

Saskatchewan's Natural Hazards Risk Assessment



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Saskatchewan Flood and Natural Hazard Risk Assessment



Between January 2016 and December 2018, we (*V. Wittrock, R.A. Halliday, D.R. Corkal, M. Johnston, E. Wheaton, J. Lettvenuk, I. Stewart, B. Bonsal and M. Geremia*), under the guidance of *Saskatchewan Ministry of Government Relations*, completed a 250+ page comprehensive report.

Note: Community consultation was a major portion of this work

<https://www.saskatchewan.ca/government/news-and-media/2018/december/17/natural-hazards-risk-assessment-report>

Saskatchewan Flood and Natural Hazard Risk Assessment

Prepared for Saskatchewan Ministry of Government Relations

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Summary

Saskatchewan's economy, citizens and environment are vulnerable to natural disasters, ranked in severity as follows:

Drought > Severe Weather > Forest Fires > Floods



- Risks were determined on a provincial scale
- Current adaptations reduce impact severity
- Resilience can be increased by enhancing adaptations for the projected greater risks:
 - Drought planning
 - Expanded emergency preparedness planning and response
 - Hydrological analysis and topographic mapping (lidar)
 - Stakeholders desire engagement, government leadership, improved inter-agency coordination, strengthened resilience

Risk Matrix Developed for Saskatchewan

Impact Categories (Emergency Management Ontario 2012, Public Safety Canada 2012, White 2016, Australian Government Attorney-General's Department 2015, consultations with various provincial government ministries 2017)					Likelihood Categories						
Human Health and Safety	Social	Public Administration	Economic	Environment	Percent chance of occurrence in any given year	Less than 1%	One to <10%	10 to <50%	50 to <100%	100% chance of occurrence	
<i>Deaths, Injuries, Illness, Psychosocial, Stress</i>	<i>Communities, Culture, Relationships</i>	<i>Provincial Scale</i>	<i>Direct and Indirect Economic Implications (including infrastructure)</i>	<i>Air Land water Biodiversity</i>	Qualitative (likelihood) description (standard for all hazards)	The event/condition may occur only in exceptional circumstances	The event/condition could happen at some time	The event/condition should occur at some time	The event/condition will probably occur in most circumstances	The event/condition is expected to occur in all circumstances	
					Likelihood Descriptions	Rare	Unlikely	Possible	Likely	Almost Certain	
					Impact Descriptions						
<ul style="list-style-type: none"> Multiple public fatalities (>50) and / or critical injuries with long-term or permanent incapacitation (>50) Extreme and ongoing exceedance of recognized health-related standards (e.g., CCME Selenium Guidelines or Canadian Ambient Air Quality Standards) Community evacuations of >50,000 people 	<ul style="list-style-type: none"> Permanent reduction in quality of life of impacted and nearby communities Permanent degradation of surrounding values and natural resources Widespread severe psychosocial impacts e.g. widespread panic and hoarding, mass riots, and long-term psychosocial impacts Disputes related to development or decisions erupt into large and violent campaigns of civil disobedience Widespread permanent loss to culturally significant objects 	<ul style="list-style-type: none"> Multi-municipal, provincial, national and international, specialized response Provincial government is unable to deliver their core functions; inability to govern. Violation of international and national treaties or agreements Sustain, permanent loss of stakeholder and public trust in the provincial government 	<ul style="list-style-type: none"> Failure of a significant industry or sector in the jurisdiction as a direct result of the natural hazard event Economic decline and / or loss of asset value greater than 5% of the provincial GDP (~\$4B) Closure of an entire resource sector Permanent loss of investment in the province. Existing markets for Saskatchewan's natural resources is closed. Inability for efficient and leading companies to break-even. Destruction of both critical infrastructure and high value property 	<ul style="list-style-type: none"> Significant regional or watershed damage incapable of remediation Ecosystem function permanently disrupted or species extirpation 	Catastrophic						Extreme Risk
<ul style="list-style-type: none"> Multiple public fatalities (>5) and / or critical injuries with long-term or permanent incapacitation (>5) and / or serious injuries (>50) Ongoing exceedance of recognized health-related standards (e.g., CCME Selenium Guidelines or Canadian Ambient Air Quality Standards) Community evacuations of >5000 people 	<ul style="list-style-type: none"> Quality of life for communities and surrounding area impacted for more than 10 years – major community social problems Values are degraded but partially recoverable over the long-term Extended evacuation of communities Irreparable damage to high value structures or items of cultural and historical significance Disputes related to development or decisions result in blockades and campaigns of civil disobedience and are extremely disruptive to the general public; Significant regionally widespread psychosocial impacts 	<ul style="list-style-type: none"> Provincial Governing bodies encounter severe reduction in the delivery of core functions Multi-municipal, provincial and national specialized response Achievement of key provincial government objectives is threatened and some not met. Major loss of stakeholder and public trust over years, although recoverable with time. Municipal governments unable to deliver core services 	<ul style="list-style-type: none"> Significant structural adjustment required by identified industry or business to respond to and recover from the natural hazard event Major damage and impact on critical infrastructure Economic decline and / or loss of asset value greater than 0.5% of the provincial GDP (~\$400M) Major portions of a resource sector impacted or suffer serious decline. Substantial loss of investment in the province, reversible over time. Existing market access for Saskatchewan natural resources is threatened / new market access not achieved. Inability for various business sectors to break-even. 	<ul style="list-style-type: none"> Significant regional damage not entirely capable of remediation Ecosystem disruption or reduced species abundance Severe effects on environmental values 	Major						High Risk
<ul style="list-style-type: none"> Single fatality and / or critical injuries with long-term or permanent incapacitation (>1) and / or serious injuries (>5) In frequent, periodic exceedances of recognized health-related standards (e.g., CCME Selenium Guidelines or Canadian Ambient Air Quality Standards) Community evacuations of 500 people 	<ul style="list-style-type: none"> Quality of life of affected region and surrounding area moderately impacted for up to 10 years Short-term evacuation of community Values are degraded but fully recoverable within 10 years Disputes related to development or decisions result in isolated blockades or other acts of civil disobedience; Significant localized psychosocial impacts including panic, self-evacuation, hoarding Some damage or localized widespread damage of culturally significant objects 	<ul style="list-style-type: none"> Provincial Governing bodies encounter significant reduction in the delivery of core functions Achievement of key government objectives impacted (significant time delay or cost increase) Moderate loss of stakeholder or public trust, short-term duration (less than 6 months) Municipal governing bodies encounter severe reduction in the delivery of core functions Multi-municipal and provincial specialized response 	<ul style="list-style-type: none"> Key industry or business sector is significantly impacted by the natural hazard, resulting in medium term (i.e., more than one year) profit reductions directly attributable to the event Noticeable drop of investment levels in the province. Economic decline and / or loss of asset value greater than 0.05% of the provincial GDP (~\$40M) Disruption of 2-3 critical community infrastructure services 	<ul style="list-style-type: none"> Regional damage capable of remediation over time Damages last >two years Values affected tend to be moderate 	Moderate						Moderate Risk
<ul style="list-style-type: none"> One serious injury requiring medical care and medical technology Approaching limits of recognized health-related standards (e.g., CCME Selenium Guidelines or Canadian Ambient Air Quality Standards) 	<ul style="list-style-type: none"> Minor effects on quality of life Short term adverse impacts on values of the affected region lasting less than 5 years; recoverable with minor effort Disputes related to development or decisions result in isolated acts of civil disobedience with minor disruptions to the public; Some localized psychosocial impacts including disruption to routine and some anxiety Some damage to localized culturally significant objects 	<ul style="list-style-type: none"> Provincial government encounters limited reduction in delivery of core functions Achievement of key government objective may be impacted Multi-municipal specialized response Municipal government encounter a reduction in the delivery of core functions 	<ul style="list-style-type: none"> Significant impact on localized industry or business sector resulting in short-term (i.e., less than one year) profit reduction directly attributable to the event Economic decline and / or loss of asset value greater than 0.005% of the provincial GDP (~\$4M) Disrupt 1 critical infrastructure service for short time 	<ul style="list-style-type: none"> Localized damage capable of remediation Damages are short term <one year Values affected tend to be minor 	Minor						Low Risk
<ul style="list-style-type: none"> First aid injury with no professional care required (MoFE, MoFGR) No impact on public health and safety 	<ul style="list-style-type: none"> No obvious impact on quality of life Minor delay in major cultural event 	<ul style="list-style-type: none"> Provincial government's delivery of core functions is unaffected and normal Municipal or multi-municipal general response (mutual aid agreements) Municipal government encounters limited reduction in delivery of core functions 	<ul style="list-style-type: none"> Insignificant economic impact Economic decline and / or loss of asset value greater than 0.0005% of the provincial GDP (~\$400,000) 	<ul style="list-style-type: none"> Localized, reversible and temporary damage Minor impact on local environmental values 	Insignificant						Wittrock et al. 2018

Comparison of Plausible Worst-Case Scenarios

Natural Hazard	Case Study Location	Likelihood of Occurrence	Impact Categories					Aggregate Risk
			Human Health & Safety	Social	Public Administration	Economic	Environment	
Drought All Types	Agricultural region of Saskatchewan	Unlikely	Major to Catastrophic	Major to Catastrophic	Catastrophic	Catastrophic	Moderate to Major	High
Convective Summer Storms	Regina and area	Unlikely	Catastrophic	Major to Catastrophic	Major	Major to Catastrophic	Major to Catastrophic	High
Forest Fire	Human-caused forest fires close to communities; forested zone of province	Unlikely	Major	Moderate to Major	Major	Moderate	Minor to Moderate	Moderate to High
Winter Storms	Southern Saskatchewan	Unlikely	Major	Minor to Moderate	Moderate to Major	Major	Moderate	Moderate to High
Overland Flooding	Agricultural region of Saskatchewan	Unlikely	Minor	Minor to Moderate	Minor	Major	Moderate	Moderate
Plains Runoff Flooding	Regina	Unlikely	Moderate	Minor to Moderate	Major	Major	Moderate	Moderate
Lake Flooding	Fishing Lakes Last Mountain Lake	Unlikely	Moderate	Minor	Minor	Minor	Moderate to Major	Moderate
Grass Fire	Grass fire > 1,000 ha; agricultural region of Saskatchewan	Unlikely	Major	Moderate to Major	Minor	Minor to Moderate	Minor	Moderate
Mountain Runoff Flooding	Prince Albert	Rare	Moderate	Minor	Moderate to Major	Minor	Minor	Low to Moderate
Groundwater Flooding	Highly localized	Unlikely	Insignificant to Minor	Insignificant to Minor	Insignificant to Minor	Insignificant to Minor	Insignificant to Minor	Low
Earthquake	Highly localized along the Saskatchewan and Montana border	Unlikely	Insignificant	Insignificant	Moderate	Moderate	Insignificant	Low

Province-wide Risk Levels – Current Climate based on Historic Events

- **High Risk** – Drought and Convective Summer Storms
- **Moderate to High Risk** – Forest Fires and Winter Storms
- **Moderate Risk** – Overland Flooding, Plains Runoff Flooding, Lake Flooding and Grass Fires
- **Low to Moderate Risk** – Mountain Runoff Flooding
- **Low Risk** – Groundwater Flooding and Earthquakes.

By the 2050s, the **Risk Levels** of most of the hazards will **increase**

Drought

- Droughts pose severe threats to the economy, environment, health and communities and can pose a challenge for public administration
- For example:
 - The 1999-2005 Canada-wide drought resulted in an estimated drop of \$5.8 billion in Canada's GDP and more than an estimated loss of 41,000 jobs (Wheaton et al. 2008).
 - In SK the 2001-2002 drought resulted in an estimated \$1.6 billion loss in Agricultural production (Wheaton et al. 2008).
- We used the severity of the drought of 1961 but with the long period of the 1930s and applied to today's living standards as the case study

Convective Summer Storms

- Convective storms can result in heavy rain, hail, strong winds and tornadoes
- Majority of these storms are relatively local and can produce minor to moderate impacts on a relatively localized scale
- These storms may result in cumulative impacts due to their complex nature.

1912 Regina Tornado Map

[See Regina in 1912](#)

[See Regina in 2012](#)



Image Source CBC 2018

Map data ©2018 Google Terms of Use Report a map error
(Credit for 1912 Regina map: Storm of the Century, Sandra Bingaman, 2011)

Convective Summer Storms

- Used the 1912 Regina cyclone (F4 tornado) as the case study and applied it to current day situation
- Approximately 150 people would now die with more than 1,000 people injured.
- Irreparable damage of at least \$82 million to high-value structures
- Major damage and impact on critical infrastructure
- Potential for secondary impacts is high....e.g., toxic substances are now carried by trains



Photo: Sherratt 2016

Forest Fires

- Fires are a natural occurrence in Saskatchewan. They occur every year.
- Only a hazard if they threaten values at risk: life, infrastructure, valuable timber, etc.
- SK has one of the highest rates of fire in Canada
- Highly variable: area burned ranges 3,885 to 1.7 million ha (1990-2015)
- 50% human-caused but burn less than 10% of area
- Areas south of the Churchill River are greater concern

Photo: Gov't of SK

Winter Storms

- Severe winter weather includes blizzards (snow and/or blowing snow with reduced visibility), snowstorms, freezing rain etc and can incorporate all of the events into one
- Worst case scenario was the blizzard of 1978 that lasted at least 60 hours and was applied to current conditions.
- Would result in:
 - Dangerous road conditions – likely closed to traffic
 - Potential for multiple fatalities: e.g., vehicular traffic, lack of heat in rural areas, carbon monoxide poisoning
 - Disruption in critical infrastructure e.g., power lines
 - Damage to buildings due to snow loads
 - Negative impacts on livestock and poultry producers
 - Delayed negative impacts with spring snow melt conditions



Flooding Risks

- Overland Flooding – potentially multi-year
 - Agricultural land, about 40 rural communities (e.g., Quill Lakes)
- Plains Runoff – April
 - 29 communities identified, 22 mapped under 1980s Flood Damage Reduction Program
- Lake Flooding – April-July
 - About 20 communities, including resort villages
- Mountain Runoff Saskatchewan River System - July
 - Four communities plus some FN Reserves

Photo: V. Wittrock June 24 2013

Grass Fires

- Grass fires have long been a part of southern Saskatchewan
- Spread extremely fast if grass/cropland is dry and winds are high (early spring before green-up and fall)
- Can result in injuries, death, loss of community infrastructure, road closures, pressure put on hospital infrastructure (moving of seniors and patients out of harms way), challenge of accessing water supplies and equipment.



Photo: Gov't of SK

Potential Adaptation Strategies

Transition from Province-wide Analysis to Community Level

- Comprehensive community response plans – natural and industrial hazards
- Proactive measures – drought planning, floodplain mapping and zoning, flood forecasting, FireSmart, insurance, improved urban infrastructure
- Reactive measures – evacuation, snow clearing, emergency dykes, water pumping, first responders, forest & grass fire suppression, Provincial disaster Assistance Programs.

Asset Management

- Build a community-level risk matrix
 - Data collection and analysis
 - Value/condition of assets
- Identify effects on Infrastructure
 - Water and Wastewater
 - Roads and other structures
- Training and workshops
- Post event analysis
- Share knowledge and lessons learned



General Recommendations

- Every province and territory in Canada should undertake a Hazard Risk Assessment that includes Natural Hazards and also includes projected future climate scenarios.
- Risk assessment should be reviewed and updated regularly.
- Important to include as many stakeholders / interested parties as possible.

Questions?

Wittrock, V., R.A. Halliday, D.R. Corkal, M. Johnston, E. Wheaton, J. Lettvenuk, I. Stewart, B. Bonsal and M. Geremia. Dec 2018.
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Wheaton, E., S. Kulshreshtha, V. Wittrock, G. Koshida. 2008. Dry times: hard lessons from the Canadian drought of 2001 and 2002. The Canadian Geographer. 52(2): 241-262. DOI: <https://doi.org/10.1111/j.1541-0064.2008.00211.x>

Photos:

Flooded road – Government of Saskatchewan

Forest fire – Government of Saskatchewan

Winter drought – V.Wittrock January 2009

Snow banks along roadway – J.Wheaton March 2013

Oil well surrounded by water – I. Radchenko May 2015

Participants at Stakeholder Meetings June 2017 – D.Corkal June 2017

Kneeling farmer on cracked soil – istock photo

Tornado by Last Mountain Lake – D.Sherratt Summer 2016

#1 Highway east of Regina - Government of Saskatchewan

South SK River Saskatoon June 24 2013 - V. Wittrock

Fire fighter – Government of Saskatchewan

Soil dunes – E. Wheaton

Air plane with fire retardant – Government of Saskatchewan

Heavy Frost – V. Wittrock Dec 2018