Extreme Climate Events and the Energy Sector in the Souris River Basin:

Key stakeholder perspectives

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Anika Terton
Jo-Ellen Parry

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Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Fax: +1 (204) 958-7710
Website: www.iisd.org
Twitter: @IISD_news

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Written by Anika Terton and Jo-Ellen Parry

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1.0 INTRODUCTION

The energy sector has long been an important part of the economy of the Souris River Basin, located at the intersection of southeastern Saskatchewan, southwestern Manitoba, and North Dakota (see Figure 1). For decades the basin has been the site of the coal-fired Boundary Dam and Shand Power Stations, which currently generate about 27 per cent of Saskatchewan's electricity, and a Heat Recovery Facility located near Alameda, Saskatchewan (D. Hanly, personal communication, Jan. 2015).[1] As well, oil and gas production has occurred in the Souris River Basin since the 1950s. Production increased after 2005, when specialized technology allowed companies to access the oil located in impermeable shale beds, which made the oil field fully accessible by the mid-2000s. The basin has since experienced significant growth in its oil and gas sector, particularly when high oil prices made exploitation of the Bakken formation more economical viable.[2] As of 2015, Saskatchewan had over 18,000 active oil wells and Manitoba had 3,385 active oil wells in the Souris River Basin (Wittrock, 2016a). The growth of this sector has created both opportunities and challenges for the region. While providing new economic and employment opportunities, expansion of the oil and gas sector has put increased demands on municipal infrastructure, resulting in higher maintenance costs and additional financial pressures on municipal governments.

In recent decades, the basin has also experienced a number of extreme weather events, ranging from droughts to excessive moisture conditions (Wittrock, 2016a). These events are consistent with the high degree of seasonal and inter-annual variability that characterizes the climate of the Canadian Prairies. Historical climate analyses have demonstrated oscillations between wetter and drier conditions in the region, including multiyear droughts (Bonsal Aider, Gachon & Lapp, 2013; Wittrock, 2016a). Such events present risks for energy sector operations in the Souris River Basin, increasing the potential for health and safety concerns, environmental damage and economic losses. During an extended dry period between 1988 and 2001, for example, SaskPower's Boundary Dam and Shand Power Stations were both impacted by drought conditions resulting in reduced availability of cooling water and power generation capacity (Nielsen, 2003).

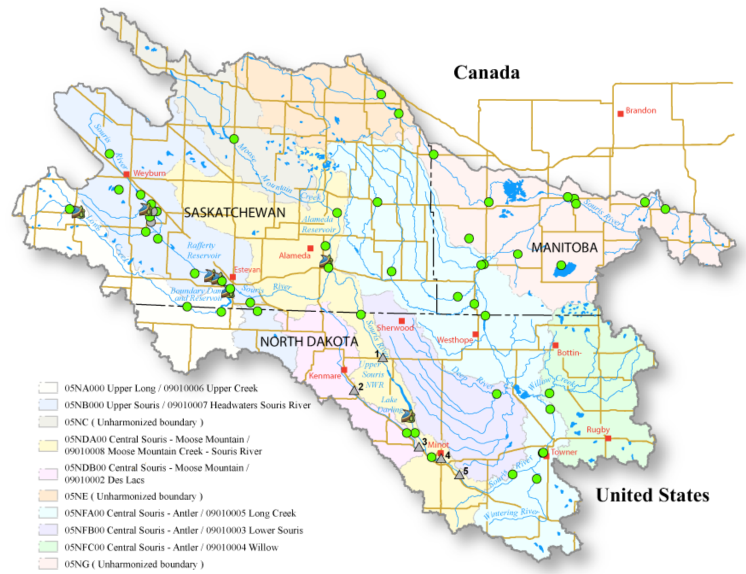

Figure 1. Souris River Basin (United States Geological Survey, n.d.)

In the coming decades the region's climate is projected to experience rising temperatures and changes in precipitation patterns that will lead to greater climate variability and potentially more frequent occurrence of extreme events such as floods and drought (Intergovernmental Panel on Climate Change, 2013; Wittrock, 2016a). Such changes likely will present additional challenges for energy sector companies as they strive to achieve their business goals. Effective and proactive adaptation strategies therefore could become

[1] The Souris River Basin is becoming a less significant location for energy production by SaskPower largely due to the utility's ongoing process of energy diversification, which is reducing the importance of coal production (D. Hanly, personal communication, Jan. 2015).

[2] Global oil prices have since gone down significantly, reaching as low as USD 30 a barrel at the time of writing, which has resulted in an economic slowdown in the oil and gas sector across Canada.

increasingly important if energy sector companies are to continue to achieve their financial goals, meet their environmental obligations, and maintain their social licences to operate.

Examining the energy sector's response to recent extreme climatic events should provide insights regarding its sensitivity and vulnerability to events such as drought and flood. Understanding how the sector has coped with historic events—and adjusted its practices in light of lessons learned—could help efforts to build the capacity of industry and governments to plan and manage for anticipated climatic changes. These insights could be informative not only for the Souris River Basin but for other regions of Canada and North America.

To capture these insights, we conducted a study that aimed to gain a better understanding of the impacts of recent extreme weather events on energy sector operations in the Canadian portion of the Upper and Lower Souris Basin region, and actions taken in response. Through interviews with representatives from the energy sector (oil, gas and coal-fired electricity) and local and provincial governments, the study sought to understand:

- How energy sector and municipal operations were impacted by recent extreme weather events.
- Immediate and subsequent actions taken to reduce these impacts, and the risk and opportunities resulting from these actions.
- The motivations or drivers for actions taken to reduce current and anticipated risks.
- Lessons learned that could increase the capacity of industry and governments to plan for and manage future events.

This report provides a synthesis of the information gleaned through this research. It presents the survey methodology, followed by a review of the interview outcomes and main observations. It concludes by providing some broad recommendations for actions that could be taken to reduce the risk extreme climate events pose for energy sector and municipal operations in the Souris River Basin. It is hoped that the research findings will help inform industry and government efforts to integrate climate variability/change concerns into current and future risk management strategies—an important step toward reducing vulnerability to both current and future extreme climate events.

This research was undertaken as part of the project "Risks to the Energy Sector Related to Extreme Climate Events: Case Studies of Adaptation Actions Focusing on the Upper and Lower Souris River Watersheds" completed between September 2014 and January 2016. Using the Souris River Basin as a case study, the project aimed to shed light on ways to improve the capacity of the energy sector to manage extreme weather events. Monetary and in-kind financing for the project was provided by Natural Resources Canada, the Government of Saskatchewan, the Government of Manitoba, the Saskatchewan Research Council, the International Institute for Sustainable Development, and other project partners.

2.0 METHODOLOGY

Research for this study was conducted primarily through interviews with key informants knowledgeable about the energy sector and municipal government operations in the Canadian portion of the Souris River Basin. Individuals from the following groups were targeted for engagement in the research:

- Oil and gas companies active in the Souris River Basin
- SaskPower, as the sole coal-fired electricity generator in the region
- Saskatchewan and Manitoba municipal governments
- Provincial government officials with portfolios related to energy and emergency management
- Municipal and watershed associations

The interviews were guided by an interview protocol prepared by the research team in consultation with the Advisory Committee for the "Risks to the Energy Sector Related to Extreme Climate Events" project, to ensure key concerns and questions were addressed. The research team sought to elicit information from participants regarding: their observations concerning the impact and consequences of extreme climate events that have occurred within the past 20 years; strategies used to immediately respond to these events and actions taken afterwards based on lessons learned; barriers and enablers of action encountered; and expectations regarding the need to prepare for climate change and ongoing adaptation planning. The protocol was structured to contain a core set of open-ended questions that would be posed to all interview participants as well as questions tailored to gain information pertinent to specific groups. The interview protocol was drafted in August 2015 and piloted through two interviews conducted in September. The protocol was then finalized following revisions made in light of insights gained in the pilot process. The interview protocol used to guide the semi-structured interviews is provided in Annex A.

A list of potential interviewees from 40 companies, municipalities or other organizations was identified by the research team based on online research and consultations with the project Advisory Committee. During the interview process, the research team applied the snowball system, a sampling technique used to identify potential subjects in studies where specific key informants are difficult to locate or pinpoint within the targeted groups identified. Interview candidates were selected based on their potential knowledge and expertise related to the energy sector in the Souris River Basin, as well as possible experience in dealing with the impacts of recent extreme climate events in the area.

Given the large number of municipalities in the Souris River Basin, particularly in Saskatchewan, the research team prioritized those to be approached based on: the extent of oil, gas and coal-fired generation activities within their jurisdiction; degree to which they had been affected by extreme climatic events within past 20 years, drawing on Wittrock (2016b); and achieving an appropriate balance between municipalities located in Saskatchewan and Manitoba, and in the Upper and Lower Souris River Basins. A goal was set to interview representatives from six municipalities (four in Saskatchewan and two in Manitoba), and 15 to 20 individuals overall, in October and November 2015.

Requests for interviews were extended by email and phone to one or more representatives of 36 organizations, and potential participants invited to review the interview protocol in advance if desired. Interviews were conducted primarily by phone, with two conducted in person and two companies providing written submissions.

As Table 1 shows, securing interviews with desired key informants proved to be quite challenging, despite the fact that persistent efforts were made to

reach out to potential candidates. A low response rate, particularly among rural municipalities in Saskatchewan, was experienced. For instance, Administrative Officers of Rural Municipalities contacted as part of the survey indicated that they had forwarded the interview request to council members and reeves, but none indicated a willingness to participate. Within the energy sector, a high level of turnover of personnel meant the requests needed to be re-directed to new contacts and, in one instance, the engagement process stalled when the interview protocol needed to be reviewed by the company's legal department prior to agreement to participate in the study.

To address the low response rate, the research team sought the assistance of Advisory Committee members, which yielded a limited number of additional interviews. These challenges also led to an extension of the timeline for conducting the interviews until mid-January, 2016.

Table 1. Distribution of key informants invited to participate in the study and interviews conducted

Group	Invited	Participated
Energy sector company representatives	16	5
Provincial government representatives	3	3
Rural municipalities in Saskatchewan	16	0
Rural municipalities in Manitoba	3	1
Municipal and watershed associations	2	2
Total	**40**	**10**

In total 10 semi-structured interviews were conducted with a total of 13 people (as some interviews involved two representatives of their company, municipality or association). The profile of these individuals is captured in Table 2. Primary information gathered through these interviews was analyzed using qualitative content analysis, a method used to analyze textual data and reducing it to manageable segments to allow for the drawing and verifying of conclusions. The major goal of qualitative analysis is to understand a phenomenon, rather than make generalizations from study samples (Forman & Damschroder, 2008). As necessary, supplementary research using secondary literature sources was undertaken to inform the discussion and recommendations contained in this report.

Table 2. Profile of interview participants

Gender		Years of Experience	
Male	9	Less than 5 years	--
Female	4	5 to 10 years	2
		More than 10 to 15 years	3
		More than 15 to 20 years	4
		More than 20 years	4

3.0 SURVEY RESULTS

The following results are based on qualitative analysis of the information shared through interviews conducted with representatives from the energy sector, municipalities and relevant associations. The results are broken down by category and discuss key messages, responses and recommendations that emerged from the interviews.

3.1 Impacts of Past Extreme Climatic Events

The majority of interview participants identified flooding as the extreme climatic event that had most affected their operations and activities in the past 20 years. Specifically, they pointed to the spring flood of 2011 and—for Manitoban respondents to a greater extent—the summer flood of 2014 as having significant impacts.

The energy sector primarily focused on infrastructure-related concerns generated by flooding and excessive moisture conditions, including washed out roads, bridges and culverts, which limited access to production sites and monitoring wells. The flooding also caused the shutdown and abandonment of some wells due to access challenges and/or to prevent environmental risks, such as a spill or contamination. Concerns were also expressed regarding the health and safety of employees during the flooding, not only in terms of the potential dangers associated with such things as moving equipment around in the fields, but also with respect to personal impacts such as flooding of their homes. One respondent pointed out transmission problems, with infrastructure being rerouted during and after the flood as a result of excessive moisture around power poles. Another interviewee mentioned damage to small- to medium-sized pipelines due to flooding that interrupted production by three months.

Energy sector respondents also expressed concerns about tornadoes and strong winds, particularly their potential impacts on electricity transmission lines and damage to oil and gas operations, as well as health and safety concerns for field personnel. One company had experienced downed electrical transmission lines due to a tornado.

Other concerns voiced by one company included heavy snowfall events, extreme cold and extremely warm temperatures. Heavy snowfall limited the company's access to facilities, resulted in power outages, delayed repairs and maintenance, and increased the cost of snow management. The respondent further noted that extremely cold temperatures have caused aboveground facilities to malfunction, damaged production equipment, delayed production due to repairs and maintenance, and raised safety concerns for workers. Soil instability from freeze–thaw cycles was also noted as potentially causing breaches in underground facilities.

Drought was identified as a significant concern by only a couple of the oil and gas sector representatives interviewed. Apprehension was broadly related to the corresponding increase in fire hazards, decrease in vegetation regrowth within reclamation areas, and operations that would face water availability risks. In general, though, the energy sector did not see drought as a serious concern for their operations, with one respondent noting the benefit of drought in terms of greater ease of access to well sites.

Many municipalities experienced unprecedented flooding in their communities in 2011 and 2014 that severely damaged local infrastructure and affected thousands of acres of farmland. In 2014, the speed at which the flooding occurred in the eastern portion of the Souris River Basin was a particular challenge and left municipalities scrambling to react.

Residents, farmers and industry in affected municipalities[3] were impacted in a variety of ways by the floods, such as through damage to and closures of flooded roads and bridges, as well as washed out culverts. With respect to the flood of 2014, one respondent emphasized lost access to roads leading to interruptions in the delivery of goods and services, and the stranding of residents (including

[3] Flooding in 2011 affected all of the rural municipalities in the Souris River Basin (Environment Canada, 2013).

municipal government officials) in their homes. The Rural Municipality of Two Borders was turned into an island, as it was cut off from other areas of the province, resulting in rationing of fuel at local gas stations. While many municipalities faced significant financial hardships as a result of the damage caused to roads and bridges, it was also emphasized that the flooding had real emotional effects on citizens beyond the economic damages it caused.

Based on the interviews conducted with rural municipality representatives, it also appeared that flooding is seen as a more severe issue compared to other climate extremes, with some respondents anticipating that the region will continue to stay in a wet cycle. One interviewee noted that the community is prepared to respond to drought and added that municipal infrastructure is less vulnerable to drought conditions.

3.2 Responses to Past Extreme Climatic Events

Respondents were asked about their actions during and immediately following extreme climatic events to cope with the impacts and minimize potential damage in the future. Overall, the energy sector respondents identified recent flooding as a challenge that had disrupted operations but something to which they were able to adequately respond within their existing policies and procedures, as well as provincial regulations. One respondent from the energy sector indicated that they had implemented their existing plans for extreme weather events leading to emergency situations and that no significant adverse impacts (e.g., spills, contamination or employee injuries) took place. One company specifically described how they deployed air surveillance daily to monitor any possible releases during the flood event and kept in close communication with Saskatchewan's Water Security Agency in order to shut down production wells to avoid impacts on the environment.

In terms of actions taken immediately following extreme climatic events, energy sector officials generally stated that lessons learned are identified through internal company reviews, leading to adjustments of their health and safety and emergency response plans. One company respondent noted that, based on the review of their response to the 2011 flood, they have started to look more closely at potential flood risk when preparing well sites to avoid potential negative impacts. Another company observed that their experience with the flood of 2011 strengthened their efforts to get the province to improve cellphone service in their region. While requests for greater coverage had been made previously, recognition of the importance of this service during an emergency response situation further emphasized this need. Others identified their current planning strategy as observing weather conditions (flooding and tornadoes) and learning from past events.

One Saskatchewan company representative commented on how their response to the 2011 flood benefited from past actions taken in response to previous experiences, namely the replacement of a spillway around their dam station as a protection measure. A review of the facility following heavy rains in 1997 that flooded whole areas around their coal delivery system led to a decision to upgrade the dam station's spillway between 2008 and 2010. In addition, the company had a policy in place (which was originally rooted in labour relations issues) to keep a 20-day stockpile of coal onsite next to its power plants. Having a large coal reserve nearby resulted in a serendipitous benefit during the 2011 and 2014 floods. Large trucks loaded, delivered and transferred the coal within the power plant, significantly reducing the impact of road closures due to flooding.

In response to the significant impact of the floods on rural municipalities, local governments closed roads, evacuated people to safer locations, and declared states of emergency due to rising flood levels and severely compromised infrastructure. Efforts were made to divert water and assess the damages caused. In the aftermath of the floods, responses focused on rebuilding damaged

Figure 2. Oilfield equipment pumping water during the 2011 flood in Weyburn, Saskatchewan. Photo credit: D. Pattyson

infrastructure. This required finding funds to support rebuilding efforts either through their own financial resources or from a provincial disaster assistance program. To undertake the repairs, they also needed to find contractors and materials that could be very scarce and difficult to access depending on the location of the rural municipality. Some municipalities are still addressing the impact of these events, such as infrastructure damage caused by the flood of 2014. Respondents from rural municipalities noted they have little capacity to prepare for extreme weather events, with actions taken during the flood events being described as more reactionary than proactive.

Both companies and rural municipalities noted the oil and gas sector's support during the floods, which included loaning equipment to municipal governments to help move equipment, repairing damaged infrastructure, raising temporary dikes, or putting other temporary structures in place. This allowed municipalities to provide a more rapid and less expensive response. All respondents, including the energy sector, mentioned the importance of working and collaborating with local municipalities and other stakeholders to respond to a flood event.

Coping strategies implemented during and immediately following other past extreme climatic events, such as droughts and tornadoes, were largely not elaborated upon during the interviews. One company did note, however, that they had experienced a shortage of natural gas during an extreme cold event and addressed the incident by using compressed natural gas trucked in from Alberta to meet their operational needs.

3.3 Climate Risk Management Strategies and Practices

Interview participants were asked if they had taken specific steps to prepare for the potential of more frequent and severe weather events in coming decades, and if so, what steps they have taken. The majority of interview participants anticipate that the Souris River Basin will become wetter rather than drier on average in future years. Despite the fact that documented historical climatic oscillations point to the possibility of another multiyear drought in the Souris River Basin, the energy sector did not consider it a significant future climate-related risk. On the other hand, municipal representatives are aware of (and concerned about) drought-induced issues, predominantly the impact of water shortages on agricultural producers. Some respondents from both the energy and municipal sectors expressed a desire to better understand current and future climate-related risks and that they would integrate improved data around anticipated temperature and precipitation projections into their decision-making processes.

When asked about oil and gas companies' strategies to prepare for a changing climate, interview participants commented on a number of measures and initiatives. One company has broader

policies around risk management, including climate change-related risks, in order to address the need to protect assets and ensure business continuity. For instance, in order to assess risks, one large company uses in-house modelling that incorporates different tools, including climate and flood risk models, to determine what exactly is at risk when a project is still in its early phases of development. These scenarios are used to proactively plan and select sites for reducing vulnerability to excessive moisture events. The company added when assessing risk management strategies, they seek to strike a balance between risk management costs and overall financial considerations.

A larger oil and gas company operating in the Souris River Basin noted that since the flood in 2011, they have kept data regarding predicted water levels and event probabilities to help plan future development of drill locations. After the flood event, the company also updated flood zone inputs in their pipeline risk assessment database to prevent the possibility of a release into a water body. The respondent emphasized the importance of paying attention to the elevation of sites in relation to documented flood elevation data for future developments. The company further concluded that it is highly beneficial to monitor culverts to ensure their effectiveness and consult with landowners and municipalities when constructing new access roads. Another noted the importance of consulting with local landowners when siting new wells to benefit from their depth of local knowledge, such as where the land has flooded in the past.

With respect to drought risk, one company mentioned it has introduced the completion of water risk assessments for projects that could face water shortages. The company did not elaborate on what types of projects they consider in this process. Another stated that their company currently does not strive to better understand current and future climate-related risks at the local level.

Rural municipalities have addressed the damages caused by the floods of 2011 and 2014 in part through financing provided by available disaster assistance programs. According to one interviewee, a number of rural municipalities have also tapped into other infrastructure grants or have taken advantage of ongoing infrastructure maintenance programs to cover the additional costs required to rebuild municipal infrastructure to a higher standard than their pre-flood conditions. Another respondent noted that 90 per cent of rural municipalities' tax revenues typically are used to finance road infrastructure, which leaves little funding available to cover additional maintenance and new infrastructure requirements, along with providing other services to community members.

The floods have also led municipal and provincial governments to revise their emergency measures plans.[4] In Manitoba, efforts are underway to strengthen the capacity of municipalities by expanding and deepening training for local governments to increase the quality, complexity and understanding of emergency planning. For example, Manitoba's Emergency Measures Organization operates within five regions covering the entire province; each region has one Regional Emergency Manager responsible for liaising with the municipalities in that region and ensuring that municipalities prepare, update and exercise their emergency management plans. Along with the former, provincial officials are working with the Manitoba Association of Rural Municipalities to better understand the roles of municipalities and the province in emergency planning. This includes examining where emergency response responsibilities overlap and can be made more efficient and agile. This review was described as a direct result of the flood events in 2011 and 2014 to develop deeper preparedness and resilience. Another outcome mentioned included a public–industry working group to prioritize and coordinate

[4] Rural municipalities in Saskatchewan are obligated by the Emergency Planning Act to establish emergency measures plans. The Act gives rural municipality councils the responsibility for the direction and control of a municipal emergency response in terms of implementing the plan to protect the property, health, safety and welfare of the public. Similarly, in Manitoba, the Emergency Measures Act requires Manitoba municipalities to have emergency preparedness programs in place, which must be approved by the Executive Director of the Emergency Measures Organization.

infrastructure repair projects to continue industry operations in the region.

One respondent highlighted the varying approaches rural municipalities take to emergency planning based on the size and capacity of the community. While emergency plans exist, they possibly differ in the level of anticipated extreme weather events, and it is unclear if the plans consider other extreme weather events to the same degree as floods. In contrast, another interviewee stated that municipalities are required to use an all-hazards approach when undertaking emergency planning measures.

A difference of opinion that arose in the interviews was whether recent flooding was due exclusively to extreme climatic events such as heavy rains and spring runoff or also caused by excessive upstream drainage and altered landscapes that have undermined their ecological capacity to cope with excessive moisture. Of particular concern appeared to be the drainage of wetlands and channelization of drainage systems that increase the flow and risk of flooding downstream. The degree to which upstream drainage poses a significant threat in a changing climate was noted. Others however felt that the excessive moisture conditions that preceded the 2011 spring floods and the amount of precipitation that fell during the summer of 2014 over a wide geographical area meant that the resulting flood conditions would not have been lessened had there been reduced channelization and greater retention of wetlands.

3.4 Barriers and Drivers

In terms of specific barriers that hindered responses to extreme weather events or risk reduction planning, representatives from rural municipalities pointed to the Provincial Disaster Assistance Programs, which provide compensation based on the cost to restore the property to its pre-disaster condition but not to make upgrades or improvements (unless required by a change in regulations). According to one interviewee, neither the federal nor provincial government has responded adequately to upgrade road standards to make infrastructure more resilient to extreme weather events.

Box 1. Federal disaster assistance program

In February 2015, the federal government introduced changes to its disaster assistance program for the stated purpose of shifting from a reactive model to one that allows for better identification, planning and prevention of flood risks and the costs that come with them. Instead, the federal government introduced the National Disaster Mitigation Program, which will provide provinces and territories with funding to help share the costs of flood mitigation measures and improving resiliency against floods (Government of Canada, 2015). Under the new federal rules, a disaster in Manitoba, for example, has to reach $3.9 million before federal cost-sharing begins; the previous minimum threshold was $1.3 million. The maximum 90:10 cost-sharing ratio will not kick in until Manitoba's cost reaches almost $20 million, compared to the previous threshold of $6.5 million. Following the federal changes, Canada's premiers issued a statement expressing their concern about the modification and urging the federal government to reconsider the decision (Government of Manitoba, 2015).

Another point of concern was the federal government's changes to its disaster financial assistance in February 2015, which reduced the amount of federal money available following disasters and makes it more difficult for rural municipalities to access funding (see Box 1). One rural municipality commented on the new Saskatchewan–Manitoba Memorandum of Understanding Respecting Water Management (2015) as an important step toward provincial cooperation on flood forecasting, watershed-management planning, and drainage monitoring.

Simultaneously, human and financial resources were named as barriers, as well as insufficient information to convince planners to make the budgetary allocations needed to finance investments that will contribute to future disaster mitigation. It was also mentioned that the integration of climate change risks into emergency

planning is currently at the very beginning stages.[5] This process is complicated by differences in planning horizons, with emergency planning typically planning for possible events five to seven years in the future, and the need for emergency planners to understand the probable occurrence of specific type of climatic risks (such as a tornado), which is challenging given the uncertainties associated with climate projections.

Energy sector companies stated they stayed in close contact with the Saskatchewan Water Security Agency, SaskPower, the Ministry of Economy and Environment and local municipalities during extreme weather events, which they found to be useful in order to provide adequate response. Of particular importance to one of the company respondents was the data obtained from the Saskatchewan Water Security Agency, which was describe as being very valuable in planning responses to the 2011 flood.

3.5 Data and Knowledge

Interview participants were asked about the types of data and resources that they would need to inform their planning and decision making. Interview participants from the energy sector noted the need for hydrologic analysis of specific areas of the provinces, as current studies have not been selective enough to meet end-users' needs. Supplementary, enhanced visualization of data to improve the sector's understanding of future climate projections was described as very useful. Respondents pointed out that additional information and data on flooding would be very valuable for their exploration work and future business decision-making processes.

When asked if their company collaborated with other groups of government departments to manage risks experienced, one respondent mentioned their membership with the Canadian Electricity Association, which has a working group on climate change adaptation that provides data, projections and modelling. This was considered to be a helpful and trusted source of information for the company. One company respondent pointed to the need for more timely surface water monitoring data provided by the government, while a different interviewee stated their respective company communicated closely with the Saskatchewan Water Security Agency (SWSA), municipalities, SaskPower, the Ministry of Economy, and the Ministry of Environment to obtain data.

Respondents from rural municipalities noted the need for improved access to data, including hydrological models, floodplain maps and future climate projections to inform development planning, new infrastructure plans and emergency responses. According to one respondent, requests for this type of information had been made to the provincial and federal governments a number of times but had not yet been received.

Several respondents spoke of the need for more LiDAR[6] topographic data to improve flood modelling and forecasting. One respondent pointed out that good-quality, high resolution topographic data is needed to allow for better hydrologic modelling that will enable more accurate flood forecasts. However, a respondent stated that both levels of government have expressed concerns about expenses, and potential negative implications of making topographic data publicly available, such as lowered housing values and possible difficulties accessing insurance in already developed areas that are established as floodplains.

There were some differences between respondents regarding the degree of support provided by the SWSA. While one interviewee suggested the agency provided only limited information to municipalities in response to requests for baseline data, another indicated that the SWSA has been supplying information and was a valuable partner when their assistance was required.

[5] For example, Manitoba Emergency Measures Organization held an event in January 2016 to raise awareness about potential climate change risks and promote the integrating of climate change adaptation into broader emergency planning processes (Manitoba Emergency Measures Organization, 2016).

[6] LiDAR (or Lidar) is sometimes seen as an acronym for Light Detection And Ranging but is defined by the Oxford English Dictionary as being a combination of "light" and "radar" (Wikipedia, 2016).

4.0 MAIN OBSERVATIONS AND DISCUSSION

The purpose of this study was to gain insight from key informants situated in the Canadian portion of the Upper and Lower Souris River Watershed regarding the impacts of recent extreme weather events, particularly impacts on energy sector operations, and their responses to these events. The main observations and discussion points presented here are based on the content of the interviews conducted and a supplemental review of secondary literature sources.

4.1 Extreme Climatic Events

Recent climate extremes resulted in increasing risks for oil and gas companies and for coal-fired electrical generation companies active in the Souris River Basin. Historically, the watershed has witnessed both drought and excessive moisture events that have affected energy generation and caused secondary impacts, such as damage to infrastructure. The last 15 years are prime examples of these extremes. From 1999 to 2003 Saskatchewan experienced the driest extended period since the 1930s (Wittrock, Wheaton & Siemens, 2010). This was followed by an exceptional shift from drought to excessive moisture conditions that led to the unprecedented 2011 spring flooding that affected large parts of Saskatchewan and Manitoba.

The flood events of 2011 and 2014 were the most prominent extreme weather events mentioned by the interview participants. Considering the severe impact of these floods and the psychological stress they caused, this finding is not surprising. In Manitoba, the 2011 flood affected 154 provincial roads and highways, 500 municipal roads, 73 provincial highway structures, and 500 municipal bridges located all over the province. Local states of emergency were declared in 70 Manitoba communities, and 7,100 Manitobans were displaced and had to be provided with temporary housing. The cost associated with flood preparation, flood fighting, repair to infrastructure, and disaster payments reached at least $1.2 billion (Government of Manitoba, 2013).[7] In southern Saskatchewan, flash flooding was experienced in Estevan, and more than 4,000 people along the Souris River were forced from their homes due to flooding (Environment Canada, 2013). States of emergency were declared by a number of communities across the province, including Weyburn and Estevan.

The predominance of extreme moisture and flood conditions in recent years may be a factor in why drought was not identified as a prominent historical climate risk by the majority of respondents. Moreover, exceptional drought conditions have not been experienced in the watershed since 1988 and 1989. As well, throughout the 21st century, the Souris River Basin has not been impacted as intensely by droughts compared to other parts of the Prairies (Wittrock, 2016b).

Wild grassfires also were named as a concern by some respondents. Grasslands can easily ignite during dry conditions and pose a threat for quick fires, potentially threatening oil wells and other infrastructure, as well as raising human safety concerns.

Tornadoes were identified as another climate risk experienced in the past and about which there are concerns regarding a potential trend toward increased occurrence and intensity. Between 2010 and 2015, 48 tornadoes were confirmed in Saskatchewan and 18 in Manitoba, some of them southeast of Regina and in southwestern Manitoba (Wikipedia, 2016b). Governments are responding to concerns about tornadoes with the introduction in 2015 of a new emergency alert system called "Alert Ready". Developed by Environment Canada in partnership with provincial and territorial emergency management officials, Alert Ready is designed to deliver immediate warnings when there

[7] The information provided is based on the Manitoba Flood Review Task Force Report, which combines the impacts of the flood experienced on locations on the Assiniboine River, on the Souris River and a number of small waterways. No specific information was available for the Souris River Basin alone.

is imminent danger from extreme weather, natural disasters, biohazards, and other life-threatening events.

For municipalities, the consequences of more frequent and severe extreme weather events contribute to the already challenging job of sustaining communities in a tight fiscal environment. While increased oil and gas exploration in the Souris River Basin has provided economic benefits to municipalities, it has also resulted in mounting stress on municipal infrastructure and made its maintenance increasingly more difficult. At the same time municipal leaders need to continue to provide other services and ensure the protection of members of the public and their property. It became evident during the interviews that, although rural municipalities are on the frontlines dealing with the immediate impacts of extreme weather events, they are often have limited capacity to respond. The challenges being experienced by rural municipalities have direct and indirect implications for energy sector actors. Oil and gas sector operations depend in part on community infrastructure, including electricity, water, transportation and communication systems, to ensure their continued operations.

While the oil and gas sector was faced with lost revenue, abandoned wells and experienced risks to worker health and safety and potential environmental damage, representatives of the sector believed they were able to effectively respond to and manage the impacts of recent extreme weather events. Responses to extreme weather events appeared to reflect existing policies and procedures, and did not necessarily translate into long-term comprehensive hazard assessments and planning processes.

4.2 Responses to Extreme Climatic Events

Within the energy sector, larger companies seemed to be more active in planning and implementing climate risk preparedness activities (including those related to climate change) compared to smaller companies. Larger companies have given consideration to climate change in asset risk management planning and when making operational decisions in terms of the design and location of energy infrastructure. As a result, a number of oil and gas sector interviewees emphasized that regionally based and end user-specific studies would meaningfully assist and inform their operational decision making.

Rural municipalities' responses to the floods of 2011 and 2014 have been described as reactive instead of proactive and prepared—although given the unprecedented scale and level of impact of these events full preparedness is perhaps not unexpected. The interview process revealed a number of challenges municipalities face in developing capacity to manage extreme climate events, particularly with respect to ensuring that infrastructure is designed, built and managed to withstand future events. Foremost among these challenges was access to reliable climate forecasts, scenarios and projections that could assist municipalities' efforts in emergency planning and climate adaptation. Equally important are the financial constraints facing municipalities. The recent changes to the federal disaster assistance program described in Box 1 make it more difficult for provincial governments to access federal funds, which in turn may be expected to limit municipal government's future access to financial assistance in the wake of extreme climate events. Respondents have linked a lack of financial resources to reactive management of extreme weather events, resulting in short-term fixes rather than long-term integrated approaches to addressing the problem.

In order to ensure that climate change is featured as a high priority in infrastructure development and management, comprehensive risk assessments need to be undertaken, supported by the data, tools and techniques required to generate baseline and future climate change scenarios, and support adaptation planning. Further, there is a necessity to integrate climate risk considerations into existing planning and risk management processes. Both

the provincial and federal governments could play a significant role in providing the data, tools and other support measures required to strengthen rural municipalities' resilience to extreme weather events and long-term planning capacities. In particular, respondents mentioned the role that governments can play in promoting research to enhance climate science and develop engineering solutions, and strengthening data collection for weather and climate variations.

In terms of information and data needs, as previously noted, a large number of interviewees were quite specific and prioritized the need for LiDAR data, a remote sensing method used to examine the surface of the Earth that can be used to generate very high resolution digital terrain models. This level of resolution is particularly needed on the Prairies given the relative flatness of the terrain. Digital models based on LiDAR data can be used for floodplain mapping and modelling that in turn can subsequently inform future land-use planning. For example, the collection of LiDAR data on the U.S. side of the Red River Basin contributes and informs flood management design and planning, hydraulic and hydrological modelling, along with flood risk assessment. In Manitoba, LiDAR data is available for the Red River Basin where it is used for flood prevention initiatives (International Institute for Sustainable Development, 2013). More data is available in the province's Interlake region, where it is used for flood mitigation and tile drainage to enhance crop production. According to one interviewee, the Province of Manitoba is in the process of accessing funding through the federal disaster mitigation program to acquire the LiDAR data needed to produce more accurate flood models and inform land-use planning.

For Saskatchewan, it appears that patches of areas in the southern and central part of the province have been surveyed. LiDAR Services International collected data in multiple sites across central and southern Saskatchewan, totalling over 2,200 square kilometres. This data was used for hydraulic modelling of floodplains and water courses in order to assess environmental risks and emergency preparedness related to the management of federally-owned dams and irrigation projects (LiDAR Services International, 2016). Specific information regarding the amount of LiDAR data available within the Canadian portion of the Souris River Basin could not be identified. While advances have been made in hydrologic modelling of prairie watersheds through LiDAR, more work and data are needed to develop a better understanding of flooding, runoff and drainage in Manitoba and Saskatchewan watersheds.

4.3 Anticipation of Future Climatic Risks

A majority of interviewees anticipated that the Souris River Basin will experience further wet cycles in the future given the Prairies' historical pattern of oscillating between wet and dry periods, and were concerned about preparing for this situation. Drought was named by a couple of energy sector representatives as an extreme weather event that has affected their operations in the past, but was considered to have minimally impacted their operations recently, and they were generally not concerned about the potential impact of future multi-year droughts. Similarly, a respondent from a rural municipality stated they were better positioned to deal with drought conditions compared to extensive flooding, particularly in terms of infrastructure impacts. Nonetheless, drought conditions can impact communities in a variety of ways, including land degradation, water shortages, feed shortages, low crop yields and crop damage. As one interviewee pointed out, the Souris River Basin experienced a significant drought in 1988 as well as during the 1999–2003 period, when grass fires around the City of Estevan sparked the province to bring in water bombers to put out the fires.

Less concern about growing water scarcity and drought may stem from a number of factors. Within the oil and gas sector, the key water issues centre on maintaining water quality and addressing largely localized water quantity concerns (Wittrock,

2016a). The water needs of the sector have declined over time, with one respondent noting that their company has introduced horizontal well development, water risk assessments, less water-intensive technology, and abandoned water injection wells. Additionally, water can be recycled by the oil and gas industry and used again in the drilling process. Additionally, oil and gas companies activity in the Souris River Basin are able to obtain water from a number of sources, including local landowners and municipal wells (Wittrock, 2016a). That being said, during an extended drought multiple water users wanting to utilize the same water resources may produce contention. More research is required to fully understand the degree to which multi-year droughts may indeed present a greater risk to the energy sector than currently anticipated.

Despite the potentially devastating impacts of drought for agriculture and municipalities, drought preparedness planning varies across jurisdictions in Canada. While British Columbia's Drought Response Plan and Ontario's Low Water Response Strategy offer detailed plans for low-water monitoring and management, Manitoba and Saskatchewan's drought preparedness planning is less developed. In Manitoba, the provincial government committed to develop a Drought Management Strategy in 2014, as part of its TomorrowNow plan (MCWS, 2014). The strategy is still under development. In Saskatchewan, the Water Security Agency described a coordinated provincial drought response plan in its 25-Year Saskatchewan Water Security Plan (SWSA, 2012). Its annual report from 2013–2014 suggested that finalization of the plan is anticipated in 2016 (SWSA, 2014).

On the anticipated risk of grassfires and nearby oil and gas infrastructure, regulations are currently in place to address this concern. In Manitoba, for example, several regulations under the Manitoba Drilling and Production Regulations address fire safety issues, including the hazard of a controlled or out of control fire extending onto a production lease.[8] Whether these regulations will be sufficient should fire risk increase in the future as the climate changes is unknown.

4.4 Drainage

The issue of upstream drainage contributing to downstream flood damage emerged during the interviews as a potential source of friction not just among farmers but also between municipalities and provinces. Surface water drainage has long been employed by landowners and communities to prevent farmland and infrastructure from being negatively impacted by flood water. According to a report by Dr. J.W. Pomeroy et al. from the University of Saskatchewan, drainage of natural prairie wetlands by farmers throughout the Assiniboine River and Souris River Basins has likely substantially increased flood peaks and the volume of flow (Pomeroy et al., 2014).

It appears that the issue has the potential to become a greater source of tension among rural municipalities, particularly if authorities are not provided with the necessary hydrologic and climatic data to advance their knowledge and allow for the most informed decision-making processes. More research and data collection are needed to fully understand how human actions such as drainage may impact changes in water flow patterns, particularly in the context of changes in the hydrological regime due to climate change. This information needs to be publicly communicated and fed into decision making related to interjurisdictional water management responsibilities that reflect the transboundary nature of the Souris River Basin. The recent development of the Saskatchewan–Manitoba Memorandum of Understanding Respecting Water Management appears to be an important first step toward meeting this need.

[8] This regulation specifically lists a five metre fire-free zone to ensure that fires do not threaten wells and/or equipment onsite. Regular inspections are performed to ensure compliance, and if grass or weeds are found to be growing within the five metre fire-free zone a non-compliance order requiring the area to be cleaned up will be issued. It is also a common industry practice to spray leases to ensure the fire-free area is maintained (L. Barsness, personal communication, Jan. 2015).

5.0 RECOMMENDATIONS

Based on the respondents' answers and main observations a number of recommendations emerged from this study, namely:

- The public availability of high-quality LiDAR topographic data should be increased to support the development of updated floodplain maps and provide a technical basis for land-use planning and development. This digital terrain analysis should be combined with climate change scenarios to estimate possible future flooding problems, particularly given projections that rainstorms will become increasingly extreme as climate change progresses (Wittrock, 2016a).
- Industry respondents identified a gap between available scientific information and data, and end-users needs. Greater opportunity for industry representatives and climate scientists to collaborate would help identify the best possible way to match current scientific knowledge with end-users data and analysis needs to inform the energy industry's decision-making processes. Equally important is to make quality and reliable information (e.g., flood hazard maps) available and easily accessible to industry and its associations.
- Oil and gas sector interviewees noted that drought conditions historically have had a minimal impact on their ability to operate, and that they do not see this risk changing significantly in the future. However, the Souris River Basin has experienced multi-year droughts in the past, and is expected to again experience these events in the future (Wittrock, 2016a). Further research may be appropriate to gain a clearer picture of the risks and potential impacts of multi-year droughts on the energy sector, particularly with respect to issues related to water quality and access.
- Effective management of transboundary watersheds depends on collaboration across political and administrative boundaries. Existing data and information that could inform this collaboration has been described as difficult for local municipalities to access, and is available for just a portion of the basin as opposed to whole basin. These information access challenges limit the ability of local planning processes to development effective strategies for preventing and responding to the impacts of extreme weather events. Greater federal and provincial collaboration could provide rural municipalities with the knowledge they need to inform their decision-making processes and strengthen their capacity for preparedness planning. This includes the provision of hydrology and floodplain maps as well as local and regional climate projections. Organizations such as the Assiniboine River Basin Initiative and the International Souris River Board might provide venues through which to pursue this goal.
- Closer analysis of the linkages between excessive moisture conditions, upstream drainage patterns, and changing weather events is needed to better understand the potential future risks of excess moisture conditions and flooding in the Souris River Basin. While land-use changes (excessive drainage) might not have been a significant factor leading to the unprecedented flooding that occurred in 2011 and 2014, these changes have contributed to other flood events. Continued research would benefit from revisiting historical climate and hydrologic analyses, such as the Pomeroy report (Pomeroy et al., 2014) and those developed as part of the "Risks to the Energy Sector Related to Extreme Climate Events" project (Wittrock, 2016a; 2016b). This analysis should help inform future climate risk management strategies in the

Souris River Basin. At the same time, there is a need to ensure that new data and results are effectively communicated to stakeholder groups, and these groups engaged in the identification of mitigation options.

- Provincial Disaster Assistance Programs could play a role in supporting adaptation to future extreme climatic events. An examination of this potential could determine the circumstances under which there would be an economic rationale for providing full funding to replace damaged infrastructure to a standard beyond its pre-disaster condition in anticipation that such additional improvements would enable the infrastructure to better withstand increased climate-related risks in the future—and therefore lower costs in the long term.
- Future studies to gather information from companies and rural municipalities about their responses to and preparedness for extreme climate events would benefit from the use of additional information-gathering techniques such as workshops or focus groups rather than relying solely on key informant interviews. Oil and gas sector industry association and municipal associations could play a leading role in facilitating such information-gathering processes given that they are considered trusted entities with well-established relationships. Future studies may also benefit from news media analysis for information about response measures taken.
- A full impact and vulnerability assessment of the implications of future climate change for energy sector operations in the Souris River Basin would greatly inform identification of adaptation options and their economic justification. More detailed and specific information regarding the consequences of historic extreme weather events than what was possible to collect through this study (e.g., degree of damage, length of exposure, detailed cost) would be needed to support completion of this analysis.

6.0 CONCLUSION

This study was an initial effort to shed light on the sensitivity and vulnerability to extreme weather events of the energy sector and local municipalities situated in the Canadian portion of the Souris River Watershed. The case study shows that rural municipalities are hardest hit during recent extreme climate events, namely the floods of 2011 and 2014. Rural municipalities require additional resources, tools and information to build their capabilities to response to and prepare for extreme weather events and climate change. Continued and enhanced cooperation with other jurisdictions in water management matters is needed, along with better baseline information, floodplain maps and future climate projections to inform decision making and allow for better adaptation to the changing risks associated with extreme weather events.

Energy sector companies appear to have weathered recent extreme climate events by applying a number of strategies and adjusting policies to build their adaptive capacity. The energy sector already undertakes activities relevant to climate change adaptation, including asset management, internal risk assessment, updating health and safety plans and policies, and infrastructure upgrades. A number of oil and gas sector participants identified gaps in information and resources they would find valuable and useful for informing their internal decision-making processes. For instance, governments could support industry adaptation efforts by ensuring practitioners have access to the quality climate data they need to integrate into their planning processes. Industry representatives also identified greater access to floodplain maps as a need.

Available climate projections suggest that the Souris River Basin's climate will change significantly in the coming decades, which could pose significant challenges for the local energy sector. This calls for further consideration of changing climate-related risk in decision-making processes, building on the industry's past experience. There is also a need for better long-term preparedness planning using an all-hazards approach if the energy sector's continued safe operation in the region is to be assured.

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ANNEX A: INTERVIEW PROTOCOL

Extreme Climate Events and the Associated Risks to the Energy Sector: Case Studies of Adaptation Actions Focusing on the Upper and Lower Souris River Watersheds

Thank you for participating in this interview.

It is being conducted as part of the project "Risks to the Energy Sector related to Extreme Climate Event: Case Studies of Adaptation Actions focusing on the Upper and Lower Souris River Watershed in both Saskatchewan and Manitoba." The project aims to shed light on ways to improve the capacity of the energy sector to manage extreme weather events. The study is co-financed both monetarily and in-kind by Natural Resources Canada, the Government of Saskatchewan, the Government of Manitoba, and the Saskatchewan Research Council, as well as other project partners.

The climate of the Canadian Prairies is known for its particularly large amounts of seasonal and inter-annual variability, most importantly in the temperature and precipitation regimes. Historical analysis has demonstrated decadal long trends of extreme dryness and extreme moisture. Future projections indicate that the climate on the Prairies will see increases in temperature and changes in precipitation patterns, which suggest greater climate variability and more frequent extreme events, including more frequent flooding and severe drought. These changes could challenge the demonstrated capacity of business and government to cope with the region's already variable and challenging climate.

The **purpose of this interview** is to gain information and a better understanding from key informants situated in the Canadian portion of the Upper and Lower Souris Basin region regarding the impacts of and responses to recent extreme weather events, particularly impacts on energy sector operations. We hope the results of this interview will provide a better indication of the sensitivity and vulnerability of the energy sector to extreme weather events and identify transferable lessons that could improve future responses to these events.

The interviews are being conducted by individuals from the International Institute for Sustainable Development (IISD), a not-for profit research organization based in Winnipeg that has worked since 1990 to promote the transition to a sustainable future through research, communication and partnerships. Complementary research regarding climate trends and the implications of the survey findings will assist with the lessons learned and risks and opportunities case study being prepared by the Saskatchewan Research Council.

Results from the interviews will be summarized and feed into a final case study report which will made available to the public. The report will identify potential strategies for reducing the risk posed by extreme events for energy sector and government agencies and help inform industry, community and government decisions around integrating adaptation to climate variability and its impact into risk management strategies. All information provided through the survey will be kept anonymous.

Interview Protocol

PART A. Respondent Profile

1. Gender: ☐ Female ☐ Male
2. How many years of experience do you have in your current field?
   - ☐ less than 5 years
   - ☐ 5-10 years
   - ☐ >11-15 years
   - ☐ >16-20 years
   - ☐ more than 20 years

PART B. Overview of organization and key informant's responsibilities

1. **For Energy Sector Representatives:** Could you please describe the nature of your company's operations in the Souris River Basin?

   For Municipalities: Could you please describe the nature of energy sector activities in your municipality?

   Follow-up questions as needed:

   Oil and gas officials:
   - What is your company's primary business area? (E.g. unconventional oil production, oil and gas exploration, oil or gas transmission pipelines)
   - How long has your company been working in the Souris River Basin area?
   - What is the scale of your company's operations in the Souris River Basin?
   - Where in the Souris River Basin is your company primarily working?
   - How have your operations in this region changed over the past 20 years? (E.g. level of activity, location of activity)?

   SaskPower / coal energy officials:
   - How have your operations in this region changed over the past 20 years? (E.g. level of activity)?

   Municipal officials:
   - How important is the energy sector to your municipality?
   - Has this level of importance changed over the past 20 years? If so, how?
2. What are the primary responsibilities of your position?

PART C. Past impact of extreme climatic events

1. What types of extreme weather have affected your operations over the past 20 years? (E.g., temperature extremes (low/high); high precipitation extremes (heavy rains, floods); low precipitation extremes (dry conditions, drought); frosts; tornadoes; blizzards; strong winds; hail.)
2. Of these events, which had the greatest negative impact? Why? (E.g. severity, timing, frequency, scale?)
3. How did these extreme weather events affect different parts of your operations, and for how long?
    - E.g. for oil and gas: impacts on planning, exploration, development, operations, transportation, or decommissioning?
    - E.g. for electricity: impacts on planning, production, cooling, or transmission?
    - E.g. for government: emergency response, expenditures, tax revenues, or infrastructure?
4. Over the past 20 years, do you think there been a relative increase in the number of extreme weather events affecting your operations?

    Supplemental question for SaskPower:

    - Would you be able to comment on the impact of the drought of 1988 on SaskPower's operations?

PART D. Responses to past extreme climatic events

1. What immediate/responsive measures did you take to cope with the impacts of these past extreme weather events? For example:
    - Technical actions
    - Operational actions
    - Policy or regulatory-based actions
2. Of these actions, did you find any to be particularly effective in overcoming immediate problems?
3. After the event, were any specific changes made to your operations or policies to reduce the risk of being adversely impacted by a similar, or more intense, extreme weather event in the future?

    Follow-up questions as needed:

    - What motivated you to make this investment?
    - How are you tracking the impact/success of the interventions you have undertaken?
    - Have you derived tangible benefits from these investments to date? (E.g. if faced a similar extreme weather event in subsequent years)
4. Were any key lessons learned or insights gained from your responses to past extreme events?

    Follow-up questions as needed:

    - Can you provide an example of a change (or changes) made in light of these lessons learned?
    - Have these lessons been incorporated into current climate risk management strategies?

PART E. Barriers and enablers

1. Either during or following the period of time in which you were affected by the extreme weather event, did you collaborate with other groups or government departments to manage the risks experienced?

   Follow-up questions as needed:

   a. If so, with whom did you primarily collaborate?

2. Either during the immediate response to an extreme weather event or when engaged in risk reduction planning and preparation, have you encountered any specific barriers that hindered your response or actions?

   Follow-up questions as needed: Were these barriers of the following type:

   - Technical barriers
   - Knowledge and information barriers
   - Operational barriers
   - Policy barriers
   - Investment barriers

3. Were there any specific factors (technical, operational etc.) that helped or enabled you to take the desired responses?

   Follow-up questions as needed: Were these enablers of the following type:

   - Technical
   - Knowledge and information
   - Operational
   - Policy
   - Investment

4. From your perspective, has the recent reduction in oil prices affected corporate planning for extreme weather events? If so, how?

5. Based on your experience, are there particular actions that local, provincial or federal governments could take to help you better manage the risks associated with extreme weather events?

6. Are there particular types of information or data to which you would like to have improved access to strengthen your capacity to plan or manage extreme weather events?

PART F. Anticipation of future climate risks

1. Do you anticipate that your operations will be exposed to more frequent or intense extreme weather events in the future?

   Follow-up questions as needed:

   - Which extreme events are you most concerned about and why?
   - What are the impacts/consequences about which you are most concerned? (E.g. financial costs, health and safety, social licence to operate, environmental damage)

2. Is your company/municipality taking any specific steps to prepare for the potential for more frequent and severe weather events in the coming decades? (E.g., vulnerability or risk assessments for particular areas of your operations, changes in insurance, planning processes, infrastructure, operations, contingency planning)

3. Given documented historical climate oscillations, it can be expected that the Souris River Basin will again experience a multi-year drought.
   - Is your company/municipality making preparations for such an event?
   - Is your company/municipality considering particular water conservation options, such as accessing and treating saline water from aquifers to meet water supply requirements?

4. Do you currently strive to better understand current and future climate-related risks and their implications for your company/municipality?

Follow-up questions as needed:

- If so, what knowledge sources do you typically use? (E.g., association newsletters, conferences, webinars, research reports)

PART G. Interview closure

1. Do you have any particular concerns regarding the capacity of your company/municipality, or the energy sector in the Souris River Basin in general, to manage extreme weather events that have not already been discussed?

2. As mentioned at the beginning of this interview, all of the information you have provided will be kept anonymous. However, we would like to recognize your participation in this survey by including your name in a list of the individuals spoken to in the acknowledgements section of our final report. Do you agree to have your name and your company's name included within this list?

In closing, interviewers should:

- Invite the interviewee to be in touch should they have any follow-up information to provide or wish to clarify any of their statements
- Remind the interviewee of how their information will be used.

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Head Office

111 Lombard Avenue, Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700
Fax: +1 (204) 958-7710
Website: www.iisd.org
Twitter: @IISD_news

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