



Moose Jaw River Watershed



Drought and Excessive Moisture Preparedness Plan

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March 2012



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Acknowledgements

Report compiled by *Dave Espeseth*

Preparedness planning approach developed by *Jeremy Pittman, Saskatchewan Watershed Authority*

Extreme climate events characterization by *Virginia Wittrock and Elaine Wheaton, Saskatchewan Research Council*

Workshop planning and facilitation by *Tammy Myers, Moose Jaw River Watershed Stewards and Dave Espeseth, Saskatchewan Watershed Authority*



With federal funding support through Natural Resources Canada's Regional Adaptation Collaborative Program

.....

Cover Photos courtesy of;
SWA (Moose Jaw River Watershed Stewards), Flooding 2011
AAFC (Agriculture and Agri-Food Canada), Arid Soil

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Moose Jaw River 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 Moose Jaw River Watershed Stewards were selected as one of the stewardship agencies to develop a Drought and Excessive Moisture Preparedness Plan for the Moose Jaw River Watershed.

1.1 Moose Jaw River Watershed Overview

The Moose Jaw River Watershed is approximately 9,360 km² (Figure 1) and is situated in the south central portion of the province (MJRWBR, 2006). The Moose Jaw River flows in a northeast direction, is fed by a number of small tributaries originating in the southeast. The Thunder Creek flows southeast into Pelican Lake which rarely spills as a result of topography. In the event that Pelican Lake spilled, the Thunder Creek would join the Moose Jaw River at the City of Moose Jaw (MJRWBR, 2006). However, most

years the Moose Jaw River is joined by the flow from Sandy Creek, a tributary of Thunder Creek which joins downstream of Pelican Lake (MJRWBR, 2006). From the City of Moose Jaw, the river drains into the Qu'Appelle River downstream of Buffalo Pound Reservoir (MJRWBR, 2006).

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

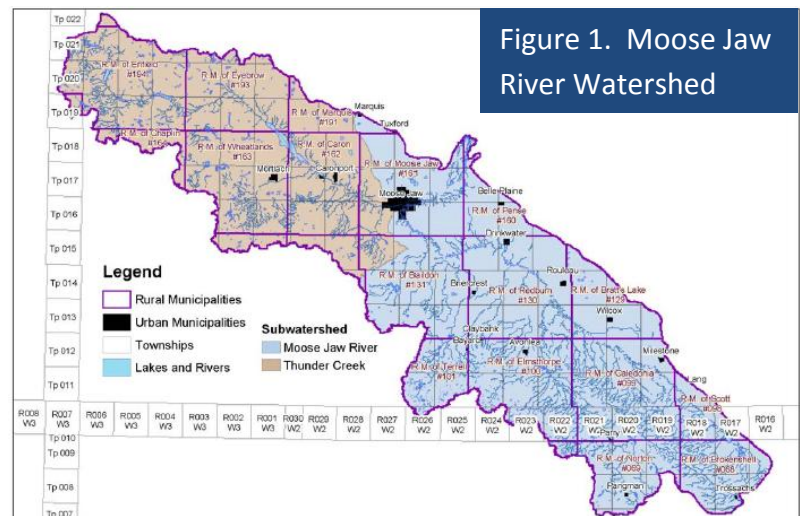


Figure 1. Moose Jaw River Watershed

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 Moose Jaw 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 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

The Moose Jaw River Watershed group held two workshops facilitated by Saskatchewan Watershed Authority and the Moose Jaw River Watershed Stewards on November 17, 2011 and December 8, 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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River Watershed workshops. The goal of the workshops was to share ideas, and 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.

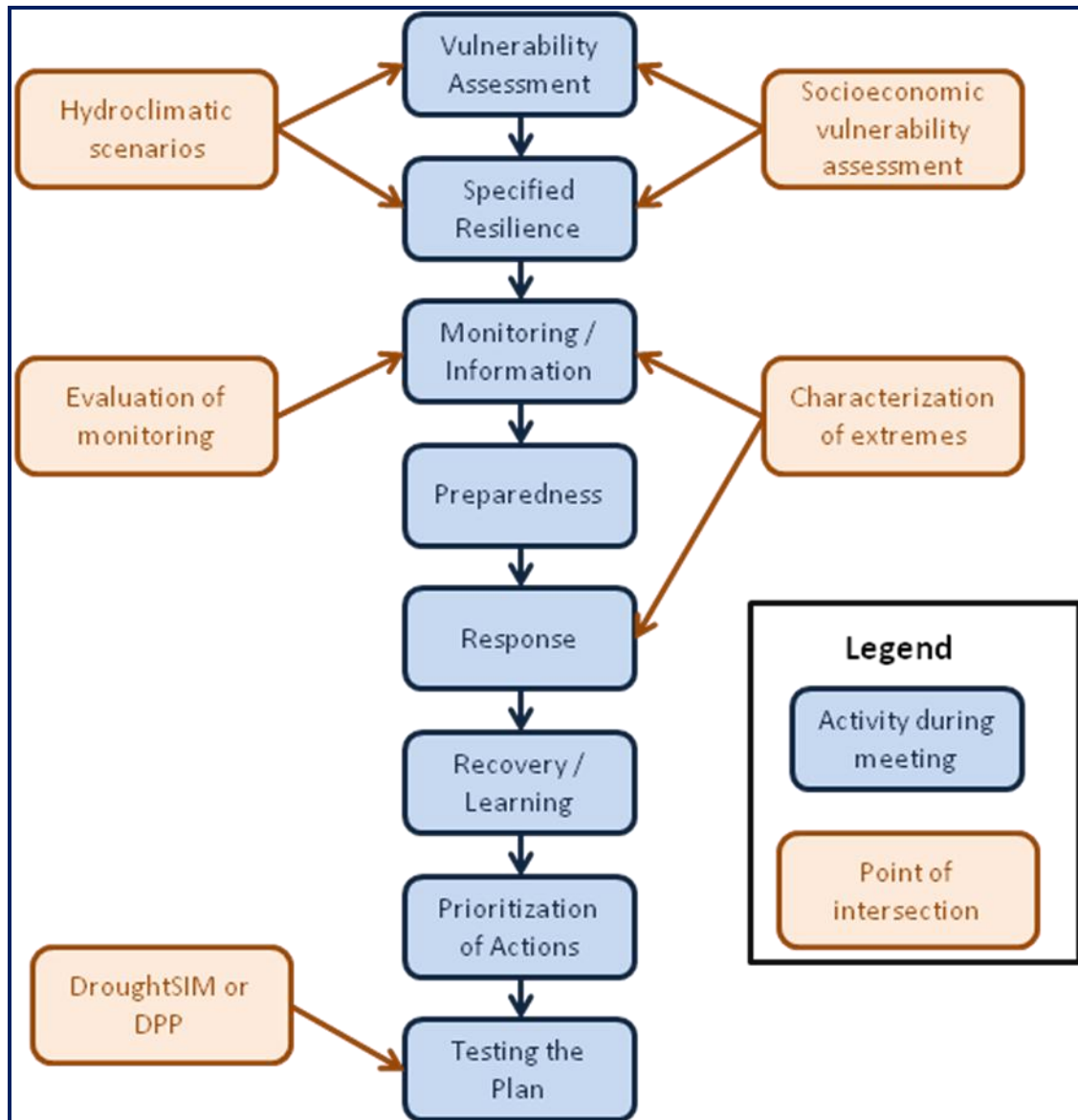


Figure 2. Preparedness Planning Approach

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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River Watershed's capacity to cope with drought and excessive moisture events, 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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River 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 Moose Jaw River Watershed map include frequently flooded areas, dams and areas previously affected by drought (Table 1).

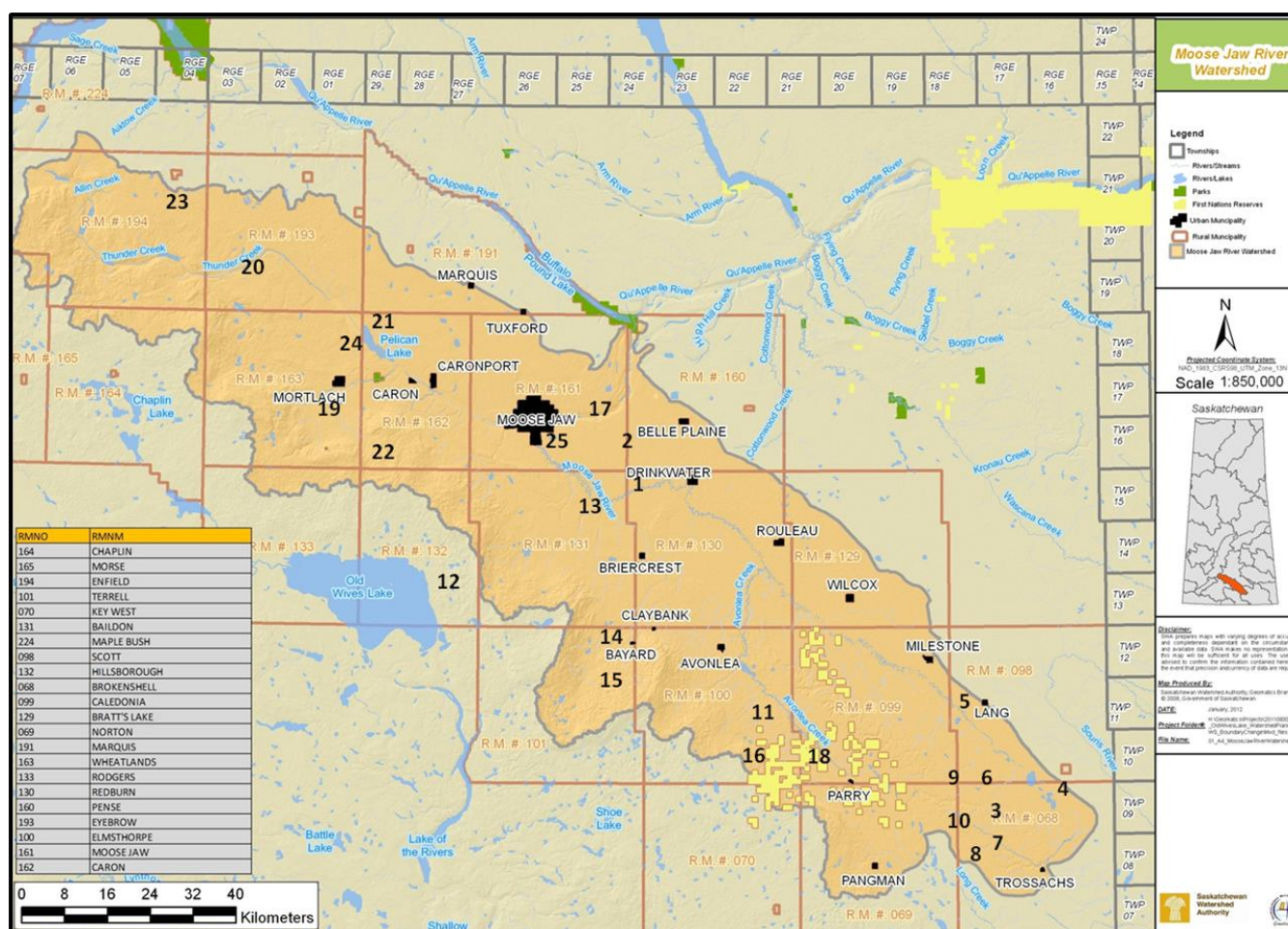


Figure 3. Moose Jaw River Watershed Mapping Participatory Mapping Exercise, November 17, 2011

Table 1. Participatory Mapping Exercise Moose Jaw River Watershed November 17, 2011

1	Sedimentation restricting flow in 2010-11	14	Drought in 1982 and 1988 in RMs 131, 130, 101 and 100
2	Excessive moisture throughout 2010-11	15	Terrell water flowed over roads in June 2010
3	Zero runoff between 2001 and 2002	16	Pothole landscape water has no place to go
4	Gated control bringing water into the watershed	17	August 1993 rain and flash flood
5	Lang West C & D will be developing drainage infrastructure with gated controls	18	Truay area RM 100 replaced several culverts that washed out
6	Excessive moisture throughout 2010-11	19	Tornado through the town of Mortlach in 1995
7	Highly valued native grass	20	Ducks Unlimited Darmody dam failed twice in 2011
8	Area was re-seeded to tame forage in the 1980's	21	Pelican Lake dry in late 1980's
9	Disaster area declared in portions of RMs 68, 69, 98 and 99 in 2011	22	Heavy rain in 1996
10	Extended periods of excessive moisture are impacting native grasses	23	2010 summer rains. Still lots of water in fall 2011 impacting RM roads
11	Widespread drought in the 1980s. Could not graze cattle	24	Pelican Lake peaked in 1997
12	Old Wives Lake went dry in 1988 and salt blowing. Snow like salt cover on lands within the RMs 132, 131, 101 and 100	25	Golf course flooded between April and July 2011
13.	Tilney weir project		

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 Moose Jaw River Watershed 1950 to 2011	
Early 1950s	Wet year. Crop rust. PFRA development of large dam projects.
Late 1950s	Low annual flow on Moose Jaw River.
1961	Severe drought year.
1960s	Significant infrastructure development (roads, bridges, etc.).
1970	Lower Inventories For Tomorrow (LIFT) program and a wet spring resulted in low crop yields.
1974	Severe spring flood. Significant winter snow pack. Late spring melt then released in May. Highest record peak flow on the Moose Jaw River. Operating permits limited MJ Refinery to discharge to river.
1982	Widespread drought.
1988	Worst drought year. Crops were impacted by grasshoppers.
1998	Old Wives Lake dry and blew salts towards the watershed.
1990-92	June no access to hay fields/marsh near Brokenshell.
1993	Mid-August 11 inches of rain by Pense.
1995	Severe thunderstorm in Caronport resulting in flood damage.
1997	Large run off event in spring and ice jam on the Moose Jaw River.
2001- 02	Severe drought until June 2002. Ground water levels were low in the Moose Jaw area.
2008	Drought no run-off and gradual spring thaw.
2010	Winter snow pack was quite fluffy. Not much for run-off considered a "normal" year.
2010	Non-stop summer rains. 5 inches above average for the area. Wet fall.
2011	2011 significant spring runoff. July peak flow second highest recorded flow on the Moose Jaw River.
2011	Head waters (Weyburn area) received excess of 7 inches in certain pockets.

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 Moose Jaw River Watershed. Work done through SRC attempts to compare and contrast dry and wet patterns within the Moose Jaw 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 Moose Jaw 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 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 Moose Jaw River Watershed (1901-2005 Agriculture 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	-6.7	1907	8.2	1961	8	-3.4	1998	10	3.2
1958	-6.5	1909	7.0	1952	12	-3.3	1993	7	3.1
1984	-6.2	1955	6.8	2001	8	-3.3	1904	3	3.0
1959	-6.0	1991	6.4	1997	12	-3.3	1967	3	2.9
1961	-6.0	1954	6.2	1968	4	-3.1	1968	8	3.8
1937	-5.9	1902	5.8	1917	5	-3.1	1909	7	3.8
1981	-5.5	1927	5.8	1978	3	-3.1	1990	7	2.8
1929	-5.2	1951	5.3	1960	9	-3.1	1902	2	2.7
1931	-5.1	1974	5.3	1993	1	-3.0	1999	2	2.7
1919	-5.0	1947	5.3	1958	5	-3.0	2002	8	2.7

Wittrock and Wheaton (2011) incorporated new categories for extreme events within the Moose Jaw River 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 Moose Jaw River Watershed using the PDSI method. The wettest month (October 1998) was compared to the driest month (August 1961) using the SPI index. Wittrock and Wheaton (2011) additional PDSI and SPI categories were overlaid on the Moose Jaw River Watershed map (Figure 4).

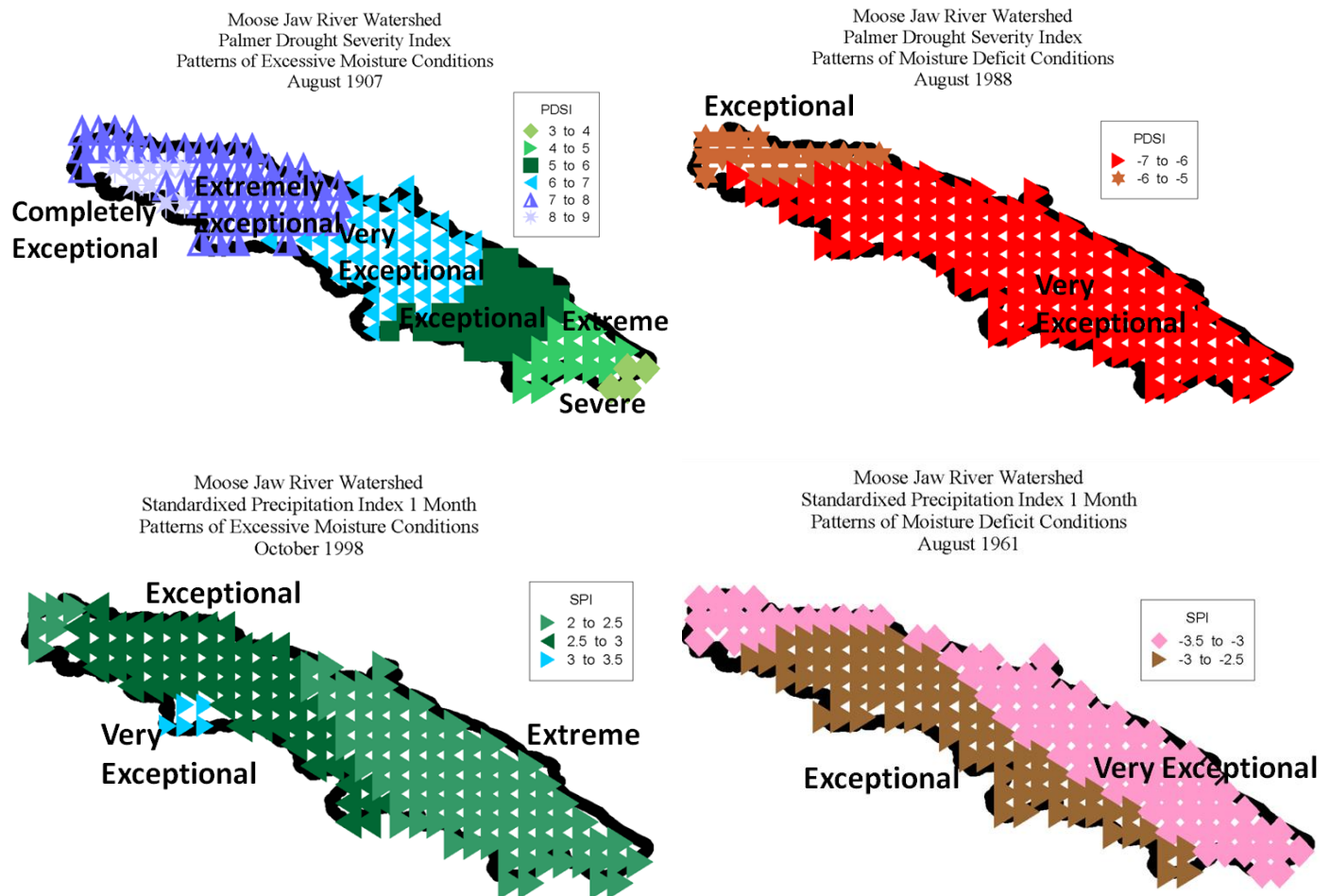


Figure 4. Comparison of Moose Jaw River Watershed PDSI Wettest Year (1907) and Driest Year (1988) and SPI Wettest Month (October 1998) and Driest Month (August 1961)

These maps indicate the spatial variability within the watershed. The PDSI excessive moisture map shows that the “completely exceptional” region is in the northwestern portion of the watershed while the southeast is categorized as “severe”. The PDSI drought conditions map illustrate that most of the watershed was under “very exceptional” drought conditions with the exception of “exceptional” conditions in the northwest corner.

The one month SPI excessive moisture month illustrates the watershed was coping with “extreme” conditions in the southeastern and “exceptional” to “very exceptional” conditions in the west central region. The one month SPI drought of 1961 illustrates the variability that can occur during a drought event. The northern half of the watershed was under “very exceptional” drought conditions while the southern portion of the watershed was under “exceptional” conditions. This illustrates the potential impacts of the drought may have been greater in the northern half than the southern region of the watershed. A more comprehensive analysis of the watershed can be found in Wittrock and Wheaton *et al.*, 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 8, 2011, various issues affecting the Moose Jaw River Watershed were identified through mapping and timeline exercises. Participants were separated into two breakout groups and discussed three scenarios which could potentially affect the Moose Jaw River 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?	<ul style="list-style-type: none"> • Municipal lagoons overflowing leading to surface water contamination • Increased erosion (stream bank and fields) • Increased presence of invasive and noxious weeds • Potential decrease in agriculture production • Flooded crop land/late seeding • Drinking water contamination (flooded wells) • Increased stress • Livestock mineral deficiencies • Decreased tourism and recreation opportunities • Reduced habitat for certain species • Increased water treatment costs • Decreased water quality impacting industrial practices • Limited site access (oil and gas, grain bins, etc.) • Road and culvert washouts • Rural Municipal human resource time constraints • Increase in operation costs (fuel, inputs, etc.) • Limited road access • Problems with hay quality • Herd relocation • Salinity/alkali issues • Cattle disease/illnesses (anthrax, etc.) • Individual producers • Rural residents may be more vulnerable than urban residents • Home owners in both situations would be vulnerable to mould and structural damage • Watershed residents downstream of municipal lagoons may be impacted by increased municipal releases • Industries such as rail lines and feedlots 	<ul style="list-style-type: none"> • Sand bags on standby for emergencies • Municipalities prioritize services (roads, culverts, etc) • Clear culverts and ditches • Identify potential ice and monitor during thaw • Support agricultural beneficial management practice research and implementation • Ecological Goods and Services incentive program to maintain ecosystem health • Incorporate drought and excessive moisture measures into their official community plans • Store hay • Stockpile agricultural resources • Maintain integrity of riparian areas which may prevent erosion and slow flood waters • Maintain the integrity of wetlands • Maintain natural tributaries and stream courses • Relocation of feed and watering areas • Permanent land cover in flood prone areas • Offsite/relocation of grain storage • Emergency response plans and community evacuation strategies • Zoning bylaw

Table 4 Scenario Two	Impacts and Vulnerabilities	Adaptation
What would happen if a	<ul style="list-style-type: none"> • Loss of available feed and crops • Increase of grasshoppers and insects 	<ul style="list-style-type: none"> • Water conservation program • Water conservation education

<p>long-term drought (lasting longer than previously experienced) occurred?</p>	<ul style="list-style-type: none"> • Herd reductions • Feed quality could increase but there would be less available • Increase in input costs (haul water and feed) • Decrease in on-farm income • Increased salinity • Nutrient enrichment in water bodies • Decreased water quality • increased wind erosion • Loss of tree and shelter belts • Decreased production for industries relying on water... • Travel/shipping delays • Decreased tourism and recreation opportunities • Increased strain on recreation areas • Decreased fish and wildlife habitat • Municipal water availability • Strain on water and waste water infrastructure • Water quality would impact all watershed residents relying on surface water • Increase need for chemical treatment • Livestock producers • Potash industry • New industrial developments 	<ul style="list-style-type: none"> • Water rationing and enforcement • Maintain riparian and wetlands • Encourage drought resistant crops • Alternate land use to reflect drought • Community/regional planning • Hay storage/stockpile agriculture resources • Alternative watering systems • Proper design of rural water supplies can alleviate or limit the effects of drought • Promote agricultural BMPs • Continuous cropping/zero till • Prioritize services in emergencies • Implement shelterbelts to reduce erosion • Establish eco-buffers • Xeriscaping in urban areas • Rain barrels/local water capture • Inter-RM planning (co-planning) • Fire-guards • Operational plans for watershed infrastructure
<p>Scenario Three</p>	<p>Impacts and Vulnerabilities</p>	<p>Adaptation</p>
<p>What would happen if drought and excessive moisture events switched back and forth from wet to dry years very quickly?</p>	<ul style="list-style-type: none"> • Difficultly knowing what to plan for • Livestock producers may be impacted by lower income and forced to reduce herd size • Reduced feed availability • Lost inputs (planning for drought and turns out to be a flood) • Reduced water quality • Reduced water availability • Niche markets may be impacted the greatest. Might not have sufficient resources to survive • Similar vulnerabilities as listed in scenarios one and two 	<ul style="list-style-type: none"> • Clear operation plans for drainage • Establishment of operating plans for watershed infrastructure • Communication of accurate and factual information to recreation communities to limit confusion and misinformation • Communication and clarification of roles of water management between C and Ds and RMs • More user friendly real-time hydrometric data • Data availability to the public and decision makers • Planning/zoning • Encourage agricultural producers seek expert advice/consultation • Communication of water use priority

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).

Representative User Groups Present within the Moose Jaw River Watershed

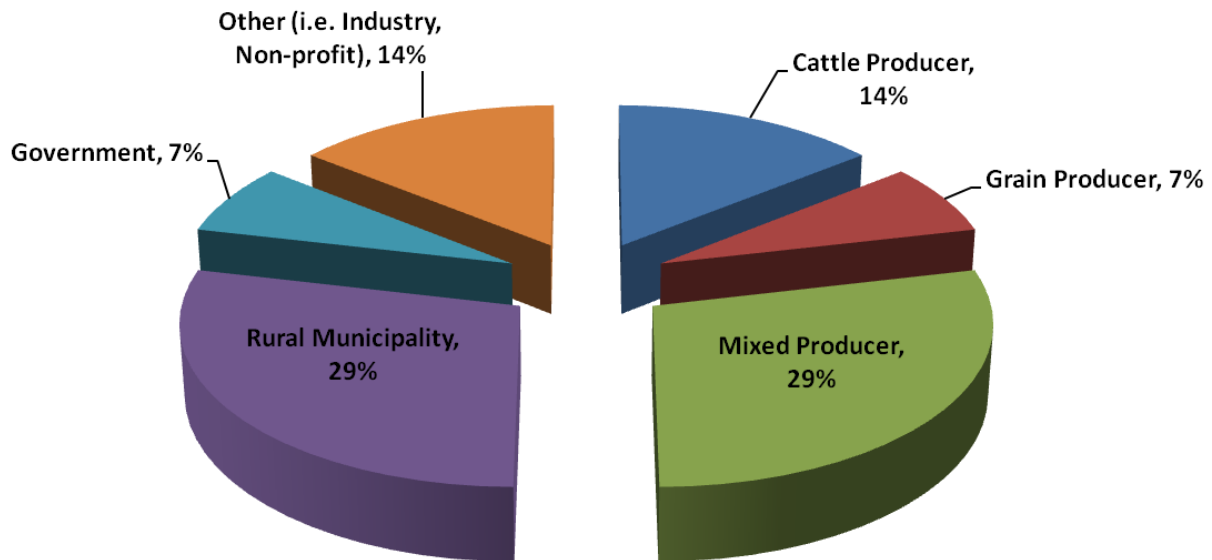


Figure 6. Representative User Groups Present (Workshop One) within the Moose Jaw River Watershed, November 17, 2011

The majority of the representative user groups present within the Moose Jaw River Watershed were rural municipalities and mixed producers (29% respectively), (Figure 6).

The Moose Jaw River 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 Moose Jaw River Watershed.

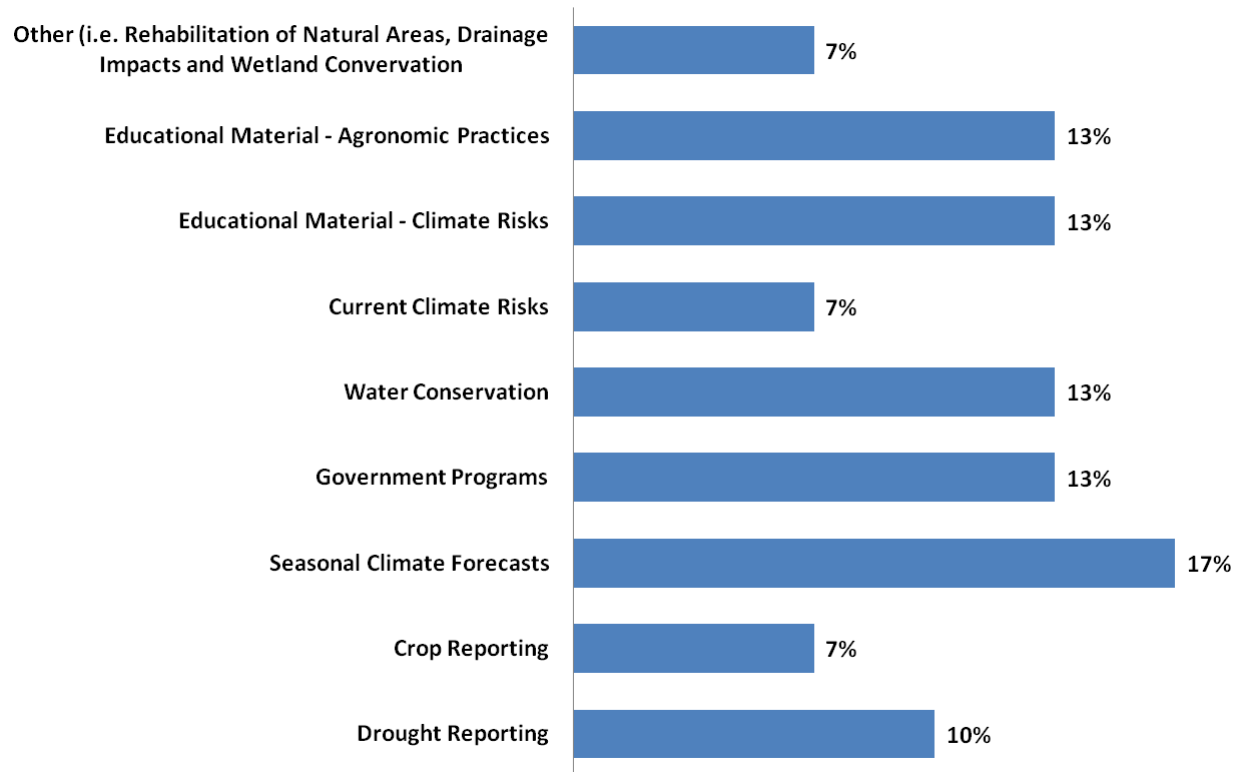


Figure 7. Comparison of Preferred Information Requirements for All User Groups within the Moose Jaw River Watershed November 17, 2011

User groups identified information regarding seasonal climate forecasts as the most important information requirement, followed by educational material on agronomic practices and climate risks and information concerning current climate risks, water conservation and government programs (Figure 7).

Table 5 compares preferred information requirements from each user group within the Moose Jaw River Watershed.

Table 5. Comparison of Preferred Information Requirements of Each User Group within the Moose Jaw River Watershed

INFORMATION REQUIREMENTS	USER GROUP					
	Cattle Producer	Grain Producer	Mixed Producer	Rural Municipality	Government	Other
Information on Government Programs	25%	50%	14%	27%	0%	0%
Information on Water Conservation	25%	0%	14%	18%	0%	17%
Seasonal Climate Forecasts	25%	0%	21%	18%	0%	17%
Information on Current Climate Risks	0%	0%	7%	0%	33%	17%
Educational Materials (EM) on Climate Risks	25%	0%	14%	9%	33%	17%
Educational Materials (EM) on Agronomic Practices	0%	0%	21%	18%	33%	17%
Other	0%	50%	7%	9%	0%	17%
Total	100%	100%	100%	100%	100%	100%

Cattle producers, mixed producers and rural municipalities identified seasonal climate forecasts, information on water conservation and government programs as priorities, while grain producers identified information on government programs as well.

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 Moose Jaw River 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 three vulnerability issues within the Moose Jaw River Watershed (Table 6):

- Planning and Communication;
- Water Conservation Programming and Education; and

- Land Management.

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, responses or recovery item in the occurrence of a potential drought or excessive moisture event.

Table 6. Issues Affecting the Moose Jaw River Watershed

Action Item #	Issue	Priority			Preparedness	Response	Recovery
	Planning and Communication	Low	Medium	High			
1	Municipalities should ensure sand bags are on standby for anticipated flood events				X		
2	Municipalities should create a list of local sandbag suppliers				X		
3	Municipalities should identify locations of potential ice jams and monitor these areas during spring thaw				X	X	
4	Municipalities should ensure culverts and ditches are cleared prior to spring thaw in wet years				X	X	
5	Municipalities require more user friendly real-time hydrometric data				X	X	X
6	Provincial agencies should communicate hydrometric and climate data to the public and local decision makers				X	X	X
7	Municipalities should develop or review their official community plans and evaluate them for drought and excessive moisture preparedness				X	X	X
8	Municipalities should renew or establish emergency response plans and evacuation strategies to better prepare for extreme flood events				X	X	
9	Municipalities should implement a zoning bylaw or update/renew the current bylaw to ensure zoning reflects drought and excessive moisture preparedness				X		
10	Neighbouring municipalities should look into opportunities to integrate planning efforts (co-planning)				X	X	X
11	Municipalities and Conservation and Development Areas should establish operating plans for watershed infrastructure for various drought and excessive moisture scenarios				X	X	X
12	Municipalities and Conservation and Development Areas should meet to establish and clarify the roles and responsibilities and a communication plan for periods of excessive moisture				X	X	X
13	Provincial agencies should communication operational plans for watershed infrastructure to the public and local municipal decision makers				X	X	
Action Item #	Issue	Priority			Preparedness	Response	Recovery
	Water Conservation Programming and Education	Low	Medium	High			
14	Municipalities should develop local water conservation strategies that utilize available resources (i.e. water use in your home, water efficiency on the farm, provincial toilet replacement rebate program)				X	X	X

Table 6. Cont'd. Issues Affecting the Moose Jaw River Watershed

Action Item #	Issue	Priority			Preparedness	Response	Recovery
	Water Conservation Programming and Education	Low	Medium	High			
15	Municipalities should promote xeriscaping in urban areas to reduce water demand				X	X	X
16	Municipalities should encouraged watershed residents to utilize rain barrels to reduce water demand				X	X	X
17	Municipalities should communicate the benefits and need for water conservation to watershed residents				X		X
18	Municipalities should develop a strategy to prioritize and ration potable water for periods of serve drought				X	X	X
Action Item #	Issue	Priority			Preparedness	Response	Recovery
	Land Management	Low	Medium	High			
19	Municipalities should establish fire guards around high priority infrastructure in times of drought to minimize the risk of prairie fires				X	X	
20	Municipalities should work with stewardship agencies to promote agricultural beneficial management practices that re-establish riparian areas and buffer strips				X	X	X
21	Municipalities should work with stewardship agencies to communicate the benefits of riparian areas, wetlands, shelterbelts and eco-buffers to watershed residents.				X	X	X
22	Municipalities and rate payers should be encouraged to maintain natural tributaries and stream courses.				X	X	X
23	Municipalities should encourage landowners to utilizing continuous cropping and zero till practices to reduce soil erosion during high runoff years				X	X	X
24	Municipalities and producers should identify flood prone areas and seed them to permanent cover				X		
25	Municipalities should encourage agricultural producers to stockpile agricultural resources (i.e. hay, grain, etc) to reduce individual producer risk and endure periods of drought or excessive moisture				X		
26	Municipalities should encourage agriculture producers to seed drought resistant crops				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 Moose Jaw River 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 Moose Jaw River 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-economics 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 Moose Jaw River 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 (Econncics, 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 (Econncics, 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®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.



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

Moose Jaw River Watershed Workshop Agendas



*Box 1682, Moose Jaw, Saskatchewan, S6H 7K7
Tel: (306) 691-3396 Fax: (306) 693-3103
www.mjriver.ca*

AGENDA

Workshop I – November 17th, 2011 @ 6PM – 9PM Moose Jaw, Saskatchewan

- 6:00pm Welcome and Introductions**
- 6:05pm Workshop I Overview**
- 6:10pm Presentation 1**
Saskatchewan Watershed Authority - Bart Oegema, Engineer Specialist,
Hydrology Services - *Watershed Hydrology*
- 6:40pm Presentation 2**
Saskatchewan Research Council – Virginia Wittrock, Research
Scientist/climatologist *Understanding Drought and Excessive Moisture
events within the Moose Jaw River Watershed*
- 7:20pm Extreme Events Timeline**
Identification of extreme events within the Moose Jaw River Watershed
- 7:40 BREAK**
- 7:50pm Participatory Mapping**
Identification of areas impacted by drought and excessive moisture as well
as those areas of highest concern
- 8:35pm Information Questionnaire**
- 8:45pm Next steps for Workshop 2**
- 9:00pm Adjourn**



**MOOSE JAW RIVER
WATERSHED STEWARDS**

*Box 1682, Moose Jaw, Saskatchewan, S6H 7K7
Tel: (306) 691-3396 Fax: (306) 693-3103
www.mjriver.ca*

**Workshop II – December 7th, 2011 @ 1PM – 4PM
Moose Jaw, Saskatchewan**

- 1:00pm Welcome and Introductions**
- 1:05pm Workshop II Overview**
- 1:10pm Presentation**
- Agriculture and Agri-Food Canada – Agri-Environmental Services Branch
– Cam Kayter, Flood Risk to a Region’s Infrastructure and Environment
- 1:40pm 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?
- 2:50pm Break**
- 2:55pm Developing Preparedness Action Items**
- 3:55pm Workshop Summary**
- 4:00pm 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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