communication, water conservation activities and emergency preparedness				X	X	X
23	Municipalities should encourage government to deliver more proactive programming focused on drought and excessive moisture preparedness				X		
24	Municipalities should encourage government to assess gaps in climatic and hydrometric monitoring and promote the establishment of more localized weather and hydrometric stations				X	X	X
25	Municipalities would benefit from more real-time data and more communication of the available data so municipalities can make more informed decisions				X	X	X

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 Old Wives Lake Watershed 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 Old Wives Lake Watershed 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 watershed.

By adopting a continuous improvement approach and incorporating lessons-learned from previous adaptation efforts - the Old Wives Lake Watershed 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

Farm and Ranch Water Infrastructure (Government of Saskatchewan)
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

Provincial Disaster Assistance Program (PDAP) (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

Stream Flows and Lake Levels (Saskatchewan Watershed Authority)
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 1st and runs for approximately 27 weeks. A regional crop report is released weekly.
http://www.agriculture.gov.sk.ca/Crop-Report

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?search_by=p&region=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.

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

National Drought Mitigation Center (NDMC) University of Nebraska – Lincoln
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

SaskAdapt – Saskatchewan's Climate Change Impacts and Adaptation Information Center (Prairie Adaptation Research Collaborative)

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

Drought Preparedness Planning: The Ten Step Process (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

University of Nebraska-Lincoln - Drought Monitor

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/cabinet/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
Old Wives Lake Watershed Workshop Agendas

Box 390 Gravelbourg, SK S0H 1X0
Tel: (306) 648-3301 Ext. 5 Fax: (306) 648-3493
www.oldwiveswatershed.com

AGENDA
Workshop 1 – November 17th, 2011 @ 1PM – 4PM
Gravelbourg, Saskatchewan

1:00pm **Welcome and Introductions**

1:05pm **Workshop I Overview**

1:10pm **Presentation 1**
Saskatchewan Watershed Authority – Gord Hagen, Supervisor, Regional Operations *Watershed Hydrology*

1:50pm **Presentation 2**
Saskatchewan Research Council – Virginia Wittrock, Research Scientist/climatologist *Understanding Drought and Excessive Moisture events within the Old Wives Lake Watershed.*

2:30pm **Extreme Events Timeline**
Identification of extreme events within the Old Wives Lake Watershed

2:45pm **Break**

2:55pm **Participatory Mapping**
Identification of areas impacted by drought and excessive moisture as well as those areas of highest concern

3:40pm **Information Questionnaire**

3:50pm **Next steps for Workshop 2**

4:00pm **Adjourn**

Box 390 Gravelbourg, SK S0H 1X0
Tel: (306) 648-3301 Ext. 5 Fax: (306) 648-3493
www.oldwiveswatershed.com

AGENDA
Workshop II – December 7th, 2011 @ 3PM – 6PM
Ponteix, Saskatchewan

3:00pm **Welcome and Introductions**

3:05pm **Workshop II Overview**

3:10pm **Presentation**

Agriculture and Agri-Food Canada – Agri-Environmental Services Branch – Cam Kayter, Flood Risk to a Region's Infrastructure and Environment

3:40pm **Scenario Discussions**

Scenario 1: What would happen if a wet year like 2010 happened twice in 5 years?

Scenario 2: What would happen if a long-term drought (lasting longer than previously experienced) occurred?

Scenario 3: What would happen if it switched back and forth from wet to dry years very quickly?

4:50pm **Break**

4:55pm **Developing Preparedness Action Items**

5:55pm **Workshop Summary**

6:00pm **Adjourn**

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 information 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 you interested in the following: (Please choose all that apply)
    a. Volunteer crop/climate reporting ___
    b. Volunteer drought and other climate impact reporting ___

Appendix VI
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