



FINAL REPORT

Climate Change Impacts to the Oil and Gas Sector in British Columbia - How are we Preparing?

A.M. Wiensczyk, S. Morford and M. Karjala

December 2014

Prepared for

Science and Community Environment Knowledge (SCEK) fund



Resources North Association
203-2666 Queensway Street, Prince George, British Columbia, V2L 1N2
T: [250] 612-5840; F: [250] 563-3697

www.resourcesnorth.org

ACKNOWLEDGEMENTS

The project team would like to thank the survey respondents and interviewees for their time and thoughtful input. Thanks to Trina Innes, Kathi Zimmerman, Brian Thomson and the project team and steering committee for their advice, comments and suggestions during the preparation of this report.

The project team and steering committee would also like to thank the Science and Community Environment Knowledge (SCEK) fund, and Natural Resources Canada for their financial support, as well as the Adaptation Platform Energy Working Group.

EXECUTIVE SUMMARY

Many scientists agree that a changing climate will likely manifest itself in increased frequency and severity of extreme weather events, such as floods, storms, droughts, and natural disturbances such as forest fires, landslides and insect outbreaks, as well as changes in temperature (average highs and lows), and precipitation patterns (timing, amounts and types [rain vs. snow]). These changes are expected to have a significant impact on the full range of upstream oil and gas sector activities including exploration, infrastructure development and production, and transmission, especially in British Columbia. Potential climate change impacts that are expected to affect the oil and gas sector include physical damage to infrastructure and access structures, changes to operational activity schedules and timing, and reduced effectiveness of current sector strategies and activities to meet government regulations, policies and standards. Adaptation strategies will become increasingly important to ensure that the sector continues to meet its environmental obligations and adequately protects its infrastructure and operations into the future. The extent of the oil and gas sector leaders' awareness of and viewpoints about the full range of possible climate change impacts to the industry, and their level of preparedness to address these impacts has been relatively unknown and was identified as a priority information need by the Energy Working Group of the Adaptation Platform.

An online survey and follow-up interviews of sector leaders in both the upstream and transmission oil and gas industries in British Columbia, Alberta and Saskatchewan were conducted in the spring and summer of 2014 to;

- 1) Assess the corporate culture and policy regarding climate change,
- 2) Determine the current state of awareness of the potential climate change impacts on the sector's operations and infrastructure,
- 3) Ascertain whether there are any perceived barriers to climate change adaptation,
- 4) Determine if any climate change strategies have been or are being developed,
- 5) Identify any information needs, and
- 6) Determine the best methods for information sharing within the oil and gas sector.

This report summarizes and discusses the results of the survey respondents and interviewees who worked for companies or who had clients with operations in British Columbia.

Twenty-eight people completed the on-line survey and six were interviewed. Thirteen of the 28 people who completed the survey and three of the six people interviewed worked for companies with operations in British Columbia. All survey respondents with company operations in British Columbia were oil and gas company employees with four respondents representing small (<100 employees), three representing medium (100-500 employees), and six representing large (>500 employees) sized companies. All sector business areas (e.g., production, transmission, and exploration) with the exception of conventional gas production and all company roles (e.g., management, operations, environment) with the exception of planning were represented in the British Columbia survey responses. Two of the three people interviewed were oil and gas company employees while the third was a consultant. One interviewee represented a gas production company (both conventional and unconventional), and one interviewee represented gas pipeline companies. The consultant has worked with both oil and gas pipeline companies. Two interviewees worked for large companies and one worked for a medium-sized company.

Opinions and experiences about climate change and the potential impacts it will have on the oil and gas sector in British Columbia varied widely among respondents. Views from the oil and gas sector leaders ran the full gamut between those who don't accept climate change and those who agree that climate change is occurring but feel hindered by government policy in their efforts to adapt. Opinions about the occurrence of climate change varied by company size. Survey respondents from small companies appear to be less certain about climate change and its predicted impacts and are less likely to consider climate change when making management decisions or to have strategies in place to address those impacts compared to respondents working for medium or large companies. Less than half of survey respondents said that their company had a strategy to prepare for a changing climate. Due to the complex nature of projecting climate change impacts on the sector, it is recommended that companies implement collaborative internal approaches that engage experts, technicians and specialists to develop adaptation strategies. Furthermore, because of the diversity of opinions and experiences, a multi-faceted and comprehensive outreach approach utilizing a variety of extension methods and techniques (e.g., workshops, reports, newsletters) should be used to increase the sector's knowledge about the predicted impacts changes to the frequency of extreme weather events and natural disturbances, as a result of a changing climate, may have on the sector's operations and/or infrastructure.

Cost increases were the most frequently mentioned risks associated with climate change, followed by worker health and safety and environmental damage. Loss of social license to operate was of least concern across all respondents. Compressed time available to conduct field operations and develop and build infrastructure, impacts on access availability and structures, increased need for emergency preparedness plans, and increased potential for physical damage were the potential impacts of changes to temperature, precipitation patterns and natural disturbances on operations and/or infrastructure cited most often by respondents. Many respondents stated that extreme weather events would have minimal impact on the sector's infrastructure as the current engineering design standards and criteria already take these events into account. However, given that the frequency and severity of extreme weather events as well as natural disturbance processes are expected to increase over the next few decades, it is recommended that design standards and criteria continue to be monitored to ensure that they remain adequate to ensure the continued safe operation of the sector's infrastructure. This may also require continued research on the risks and potential impacts of a changing climate on the sector's operations and infrastructure as well as on the associated costs of adaptation.

A third of survey respondents with company operations in British Columbia felt that current government regulations, policies and standards make it difficult for companies in the oil and gas sector to modify management practices to adapt to a changing climate. Some respondents commented that the regulatory process is slow and lacks the flexibility to deal with issues and situations arising as a result of a changing climate. An analysis of both federal and provincial government policies that further examines which policies are considered hindrances and what policy changes could help provide incentives and remove barriers for energy sector companies to address climate change through modification of management practices should be conducted as a start in eliminating barriers to adaptation in the sector.

Lack of local/regional climate change monitoring data as well as models and other forecasting tools to help the sector make operational or environmental decisions regarding adaptation to a changing climate was identified as a key information gap and increased efforts, funded by government, to gather this data and develop these models and tools is recommended.

Industry associations are the most trusted information source and electronic newsletters from those associations are the most effective method for distributing information on climate change and its predicted impacts to oil and gas sector leaders. It is recommended that oil and gas sector industry

associations take a lead role in fostering the dialogue on climate change within their sector and in identifying opportunities for coordinated climate change adaptation strategies given their role as a trusted and representative body that addresses relevant issues across their membership.

The survey design was limited by the required use of a non-probability sampling method which does not allow for extrapolation of survey results to the larger population of industry leaders. However, potential respondents identified for the study were deemed to be key energy sector leaders with extensive knowledge and influence on their company's or client's activities and plans. Because of their influence in the sector, their perceptions are likely to have broad application in company operations and planning relating to extreme weather events. A second study limitation was that some potential respondents to the survey were missed due to incorrect email addresses.

Future studies designed to gather information about the sector's preparedness for climate change would be best accomplished through engagement such as focus groups or workshops rather than surveys of individuals. It is also recommended that future discussions on the potential impacts of a changing climate on the sector should use more neutral terms such as 'extreme weather events' and 'climate variability' instead of 'climate change' and should be framed in a risk and cost reduction context.

INTRODUCTION

Many scientists agree that a changing climate will likely be linked to a rising frequency and severity of extreme weather events in Canada, such as floods, storms, and droughts, because warmer temperatures tend to produce more violent weather patterns (IBC 2012). A changing climate could result in changes in temperatures (average highs and lows), which may, in turn, affect permafrost levels, timing of winter freeze up and/or spring melt as well as changes to precipitation patterns (timing, amounts and types [rain vs. snow]) in some areas which could result in raised or lowered water tables and changes to run-off patterns and timing. Natural disturbance regimes are also expected to shift in North America in the coming decades as a result of a changing climate, with increases in the frequency and severity of wildfires, and insect outbreaks (Intergovernmental Panel on Climate Change [IPCC] Working Group II, 2007; IPCC 2011). A regional assessment of Canada's vulnerability to climate change reached the same conclusions, noting that in the prairies the most significant threat is the projected increase in climate variability and the frequency of extreme events (Sauchyn and Kulshreshtha 2008) while British Columbia has the highest certainty of shifting disturbance regimes (Walker and Sydneysmith 2008).

These changes are expected to have a significant impact on the full range of upstream oil and gas sector activities including exploration, infrastructure development and production, and transmission, especially in western Canada. Climate change impacts that are expected to affect the oil and gas sector include:

- 1) Changes to the frequency and severity of natural disturbance events such as forest fires, landslides, and storms. These events can cause physical damage to production infrastructure (well sites, power supply, equipment), and access infrastructure (washed out or blocked roads due to fires, wind storms, etc.).
- 2) Changes to the diversity and extent of plant species distribution. This will subsequently impact the success of site reclamation under the new climatic conditions.
- 3) Reductions in the effectiveness of strategies and techniques used to meet government regulatory and policy requirements, such as those employed to mitigate habitat loss for species at risk, or manage invasive plant species.

Adaptation strategies will become increasingly important to ensure that the sector continues to meet its environmental obligations and adequately protects its infrastructure and operations into the future.

PURPOSE / OBJECTIVES

The extent of the oil and gas sector leaders' awareness of the full range of possible climate change impacts to the industry, and their level of preparedness to address these impacts has been relatively unknown and was identified as a priority information need by the Energy Working Group of the Adaptation Platform. In September 2013, Resources North and partners, with support of Natural Resources Canada and the Science and Community Environmental Knowledge (SCEK) fund, undertook this project to assess the current state of awareness and action on climate change adaptation among oil and gas company leaders operating in Western Canada, identify potential opportunities to improve awareness and preparedness, and identify opportunities to coordinate efforts for climate change adaptation. The project focused on both the upstream and transmission oil and gas industries in the provinces covered by the New West Partnership area, where there was an agreement signed between British Columbia, Alberta, and Saskatchewan to improve coordination of oil and gas development. The findings of this project are expected to be valuable to the oil and gas sector associations, including the Canadian Association of Petroleum Producers [CAPP] and the Canadian Energy Pipeline Association [CEPA], and the Federal and western Provincial governments (Saskatchewan, Alberta and British Columbia) as well as the sector itself. The project was designed to:

- 1) Assess the current level of awareness among oil and gas company leaders of the potential impacts of a changing climate on the sector's infrastructure and operations;
- 2) Raise the level of the awareness within the sector of the potential impacts of climate change on their infrastructure and operations;
- 3) Identify opportunities for companies to work with government, academia and others, as appropriate, to develop and implement adaptation strategies and action plans;
- 4) Identify opportunities for synergies among key players in the sector, that could result in collaborative approaches to reduce costs and protect their investments; and
- 5) Increase economic certainty, environmental protection and social licence with respect to operations and infrastructure.

This report summarizes the project results for companies with operations in British Columbia. For information on other Western Canada provinces please refer to the full project report (Wiensczyk, A.M., S. Morford, and M. Karjala. (2014). Climate Change Impacts to the Oil and Gas Sector in Western Canada - How are we Preparing? Report submitted to Climate Change Impacts and Adaptation Division, Natural Resources Canada, 72pp.).

METHODS

The project team used a mixed research method involving an on-line survey using SurveyMonkey® which was administered in March 2014, as well as phone interviews that were conducted in August and September 2014. The purpose of the study was to gather information and perspectives from a broad spectrum of personnel from oil and gas upstream and transmission companies in western Canada as well as their contractors/consultants relating to the potential impacts of a changing climate on the sector's operations and infrastructure and the sector's response. The survey and interviews were based on a series of research questions developed in consultation with a steering committee of energy sector stakeholders in January-February 2014 (see Appendix I for list of steering committee members).

Demographic questions were also included in the survey to enable cross-tabulations. The introductory letter, survey questionnaire and interview protocol are found in Appendices II and III. The research questions included:

- 1) What is the corporate culture and policy around climate change? To what degree do executives as well as environmental and operational staff recognize that climate change is occurring? Do they anticipate that climate change could affect their operations?
- 2) To what degree are company leaders and environmental and operational staff aware of the potential impacts of climate change on their operations and infrastructure? And if they are aware, how are they planning to adapt? Are there any existing company policies that would hinder their company's ability to adapt? Are there other barriers?
- 3) To what degree are the environmental and operational staff aware of, or have already experienced, the potential impacts of climate change on extreme weather events/natural disturbance regimes such as forest fires, landslides, wind storms, and flooding.
- 4) Do existing government policies or standards help or hinder attempts to adapt to climate change. Do the environmental and operational staff perceive that changes in climate will affect their ability to meet provincial regulations and standards?
- 5) To what degree are the environmental staff aware of the potential changes to plant species diversity and extent. These changes might influence;
 - a. Site reclamation and restoration efforts.
 - b. Presence of invasive plant species.
- 6) Have companies begun development of, or already developed, adaptation strategies to address the potential impacts of climate change on their operations and infrastructure? And if so, what do the strategies look like?
- 7) What types of information do the environmental and operational staff need? And where do they currently get information to inform their decision-making around potential adaptation to climate change. What methods/techniques do they think would be the most effective in

increasing the level of knowledge within the sector of the potential impacts of climate change on operations and infrastructure?

The purpose of the interviews was to gather information related to the project research questions, and to clarify, verify and garner a better understanding of some of the sector's responses to the on-line survey questions.

Survey and sampling design

A list of 191 potential respondents representing a range of oil and gas company representatives were identified by project staff and the steering committee during the initial phases of the project (October 2013 to February 2014). Potential respondents were identified as key energy sector leaders who were expected to have extensive knowledge and influence on their company's or client's activities and plans relating to extreme weather events. Based on feedback from the steering committee, the project team drafted and then beta-tested a questionnaire by asking three natural resource management professionals not associated with the project to complete the survey and provide comment. To minimize measurement error, we used both closed ended and open ended survey questions, used simple, clear and short sentences that avoided jargon, and included definitions of unfamiliar terms. The final 37-question questionnaire was sent out via email to the potential respondents (summarized in Table 1) on March 6 and 7, 2014 with a deadline for completion of March 21. Email reminders were sent to non-respondents on March 14 and March 21. The survey was closed at 7 pm (PST) on March 21. The email invitation included a project description, assurance of anonymity, and a link to the on-line questionnaire. Potential respondents were not asked to include their name or affiliation but they were asked a series of demographic questions to identify their role in the sector, province(s) of operations, and their core business area.

The Canadian Association of Petroleum Producers (CAPP) and the Canadian Energy Pipeline Association (CEPA) staff distributed the questionnaire via email to selected members to protect the confidentiality of the email addresses of the CAPP and CEPA membership (as requested by their respective executive boards as a condition for project participation). Prior to survey distribution to the CAPP membership, a CAPP representative contacted their member companies to determine the most appropriate person to receive the survey. The CEPA representative determined that the most appropriate people to receive the survey were those participating on the CEPA Climate Change Working Group. The project team

distributed the questionnaire via email to other potential respondents who were members of the Energy Producers Association of Canada (EPAC) and the Pipeline Contractors Association of Canada (PCAC). Email addresses for the latter were obtained through an internet search of publically available contact information of member companies. Individuals involved in company operations or management were selected.

Given that respondents were selected by their associated industry associations to receive the survey, the study used a non-probability sampling design.

Table 1: Survey Distribution List

Association	Potential respondent description	Number of potential respondents	Distributed by
Canadian Association of Petroleum Producers (CAPP)	Environmental and/or Operational staff of member companies	86	CAPP
Canadian Energy Pipeline Association (CEPA)	Climate change working group members of member companies	13	CEPA
Explorers and Producers Association of Canada (EPAC)	Environmental and/or operational staff and/or senior managers of member companies	76	Project team
Pipeline Contractors Association of Canada (PCAC)	Senior or operational managers of member companies	16	Project team
Total		191	

The survey response data were compiled in an Excel spreadsheet. The project team cleaned the data and conducted a descriptive statistical analysis using Excel. Summary tables and graphs were prepared. A cross tabulation was conducted to break out responses by company size.

Interview Process

Potential interviewees were identified by the project team and steering committee based on the interviewees' knowledge and experience within the oil and gas sector in western Canada. The project team developed the interview questions after a cursory analysis of the on-line survey results. Prior to their interviews, interviewees were emailed the questions, and a consent form assured confidentiality, explaining that their names would not be identified in the report. Interviewees were asked to print and sign the form indicating their willingness to be included in the study. Project staff conducted the

approximately 40-minute one-on one interviews with six respondents by telephone in August and September 2014. Interview data were compiled and summarized, sent to the respondent for review with a 7 day deadline, and then incorporated into the analysis of the survey.

The interview response data were integrated with the survey results data to provide a comprehensive overview of the respondents' current level of preparedness for potential climate change impacts on their infrastructure and/or operations.

Project Team and Steering Committee

The project team consisted of Melanie Karjala (Resources North Association), Alan Wiensczyk (Trout Creek Collaborative Solutions), Dr. Shawn Morford (Benchmark Social Research and Program Evaluation) and Jason Morris (University of Northern British Columbia). Ms Karjala administered the project and led the development, delivery and analysis of the interview phase of the project while Mr. Wiensczyk led the development, delivery and analysis of the survey. Dr. Morford provided input on the survey design and analysis and Mr. Morris provided input on the qualitative design and analysis. All members of the project team were also participants on the project steering committee. The Project Steering Committee consisted of representatives from the following project partner organizations;

- Canadian Association of Petroleum Producers (CAPP)
- Canadian Energy Pipeline Association (CEPA)
- BC Oil and Gas Commission
- BC Ministry of Environment Climate Change Secretariat
- Saskatchewan Ministry of Environment Climate Change
- Alberta Environment and Sustainable Resource Development – Policy Division

Study Limitations

Because of the requirement by the partnering organizations for member confidentiality , it was not possible to use a random sampling method. As a result this study used a non-probability (non-random) sampling method which does not allow for extrapolation of survey results to the larger population of industry leaders.

However, potential respondents identified for the study were deemed to be key energy sector leaders with extensive knowledge and influence on their company's or client's activities and plans. Because of

their influence in the sector, their perceptions are likely to have broad application in company operations and planning relating to extreme weather events. In addition, many of the questions in the survey asked respondents to answer on behalf of their company or their clients on what their company or their clients were doing in regards to climate change awareness and adaptation. A random sampling method was not appropriate for those kinds of questions. The study also included a series of interviews to triangulate the quantitative results.

The list of potential survey respondents and interviewees was compiled in cooperation with two member-based organizations (CAPP and CEPA) along with internet-based searches for members of the Energy Producers Association of Canada (EPAC) and the Pipeline Contractors Association of Canada (PCAC). We assumed that the membership lists contained the majority of sector leaders in western Canada. However, it is probable that some leaders were missed, as in some cases only a general email address for a company was available and it was not possible to determine if the survey reached the person with the appropriate level of expertise. Staffing changes, reorganizations, and company amalgamation that frequently occur within the sector may also have led to some missed responses.

One of the challenges of the study was that some survey respondents were employed by companies with operations in multiple provinces which created some difficulty in interpreting the results regarding barriers created by government policies and standards.

RESULTS

Response rate

Of the 191 oil and gas sector employees and contractors/consultants who received the questionnaire, (Table 1), seven email addresses generated delivery error messages reducing the sample size to 184 potential respondents. A total of 28 people responded to the survey resulting in a response rate of just over 15%. Of the 28 respondents, 23 (12.5%) completed the entire survey while five partly completed the survey. Of the 28 survey respondents thirteen (46%) indicated that they worked for a company with operations in British Columbia and 10 of those respondents completed the entire survey while three partly completed the survey.

Respondents were asked to provide comments on expected impacts to their company's or their clients' operations and/or infrastructure. Comments were reviewed for similarities among respondents and grouped into thematic areas. In addition, the cross tabulation of survey responses using company size was examined and discussed where trends were noted. Cross tabulations of survey responses using company role, and company primary business area were not conducted for the BC data as the low survey response rate resulted in too few responses per cross tabulation category to allow for the identification of response trends.

Of the 13 key oil and gas sector personnel identified as potential interviewees, six were interviewed. The others were either unavailable or did not respond to the interview request. Of the six people interviewed, three indicated that they worked for a company or for clients with operations in British Columbia.

The response rate for the on-line survey portion of the project was lower than expected, possibly because of lack of available time for sector leaders, lack of required level of expertise, lack of interest, or low priority for recipients. One respondent commented after the survey had closed that they were unable to complete the survey as some of the questions were outside of their area of expertise and they had wanted to consult with others in their company before answering but were unable to do so due to their own time constraints. In addition, one email response noted that climate change adaptation doesn't currently make their list of priority issues that they are putting their time and resources into,

citing that commodity price volatility, lack of availability of drilling rigs and pipe, rising materials and services costs, regulatory permitting, provincial taxation & royalties, workforce skill shortages, pipeline protests, and aboriginal consultation are much higher priority issues for them than climate change or extreme weather events. These comments are consistent with our findings that some energy sector leaders don't consider climate change risk and adaptation as seriously as the science would suggest is needed.

The following results, discussion and key messages and recommendations are based on the responses from the 13 survey respondents and three interviewees who worked for companies with operations in British Columbia.

Survey Respondent Profile

Business and demographic information were collected to provide background information about the respondents and to enable cross-tabulations to look for trends among respondents. Respondents provided their sector involvement, primary business area, company size, province of company operations, role within their company, age, years of experience in the sector, and education level.

All survey respondents were oil and gas sector company employees. No contractors or consultants completed the survey. With the exception of conventional gas production, all business areas within the oil and gas sector were represented. Table 2 shows the respondents who worked for a company with operations in British Columbia by primary business area.

Three survey respondents selected 'other' and provided the following business areas:

- 1) Gas distribution pipeline
- 2) Integrated oil and gas
- 3) Conventional oil and gas, oil sands, shale gas

The survey responses from the respondent who indicated their business affiliation as "gas distribution pipeline" were added to the gas transmission pipeline business area. Two other respondents were left as 'other' since it was not possible to determine their primary business area from their answer.

Respondents were also asked to provide information on the location(s) of their company's or their clients' operations. Respondents could choose multiple locations to allow for companies having

Table 2: Respondent Primary Business Area (BC Data).

Primary Business Area		Number of Respondents	Percent
Oil Transmission Pipeline		1	8
Gas Transmission Pipeline		3	23
Oil production	Conventional	1	8
	Unconventional	1	8
Gas Production	Conventional	0	0
	Unconventional	3	23
Oil and Gas Exploration		2	15
Other		2	15
Total		13	100

operations in more than one province. Thirteen respondents worked for companies with operations in British Columbia. Two survey respondents worked for companies who only had operations in British Columbia, while six worked for companies with operations in both British Columbia and Alberta, and five indicated that their company had operations in British Columbia, Alberta and Saskatchewan. Other areas of company operations in addition to British Columbia included Newfoundland and the United States.

Four respondents with company operations in British Columbia worked for small companies (less than 100 employees), three worked for medium (100-500 employees) and six worked for large (greater than 500 employees) sized companies.

Just under half of the survey respondents with company operations in British Columbia were involved in management (40%) although all company roles, with the exception of planning, were represented by at least one respondent (Table 4). One respondent selected 'other' and indicated that they were involved in "Policy and Government Relations."

Years of experience in their current field among respondents with operations in B.C. ranged from less than five to more than 20 (Table 5) with most respondents having 5 to 15 years of experience.

Table 4. Company Role of respondents (BC data)

Company Role	Number of Respondents	Percent
Management	4	40
Planning	0	0
Operations	1	10
Environment (general)	1	10
Environment (Climate change specific issues)	3	30
Other	1	10
Total	10	100

Table 5. Years of Experience in current field (BC data)

Years of experience	Number of Respondents	Percent
Less than 5	1	10
5-10	3	30
11-15	3	30
16-20	1	10
More than 20	2	20
Total	10	100

Half of the respondents were over the age of 40 and all were over the age of 20. All of the survey respondents working for a company with operations in British Columbia had attended university and had received an undergraduate degree (50%) or a post-graduate degree (50%). Three respondents with company operations in British Columbia did not answer the questions regarding their company role, years of experience, age, and education level.

<i>Interviewee Profile</i>

Two of the three people interviewed were oil or gas company employees and the third was a consultant. One interviewee represented a gas production company (both conventional and unconventional), and one interviewee represented gas pipeline companies. The consultant has worked with both oil and gas pipeline companies (Table 6). Both employees interviewed worked for companies with operations in British Columbia and Alberta with one also having operations in Saskatchewan. One interviewee

indicated that their company also has operations in Ontario, Quebec and the United States. The consultant has worked with companies in all three western provinces.

Table 6: Interviewee Business Areas (BC Data)

Primary Business Area		Number of interviewees*
Oil Transmission Pipeline		0
Gas Transmission Pipeline		1
Oil production	Conventional	0
	Unconventional	0
Gas Production	Conventional	1
	Unconventional	1
Oil and Gas exploration		0
Consultants		1

* Interviewees could work for a company that had more than one business area.

Two interviewees work for large companies (greater than 500 employees) while one works for a medium sized company (100-500 employees).

Extreme Weather and Climate

Nearly half of respondents working for companies with operations in British Columbia (46%) said that they had observed extreme weather events within their company’s geographic operating area within the last two years. There were some observed differences between different sized companies. Eighty-three percent of respondents working for a company with greater than 500 employees reported observing extreme weather events while 67% of respondents working for a company with 100-500 employees and all of the respondents working for a company with less than 100 employees reported not observing such events. Respondents listed “the 2013 flood in Calgary and 2011 flood in SE Saskatchewan” as examples (see Appendix IV – Q5 for list of extreme weather events observed).

Most respondents who had observed extreme weather events indicated that the extreme weather events had slowed down or temporarily suspended administration, planning, development, environmental, decommissioning and operational activities but had not affected exploration, or the

transportation of product to market. All respondents who had observed extreme weather events in their geographic operating area indicated the slow down or temporary suspension lasted 1-7 days.

When asked if they believed that the extreme weather event they observed in their company's operating area could be a result of a changing climate, no respondents indicated that they believed it could be, while one said that that they did not believe it was. Five were not sure. Several survey respondents commented that they felt it was difficult to link climate and weather.

"The connection between climate and weather is difficult to ascertain"

"Not sure anyone can say with any reasonable certainty"

"It was a 50 year flood which will happen (again)."

One respondent expressed doubt that the climate is changing in Canada at all. See Appendix IV – Q8 for all comments provided by respondents to the question of the potential link between weather events and a changing climate.

Of those who responded that they had observed extreme weather events, all six selected "not sure" when asked if they anticipated that there may be more frequent and/or severe weather events in the future than would have occurred without a changing climate. All six were also not sure how far in the future they thought the onset of more frequent and/or severe weather events would be.

"I don't know the science behind changing climate so I can't say if it is part of normal climate fluctuations or not."

"Open ended - what time frame is "future"? and How can we attribute those events to changing climate?"

Please refer to Appendix IV – Q9 for additional comments received from survey respondents.

Changing Climate

Just over half (54%) of all respondents with company operations in British Columbia agreed or strongly agreed that global climate change is occurring (Figure 1). The remaining respondents were neutral. Responses varied by company size. Sixty-seven percent of respondents working for a large (more than 500 employees) or medium (100-500 employees) company agreed or strongly agreed while only 25% of respondents working for a small company (less than 100 employees) agreed. The same percentage of survey respondents (54%) also agreed or strongly agreed that a changing climate could affect their

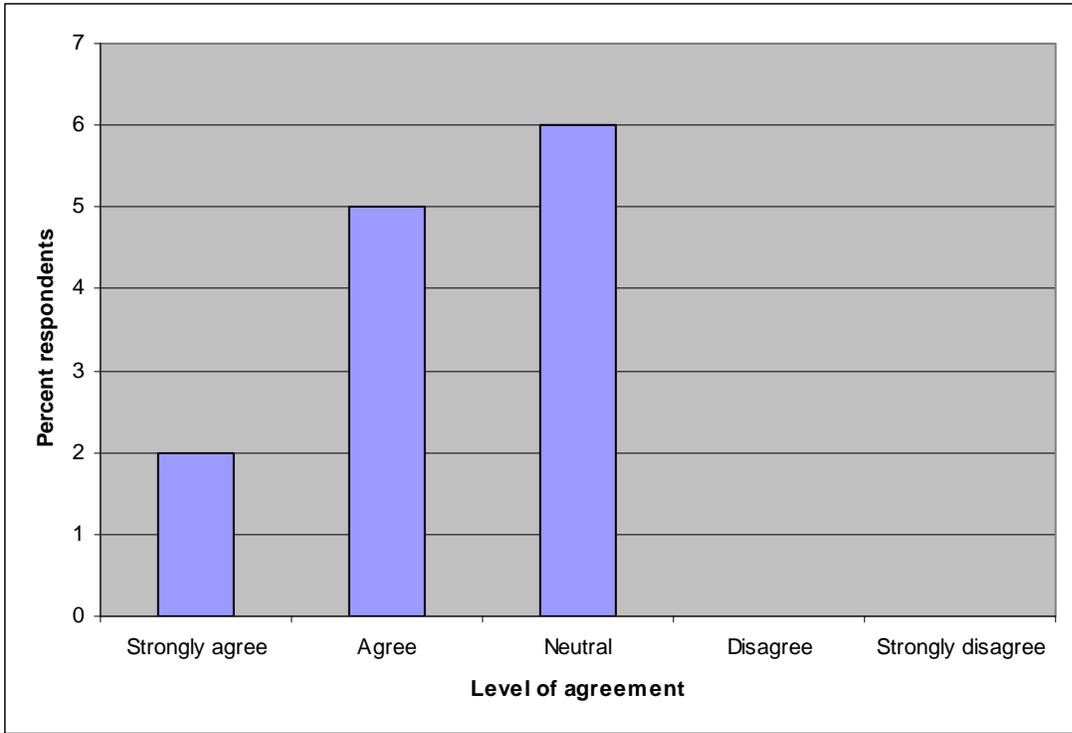


Figure 1. Level of agreement with the existence of global climate change (BC Data).

company’s operations and/or infrastructure while 8% disagreed (Figure 2). Responses to this statement also varied by company size. Again, 67% of respondents working for a large or medium company agreed or strongly agreed that there could be an impact, while only 25% of respondents working for a small company agreed.

All of the interviewees agreed that climate change is occurring and would have some affect on their company’s or their client’s operations and/or infrastructure and therefore needs to be addressed.

Survey participants were asked if they had observed their company participating in planning activities to prepare for potential impacts of a changing climate on their company’s operations and/or infrastructure. Over half of respondents (54%) with company operations in B.C. indicated that they had observed their company participating in planning activities while 30% said that they had not (Figure 3).

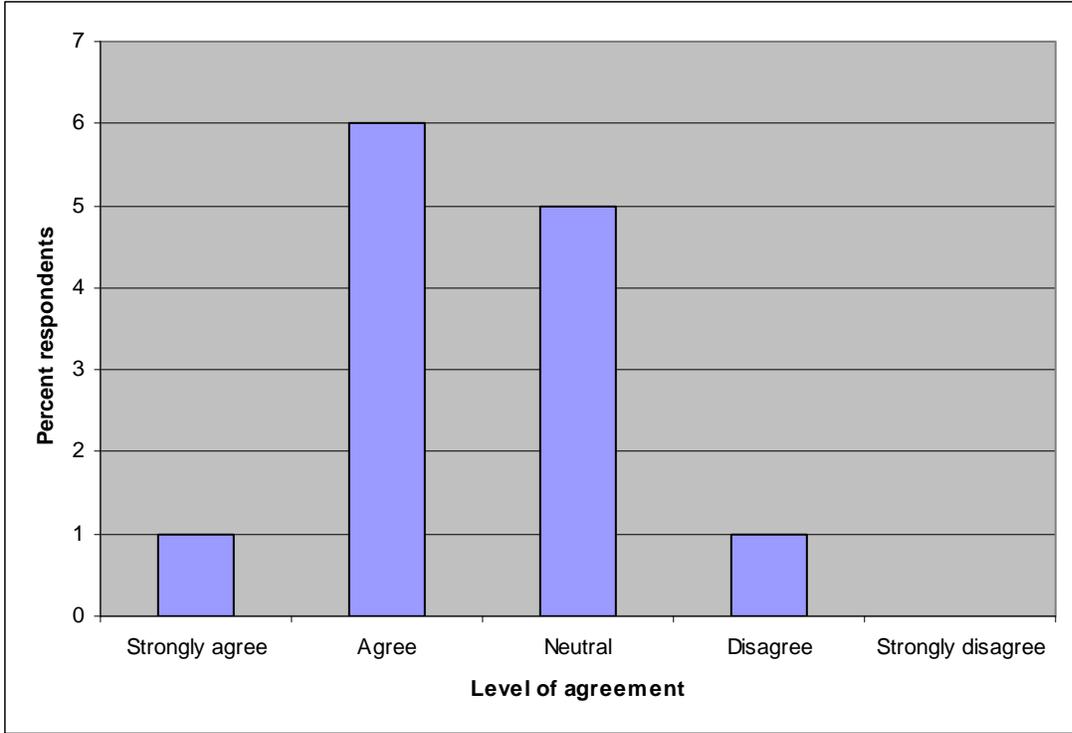


Figure 2. Level of agreement that a changing climate could impact company operations and/or infrastructure (BC Data).

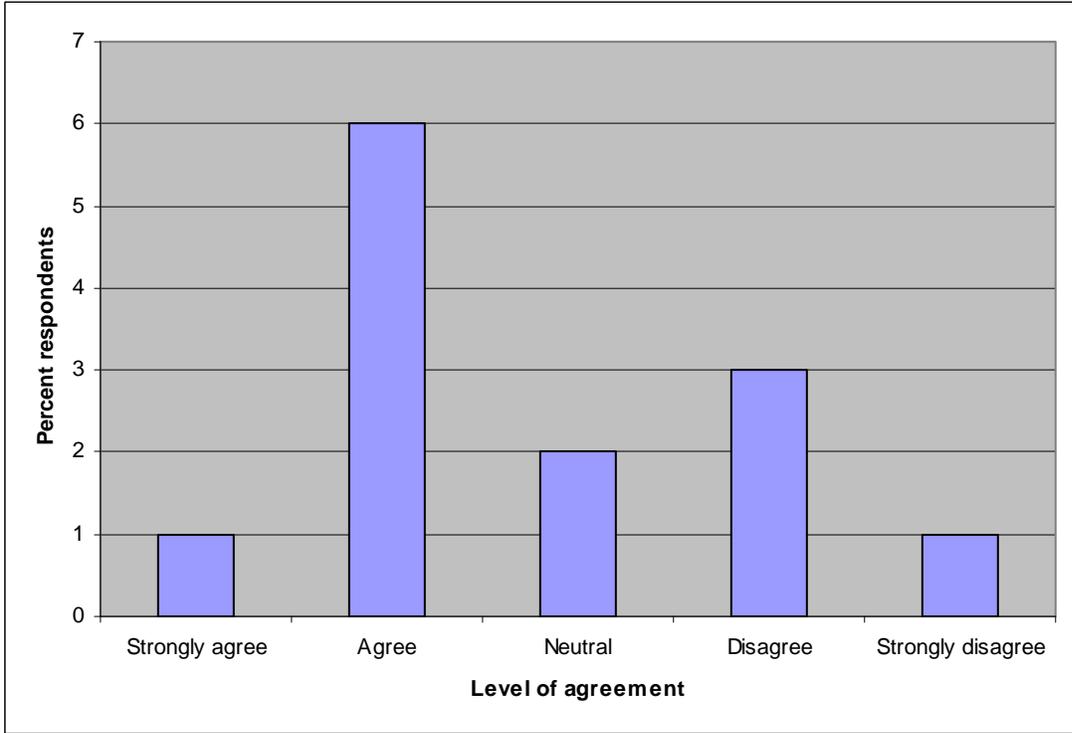


Figure 3. Level of agreement with observation of company participation in planning activities to prepare for potential impacts of a changing climate (BC Data).

Eighty-three percent of respondents working for a large company indicated that they had observed their company planning for potential impacts compared to 33% of respondents working for a medium company and 25% of respondents working for a small company making the same observation. While the remaining 17% of respondents working for a large company were neutral, the remaining 75% of respondents working for a small company and 33% of employees working for a medium company indicated that they had not observed their company planning for potential impacts of a changing climate on their company's operations and/or infrastructure.

Participants were also asked if they had observed their company implementing changes to operations and/or infrastructure to prepare for a changing climate. Just under half of respondents (46%) said that they had not while only 39% said that they had (Figure 4). No respondents from a medium company and 25% of respondents from a small company had observed their company implementing changes compared to 67% of respondents from a large company indicating that they had made that observation.

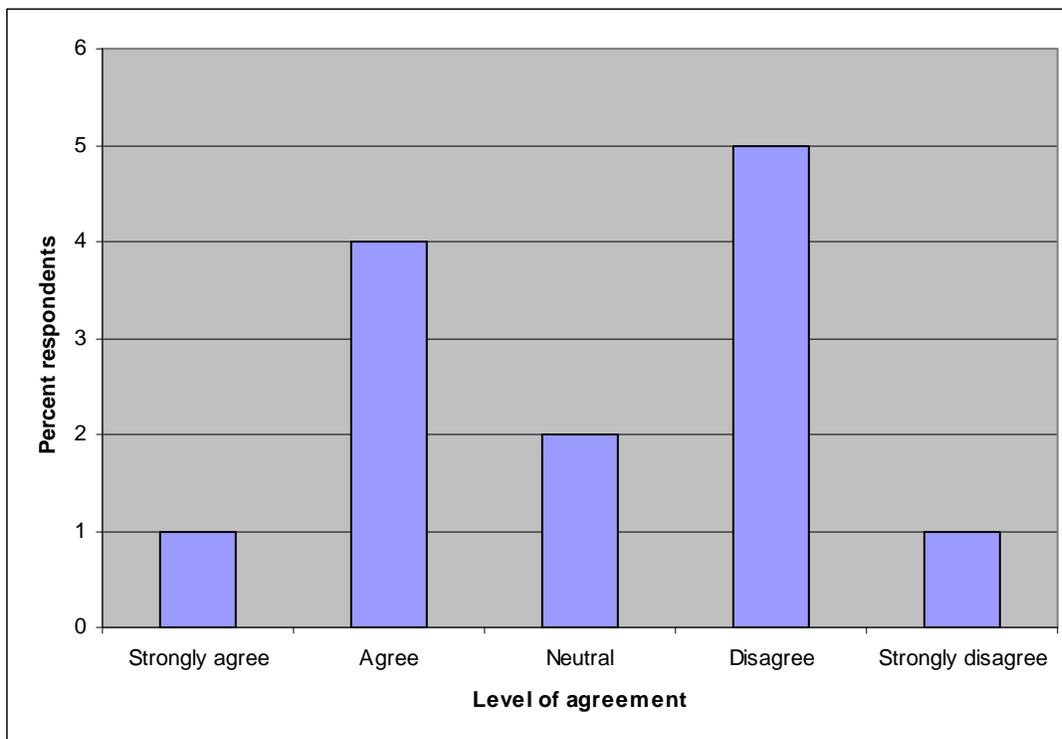


Figure 4. Level of agreement with observation of their company implementing activities to prepare for potential impacts of a changing climate (BC Data).

Respondents were also asked about the integration of extreme weather into their company's management decision-making, in particular, operational decision-making, long-term forecasting/planning, risk management planning, designing infrastructure, and when developing long-

term strategic plans. In all cases with the exception of operational decision making and long-term strategic plan development, a higher percentage of respondents said their company is currently making management decisions in these areas in response to current or predicted changes to the frequency and severity of extreme weather, than who said their company is not (Table 7). For long-term strategic plan development, the percentage of respondents was equal between those who said that their company is and those who said their company is not.

Table 7. Percent of respondents indicating that their company considered current or predicted changes to the frequency and severity of extreme weather when making management decisions, by decision type. (BC data)

Management Decision	Yes	No	Not sure
When making operational decisions	31%	54%	15%
When doing long-term forecasting/planning	46%	38%	15%
When doing risk management planning	54%	23%	23%
When designing infrastructure	54%	38%	8%
When developing long-term strategic plans	38%	38%	23%

Responses based on company size were similar for operational decisions but differed for other management decisions (Table 8). Two-thirds of respondents working for medium and large companies

Table 8. Percent of respondents by company size indicating that their company considered current or predicted changes to the frequency and severity of extreme weather when making management decisions, by decision type. (BC data)

Management Decision	Company Size	Yes	No	Not sure
When making operational decisions	Small	25%	75%	0%
	Medium	33%	67%	0%
	Large	33%	33%	33%
When doing long-term forecasting/planning	Small	25%	50%	25%
	Medium	67%	33%	0%
	Large	67%	0%	33%
When doing risk management planning	Small	50%	50%	0%
	Medium	67%	33%	0%
	Large	67%	0%	33%
When designing infrastructure	Small	50%	50%	0%
	Medium	33%	67%	0%
	Large	66%	17%	17%
When developing long-term strategic plans	Small	25%	50%	25%
	Medium	67%	33%	0%
	Large	33%	33%	33%

indicated that extreme weather events are accounted for in their company's long-term forecasting/planning and risk management planning and for large companies when also designing infrastructure.

As a follow up to survey questions about management decisions in response to extreme weather events, interviewees were asked about their company's preparation for climate change variability or extreme weather events. All indicated that their company or their clients plan and implement preparatory activities, although these plans and activities were not specifically developed and implemented to address climate change or variability, but to mitigate risk. Both company interviewees noted that their company's infrastructure design standards and plans take into account extreme weather events and conditions. One interviewee also stated that their company has risk management plans and/or emergency preparedness plans and procedures to address catastrophic events, including those that are weather-related.

Risk Factors

Respondents were asked about their perception of risk relating to a change in the frequency and severity of extreme weather events to both operations and infrastructure. For operational risk factors, operational cost increases and health and safety-related incident increases were the most frequently selected risk factor across all respondents with company operations in B.C. (75%), followed by design cost increases and environmental damage, both at 67%. Loss of social license to operate was the least concern regardless of company size (Figure 5). Operational cost increases were selected most often by respondents working for small companies, while respondents who work for large companies selected health and safety-related incident increases most often.

With regards to the perceived risk factors relating to infrastructure, respondents reported design cost increases most frequently (Figure 6). Loss of social license to operate was perceived to be a small risk by survey respondents.

The interviews supported the results of the survey. Two of the three people interviewed also agreed that the biggest risks to their respective businesses from changes in the frequency and severity of extreme weather events would be cost increases, both operational and design. Interviewees were asked

if they agreed that design costs are a higher risk factor than social licence. One interviewee indicated that these categories may not be mutually exclusive, and that good infrastructure design will lead to social licence. They also stated that loss of social licence was at least an equal risk for their company.

'Social license has a significant impact on my company's ability to develop infrastructure, and our infrastructure crosses a lot of land and touches many communities and interests. Therefore social license is a huge issue.'

Other risks identified by the interviewees included slope stability and water sources and use. Interviewees were also asked about the magnitude of expected cost increases and the cost effectiveness of proactive versus reactive strategies. One interviewee explained that the anticipated cost increases are hard to pinpoint and will depend on the infrastructure involved as well the type of impact and adaptation required. However, another interviewee said that there have been no increases in design costs for climate adaptation as their infrastructure is already built to be adaptable and withstand any impacts.

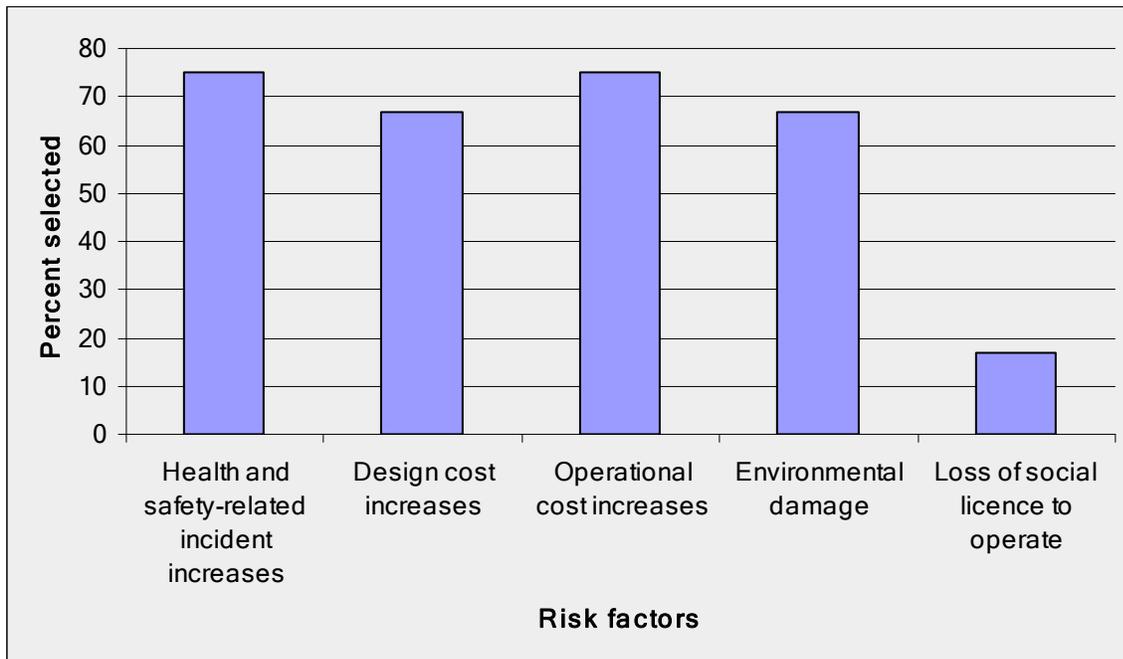


Figure 5. Operational risk factors from change in frequency and severity of extreme weather events. (BC Data)

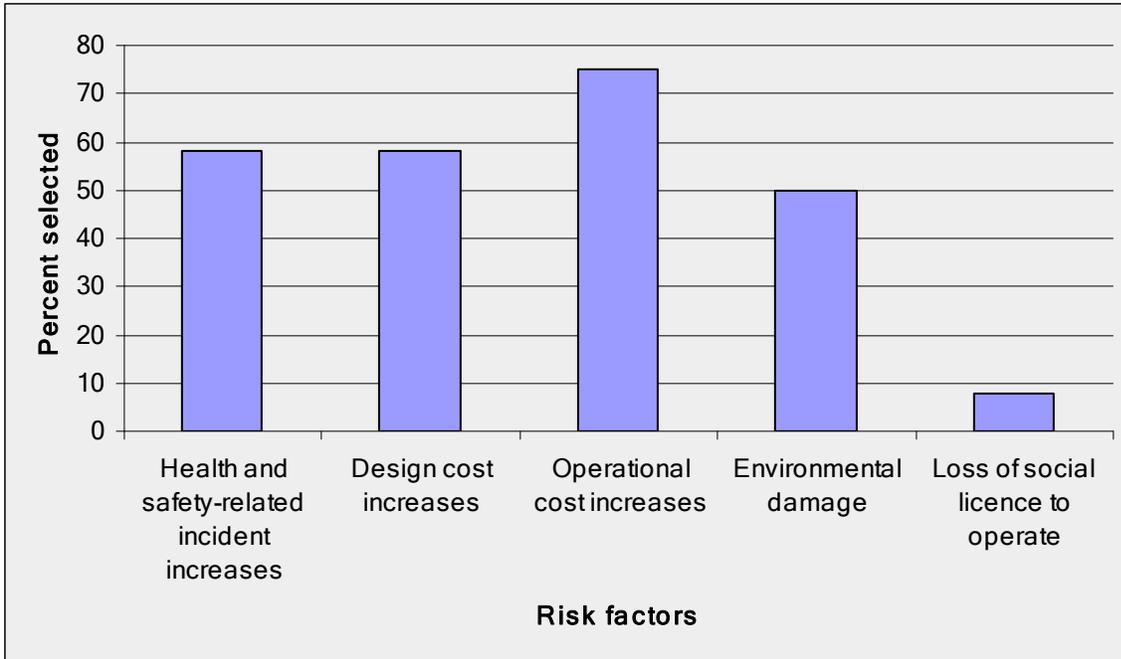


Figure 6. Infrastructure risk factors from change in frequency and severity of extreme weather events. (BC Data)

Temperature

Operationally, five respondents with company operations in B.C. noted that changes to the timing of winter freeze and/or spring melt due to changes in temperatures as a result of a changing climate would compress the time available to conduct field operations and to develop and build infrastructure, and may require the upgrade of access roads (i.e., winter roads to all-season roads) all of which would result in increased costs. Two respondents commented that a compressed activity timeframe could increase the potential for safety or environmental incidents and that more emergency response procedures and training will be required. Another respondent also noted that melting permafrost as a result of a change in temperature would make summer operations difficult and could negatively impact access. Another impact noted by a respondent was changes to the localized demand for natural gas for heating.

Two respondents commented that they did not believe that climate change was occurring and thus it would have no impact on their operations (See Appendix IV – Q15 for a list of all comments received on temperature impacts on operations).

For impacts of temperature changes on infrastructure, the biggest concern raised by respondents was changes to road access. Other potential impacts included changes to slope stability which may affect pipeline integrity. One respondent said that they expected no impact on their company's infrastructure from changing temperatures, and two expressed doubt regarding climate change. One commented that it was "*Difficult to put significant capital into overdressing for temporary or occasional events.*" (See Appendix IV – Q16 for a list of all comments received on temperature impacts on infrastructure).

Precipitation

The most common operational impact related to potential changes to precipitation patterns noted by respondents with company operations in B.C. was access limitations due to increased winter snowfall and spring melt or increased rainfall in other seasons, especially in flood-prone regions. One respondent commented that larger snow packs could lengthen the spring melt which could delay projects and shorten the field activity window, increasing costs. Lack of water for industrial purposes was also noted as a potential impact. Two respondents commented that changes in precipitation patterns would not impact operations (See Appendix IV – Q17 for a list of all comments received on precipitation impacts on operations).

Potential impacts on infrastructure access was the most noted concern by survey respondents. One respondent said that changes to runoff patterns and/or increased runoff could cause changes to slope stability and that any shifting in the ground could rupture or fracture a pipeline. Three respondents felt that there would be no impact to infrastructure (See Appendix IV – Q18 for a list of all comments received on precipitation impacts on infrastructure).

Ecological Processes

Fifty-eight percent of respondents indicated that they did not know if climate change induced changes to natural disturbances and other processes that are a regular part of our ecosystems would occur in their company's operating area, while 25% said they would expect such changes and 17% expected that changes would not occur (Table 9). Responses varied by company size with 60% of respondents working for a large company indicating they expect such changes to occur while no respondents working for a

either a small or a medium company indicated that they expect such changes to occur in their company's operating area.

Table 9. Expectation of changes to disturbance patterns and ecological processes. (BC data)

Response	Percent of respondents (%)	Number of Respondents
Yes	25	3
No	17	2
Don't know	58	7
Total	100	12

One respondent who expected that changes will occur in their company's operating areas indicated that operationally there would be decreased access to sites (See Appendix IV – Q20 for list of all comments received on natural disturbance impacts on operations).

Impacts on infrastructure included increased potential for physical damage to the infrastructure from forest fires or flooding (See Appendix IV – Q21 for list of all comments received on natural disturbance impacts on infrastructure).

Survey respondents were asked to rate their personal level of awareness regarding the impact that changes to the extent and diversity of plant and tree species occurring in the ecosystems in which they operate as a result of changing temperatures, precipitation patterns and ecological processes may have on site reclamation and restoration efforts and the presence of invasive plants. All respondents were at least somewhat aware on how these changes would impact site reclamation and restoration efforts, and only slightly fewer (82%) were at least somewhat aware on how these changes would impact the presences of invasive plants (Table 10).

Table 10. Level of awareness of impact of changes to extent and diversity of plant species on site reclamation and restoration efforts and presence of invasive plants (BC Data).

	Very aware	Aware	Somewhat aware	Not at all aware	Total
a) Site reclamation and restoration efforts	9%	27%	64%	0%	100%
b) Presence of invasive plants	9%	18%	55%	18%	100%

Company Strategies

Survey participants were asked about the existence of company strategies to prepare for a changing climate. Almost half of respondents (46%) with company operations in B.C. said that their company had a strategy while 27% did not and 27% didn't know. Seventy-five percent of respondents working for a large company said that their company had a strategy while only 25% of respondents working for a small company and 33% of respondents working for a medium company said that their company had a climate change strategy.

Of the six respondents whose companies did not have strategies or did not know, there were none who indicated that their company had any plans to develop such strategies in the next 6-12 months. One respondent commented that they didn't have a major strategy but that they plan for downtime which could be weather related. One respondent also commented that strategies in response to a changing climate were not necessary (See Appendix IV – Q23 for a list of all comments received on company climate change strategies).

“Climate change has happened throughout history, including before man. The majority of the influence is not man caused nor can it be man controlled”

Interviewees were asked to provide examples of strategies and activities that their company uses that could help with preparations for climate variability. Both interviewees working for companies with operations in B.C. said the main preventative strategy that is used by their respective company is ensuring that infrastructure design criteria take into account expected changes related to climate change such as melting permafrost, sea level rise, increased precipitation and temperatures. Other strategies mentioned include emergency preparedness plans to deal with things such as forest fires, floods and snow storms, and strategies to deal with water storage. The consultant noted that they have never been approached to conduct any vulnerability assessments. They added that the companies that they have done work for are used to responding to events but questioned whether companies are building the necessary capacity to deal with the potential increase in the frequency of the events as a result of a changing climate. They also questioned if anything was being done by the regulators to ensure that engineers are adopting the necessary design standards to deal with the changing environment resulting from climate change.

Government Policies

Survey respondents were asked a series of questions on the impact of government policies, standards and regulations on the modification of management practices to adapt to a changing climate. Thirty percent of respondents with company operations in British Columbia indicated that existing government policies or standards make it difficult to modify management practices while 20% thought that they are not a hindrance. The remaining 50% were neutral (selected “3” on a scale from 1-5, as shown in Figure 7). Please refer to Appendix IV – Q25 for a list of all survey respondent comments on the adaptation and government policies.

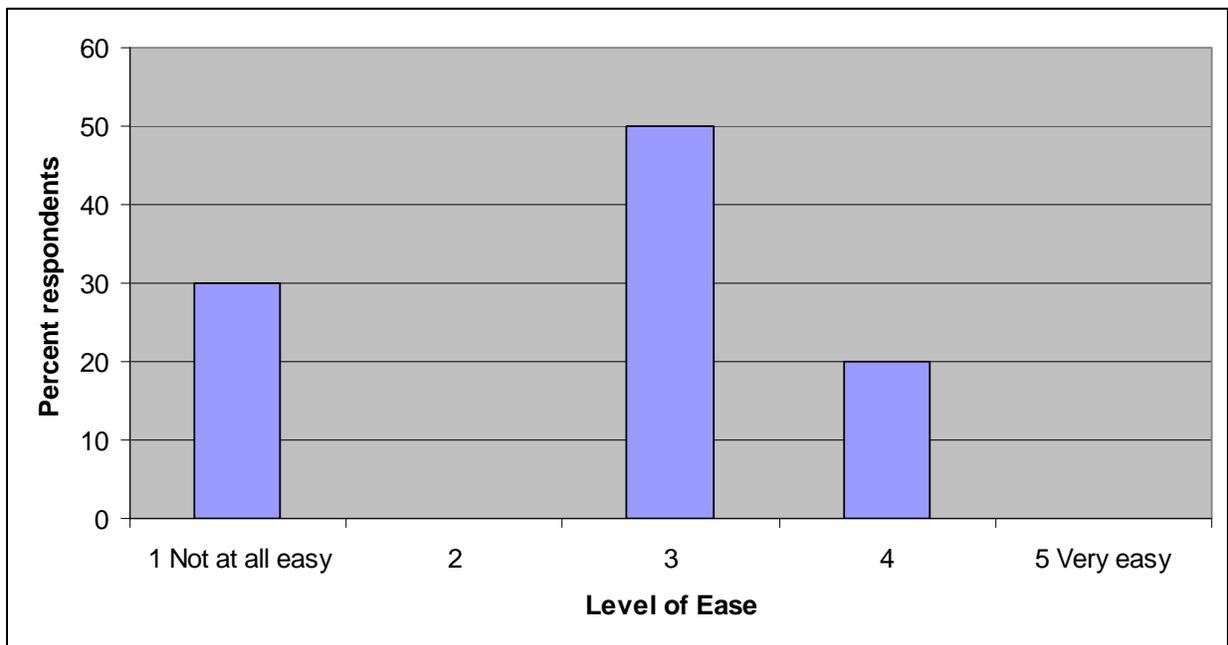


Figure 7. Perceived impact of existing government policies or standards on their company’s ability to modify management practices to adapt to a changing climate (BC Data).

Almost half of respondents (45%) indicated that a changing climate would have little effect on their company’s ability to meet current government regulations and policies whereas nine percent thought there would be some effect. Please refer to Appendix IV – Q26 for a list of all survey respondent comments on climate change impacts on their ability to meeting regulatory requirements.

Most respondents (82%) were neutral when asked if existing government policies or standards create barriers to climate change adaptation, with 9% disagreeing and 9% strongly agreeing. Please refer to Appendix IV – Q27 for a list of all survey respondent comments on climate change adaptation barriers.

‘Some do, some don’t. Some of the tech funds spur innovation. Some of the prescriptive regulations stifle innovation’

One of the three interviewees commented that they had experienced challenges with the regulatory process in the jurisdictions in which their company operates. They noted the lack of flexibility in the allowable window (timeframe) for drilling within the regulation controlled permitting process.

‘If climate change is causing events(e.g., floods, fire) that conflict with the timing to build access infrastructure or to conduct drilling operations, the regulations are not really set up for that.’

Another interviewee suggested the need for tools and policies that are consistent. The third interviewee responded that they had not encountered any regulatory issues.

Information needs and Sources

Survey participants were asked about the types of information that they would need to help them make operational or environmental decisions regarding adaptation to a changing climate. Monitoring data and predictive models, both at a local/regional level were the two types of information most often mentioned by both survey respondents and interviewees (See Appendix IV – Q28 for a list of all information needs identified by survey respondents). One interviewee suggested that these models and tools do exist, citing the Pacific Institute for Climate Solutions and the University of Northern British Columbia as two sources, but that the availability of the data and tools varies by region and is dependent on government. Other information needs included general adaptation strategies and techniques and associated costs, and risk assessments.

Respondents indicated that get information on the potential impacts of a changing climate within their field of expertise from:

- 1) Industry associations,
- 2) Colleagues/co-workers in your company, and

3) Independent contractors/consultants (Figure 8).

They are currently not getting their information from:

- 1) Non-government organization (NGO) technical specialists
- 2) Workshops/training sessions, or
- 3) Internet based information sources (Wiki's, discussion boards and forums, etc.).

There were some differences between respondents from different sized companies. Respondents employed by large companies indicated that their current primary source of information was scientific literature, followed by government researchers and/or technical specialists. Respondents working for medium-sized companies said that their first choices for climate change information were industry associations and independent private contractors or consultants (tied). Respondents working for small companies relied on colleagues/co-workers in their own company as well as industry associations (tied) as their two main information sources.

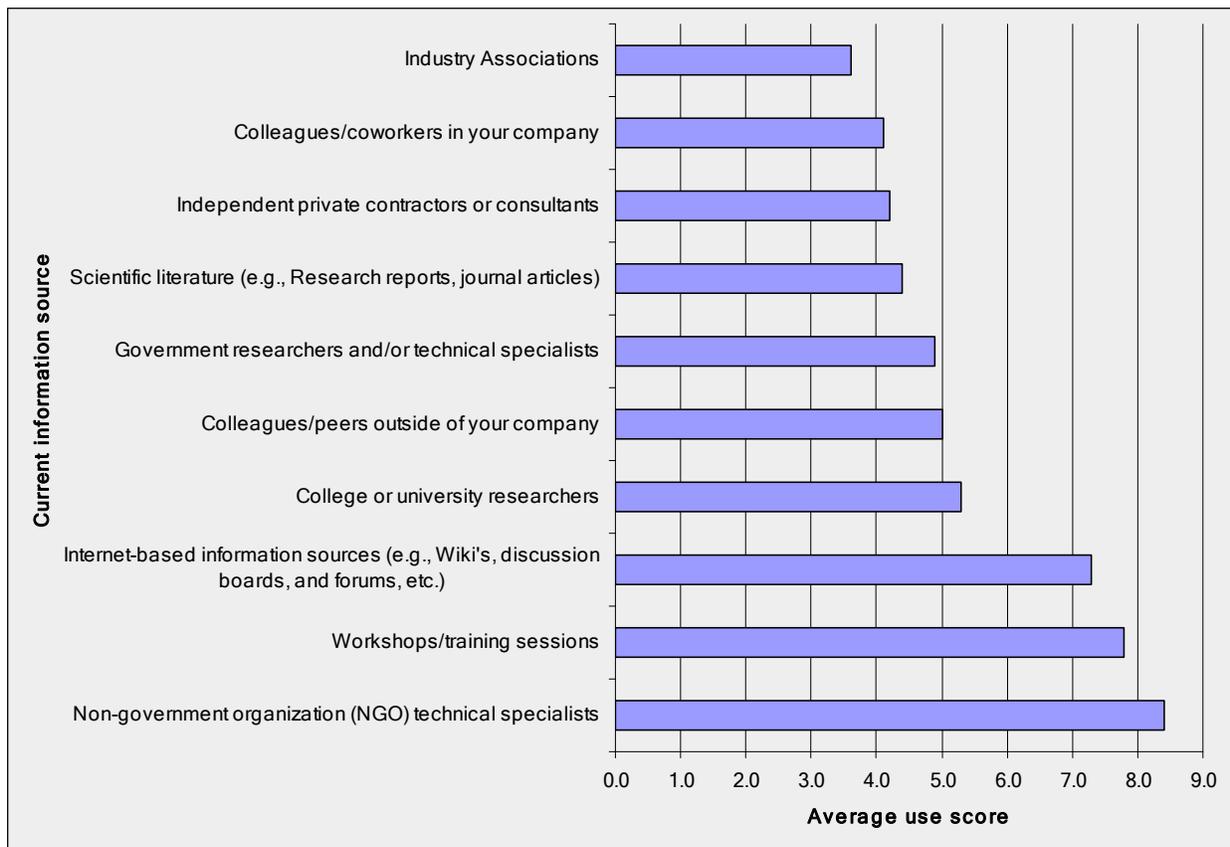


Figure 8. Sources of information on potential impacts of climate change within respondents' field of expertise. (Ranked from 1-10 where 1 is the most used and 10 the least used) (BC Data)

Respondents were asked to select their top three methods or techniques that would be the most effective for them to receive information on climate change and its predicted impacts. Industry associations were selected by 90% of respondents, followed by research reports (60%) and workshops at 50%. The two least effective methods were trade magazine articles and on-line discussion forums/blogs (0%).

Survey respondents were asked about what methods or techniques would be most effective in increasing the overall knowledge level within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure. Industry Association newsletters, distributed by email, were by far the most often selected method with 6 of 10 respondents ranking it as the most effective technique (Figure 9). The second most effective technique was workshops, followed by online presentations/workshops. The least effective method was trade magazine articles, followed by social media and on-line discussion forums/blogs.

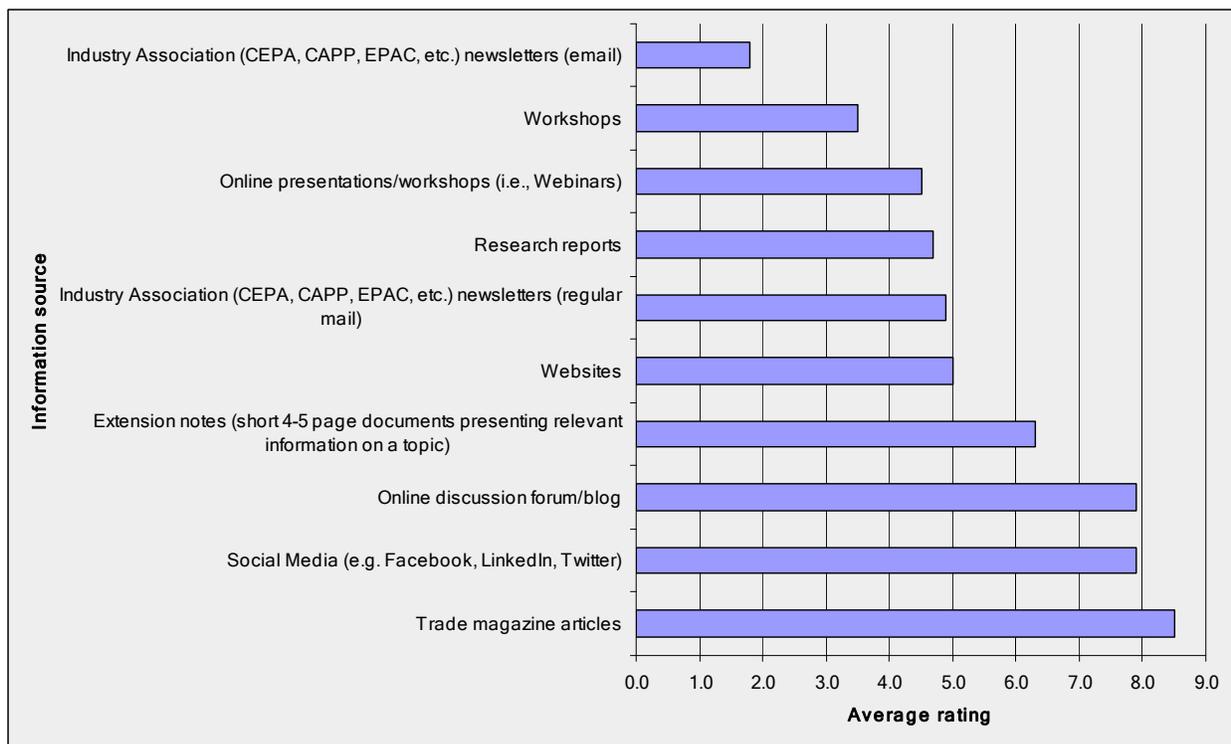


Figure 9. Effectiveness of various information sources for increasing the overall knowledge level within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure. (Ranked from 1-10 where 1 is the most effective and 10 the least effective) (BC Data)

Respondents working for a small company ranked websites as the most effective technique followed by industry association newsletters distributed by email, and workshops. The responses from respondents working for large or medium companies were the same as the overall results.

Climate change terminology

Interviewees were also asked whether using the terminology “climate-change impacts” which is often used by policy makers is a barrier to advancing the discussion on preparedness for extreme weather events. This question was not asked of survey respondents and was added as a result of project steering committee and project team discussions following the preliminary analysis of the on-line survey results.

One interviewee thought that the current terminology was very much a barrier due to the recent use of the terms within the political realm while another thought that using other terminology would be useful to avoid any preconceived notions. The latter suggested that using other terms like ‘extreme weather events’ and ‘climate variability’ would be better. The industry is accustomed to using a risk-based approach so presenting the discussion in the context of reducing risk and costs would be beneficial. More research on the impacts to the industry of a changing climate and the risk associated with those impacts will help motivate the industry to develop solutions.

DISCUSSION

The purpose of this study was to address research questions relating to climate change impacts and adaptation from the perspective of oil and gas sector leaders in western Canada. Through an on-line survey and interviews, we explored how seriously various energy sectors leaders are taking what is widely considered by many in the scientific community as an inevitability: a changing climate that will ultimately affect how the sector operates and how it will need to respond. The discussion presented here is based on the responses from those survey respondents and interviewees working for companies with operations in British Columbia.

Extreme weather and climate

Our analysis of survey and interview responses of energy sector leaders working for companies with operations in British Columbia showed that there is wide variability in how energy sector leaders view the existence of global climate change – only just over half of respondents agree that global climate change is occurring and the rest are neutral. There appears to be considerable uncertainty about the reality of climate change among a wide array of individuals in the sector. Opinions about the occurrence of climate change varied by company size. Respondents working for either a large (greater than 500 employees) or a medium (100-500 employees) company were more certain than respondents working for a small company (less than 100 employees) about the existence of climate change.

However, all of the sector leaders interviewed agreed that climate change is occurring and needs to be addressed which potentially indicates that the view that climate change is not occurring may not be as pervasive as suggested by the survey results.

There is also a wide range of opinion on whether a changing climate could affect company operations and/or infrastructure - less than half of respondents felt that there could be an impact and nearly a fifth of respondents disagreed. The majority of respondents representing medium or large companies agreed while only a quarter of those working for a small company agreed. Interviewees from the production sector indicated that any impacts of severe weather or natural disturbances are accounted for in the design standards and criteria for production facility infrastructure. However, design standards and criteria will need to continue to be frequently monitored and reviewed to ensure that they are adequate

should the frequency and severity of the extreme weather events and natural disturbances increase as expected due to the changing climate.

Only about half of respondents said that they had observed extreme weather events and this varied depending on the size of company that they worked for. Not all who have seen extreme weather attributed it to climate change. Over half of those respondents either questioned the linkage between the extreme event they observed and a changing climate or expressed doubt regarding the climate change.

Climate Change Risks and Impacts

Over half of respondents indicated they had seen their companies planning for impacts of a changing climate while a third said they had not. Just under a half of respondents indicated that they had observed their company implementing climate change preparedness activities. Large companies were found to be more active in planning and implementing climate change preparedness activities than medium or small companies. There was slightly more consideration given for climate change in both risk management and infrastructure design decisions than any other type of management decision. Just under a third of respondents said that climate change impacts are considered when making operational decisions and the just under 40% indicated they are considered when developing long-term strategies. Compared with respondents working for small companies, those working for either large or medium companies appeared to consider climate change in most types of management decisions.

Cost increases were the most frequently mentioned risks associated with climate change, followed by worker health and safety and environmental damage. Loss of social license to operate was of least concern across all respondents and company sizes.

Compressed time available to conduct field operations and develop and build infrastructure due to changes in the timing of winter freeze and/or spring melt was the most frequently mentioned concern related to climate change-induced changes to temperatures. Cost increases due to required upgrades to access roads and increased difficulty of summer operations due to melting permafrost were also noted. Most respondents felt that temperature changes would not impact infrastructure.

Impacts on access availability and the access structures themselves were the most frequently noted operational concern related to potential changes in precipitation patterns as a result of a changing climate. Ensuring adequate storm water drainage and construction of facilities above the flood plain were the two most cited infrastructure-related concerns. Respondents working for both oil and gas pipelines also expressed concerns that changes to run-off levels and patterns could lead to increased erosion of access roads as well as watercourse crossings resulting in increased pipeline exposure.

A quarter of survey respondents expected that changes to natural disturbances and other processes (e.g., flooding, forest fires, landslides) would occur in their company's operating area, while just under 60% were unsure. Decreased access to sites was given as one of the main operational impacts of these changes while the increased potential for physical damage and resulting increases in costs for mitigation and/or replacement was the main infrastructure impact noted by survey respondents.

All of the respondents were at least somewhat aware of how changes to the extent and diversity of plant and tree species would impact site reclamation and restoration efforts while slightly fewer were at least somewhat aware of how these changes would impact the presence of invasive plants.

Company Strategies

Less than half (40%) of survey respondents said that their company had a strategy to prepare for a changing climate and nearly a quarter of respondents didn't know if their company had a strategy or not. Of the respondents whose company didn't have a strategy or those that didn't know, all indicated that there were no plans to develop such a strategy within the next 6-12 months. Differences in the existence of strategies to prepare for climate change were evident between company sizes. No respondents working for a small company and a third of respondents working for a medium company indicated that their company had a strategy while three-quarters of survey respondents working for a large company said that their company had such a strategy.

Ensuring that the infrastructure design takes into account the potential impacts of climate change is the main preventative strategy currently being used by the companies of those people interviewed. Emergency preparedness plans are another strategy being used.

Government Regulations, Policies and Standards

Just under a third of respondents felt that current government regulations, policies and standards make it difficult for companies in the oil and gas sector to modify management practices to adapt to a changing climate, and one respondent thought that existing government policies or standards create barriers to climate change adaptation, while the majority were neutral. One respondent commented that the regulatory process is slow and lacks the flexibility to deal with issues and situations arising as a result of a changing climate.

Information Needs and Sources

Regionally-based monitoring data and predictive models to assist with operational or environmental decisions regarding adaptation to a changing climate were the top two information needs cited by both survey respondents and interviewees. Interviewees suggested that government should provide the necessary funding to help support the collection of the required climate change monitoring data as well as the development of the predictive models. Government should also take a lead role in storing and making accessible the collected climate change monitoring data.

Industry associations are the most trusted source of information although scientific literature is also used, especially by those working for large companies. Emailed newsletters from industry associations along with websites were perceived to be the best methods for receiving information on climate change and its predicted impacts on the sector.

KEY MESSAGES

- A wide variety of opinions and experiences exists across the sector about climate change and the potential impacts it will have on the oil and gas sector in British Columbia. The oil and gas sector leaders surveyed run the full gamut between those who don't accept climate change and those who agree that climate change is occurring but feel hindered by government policy in their efforts to adapt.
- Small companies (less than 100 employees) appear to be less certain about climate change and its predicted impacts and are less likely to consider climate change when making management

decisions or have a strategy in place to address those impacts compared to their counterparts working for medium (100-500 employees) or large (greater than 100 employees) companies.

- Climate change adaptation appears to be low on the priority list of junior and mid-sized oil and gas exploration and production company respondents given their other concerns regarding capital investment, operating costs, regulations and permitting, and skilled workforce shortages.
- Government policies are seen as a hindrance to climate change adaptation by just under a third of respondents.
- Lack of local/regional climate change monitoring data as well as models and other forecasting tools to help the sector make operational or environmental decisions regarding adaptation to a changing climate was identified as a key information gap. Government should provide the necessary funding to ensure the collection and storage of this data, and development of the models and forecasting tools.
- Industry associations are the most trusted information source and electronic newsletters from those associations are the most effective method for distributing information on climate change and its predicted impacts to oil and gas sector leaders.
- The low survey response rate indicates the need for a different approach to engage the oil and gas sector in the conversation on climate change and adaptation. Focus groups or workshops may be better methods of engagement as interview participants felt that they needed to consult with colleagues on many of the questions posed and indicated that addressing climate change adaptation within the oil and gas sector will require a diverse team of company experts.

RECOMMENDATIONS

- Given the variability of the opinions and experiences among respondents about climate change, a multi-faceted and comprehensive outreach approach utilizing a variety of extension methods and techniques (e.g., workshops, reports, newsletters) will be required to increase the sector's knowledge about the predicted impacts changes to the frequency of extreme weather events and natural disturbances, as a result of a changing climate, may have on the sector's operations and/or infrastructure. For example, preparing for climate change is good practice for risk management in general; even those in the energy sector who don't agree with climate change do agree with good risk management. And so, for example, an outreach program aimed at risk management in general could include climate change adaptation as one of the topics.
- Due to the complex nature of projecting climate change impacts on the sector, it is recommended that companies implement collaborative internal approaches that engage experts, technicians and specialists to develop adaptation strategies.
- Small companies could be more vulnerable to the impacts of a changing climate depending on the extent and diversity of their operations and may not have the necessary resources to focus on climate change adaptation. Companies operating in a small area or with a small number of facilities could be severely impacted should an extreme weather event or natural disturbance cause a shutdown/suspension of their operations at either a critical time or for an extended period. Outreach activities targeted specifically at small oil and gas companies are required to help them prepare for the potential impacts of a changing climate on their operations and/or infrastructure.
- An analysis of government policies that further examines which policies are considered hindrances and what policy changes could help provide incentives and remove barriers for energy sector companies to address climate change through modification of management practices would be important as a start in eliminating barriers to adaptation in the sector.
- Increased efforts to gather local/regional climate change monitoring data and develop local/regional models and forecasting tools is recommended. Or, if such tools do already exist,

then increased efforts are required to increase the awareness of these tools and to increase the sector's knowledge on how to use them in decision making.

- Many survey respondents and interviewees stated that extreme weather events would have minimal impact on the sector's infrastructure as the current engineering design standards and criteria already take these events into account. However, given that the frequency and severity of extreme weather events as well as natural disturbance processes are expected to increase over the next few decades, it is imperative that design standards and criteria continue to be monitored to ensure that they remain adequate to ensure the continued safe operation of the sector's infrastructure. This may also require continued research on the risks and potential impacts of a changing climate on the sector's operations and infrastructure as well as on the associated costs of adaptation.
- Oil and gas sector industry associations should take a lead role in fostering the dialogue on climate change within their sector and in identifying opportunities for coordinated climate change adaptation strategies given their role as a trusted and representative body that addresses relevant issues across their membership.
- Future studies designed to gather information about the sector's preparedness for climate change would be best accomplished through engagement such as focus groups or workshops rather than surveys of individuals. It is also recommended that future discussions on the potential impacts of a changing climate on the sector should use more neutral terms such as 'extreme weather events' and 'climate variability' instead of 'climate change' and should be framed in a risk and cost reduction context.

REFERENCES

- Insurance Bureau of Canada. 2012. Telling the weather story. Prepared by Dr. Gordon McBean. The Institute for Catastrophic Loss Reduction (ICLR), Toronto, Ontario. 67 pp.
http://www.abc.ca/en/natural_disasters/documents/mcbean_report.pdf
- Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the fourth assessment report of the intergovernmental panel on climate change. M.K. Parry, O.F. Canziani, J.P. Palutikof, P.J. can der Linden, and C.E. Hanson (Eds.), Cambridge University Press, Cambridge, UK, (pp. 976).
- Intergovernmental Panel on Climate Change (IPCC). 2011. Summary for Policymakers. In: Field, C. B., Barros, V., Stocker, T.F., Qin, D., Dokken, D., Ebi, K.L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S., Tignor, M. and P. M. Midgley (editors). Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
- Sauchyn, D. and Kulshreshtha, S. 2008. Prairies. In Lemmon, D.S., F.J. Warren, J. Lacroix, and E. Bush (eds.). From impacts to adaptation: Canada in a changing climate 2007. Government of Canada, Ottawa, On, (p 275-328).
- Walker, I.J., and R. Sydneysmith. 2008. British Columbia. In Lemmon, D.S., F.J. Warren, J. Lacroix, and E. Bush (eds.). From impacts to adaptation: Canada in a changing climate 2007. Government of Canada, Ottawa, On, (p. 329-386).

APPENDIX I

Project Steering Committee members

Name	Affiliation
Amanda Affonso Kai Horsfield Evan Wilson	Canadian Energy Pipeline Association (CEPA)
Jenna Dunlop Mikaela McQuade	Canadian Association of Petroleum Producers (CAPP)
Kim Graybiel	Saskatchewan Ministry of Environment – Climate Change
Howard Madill	BC Oil and Gas Commission (OGC)
Jennifer Pouliotte	BC Ministry of Environment Climate Change Secretariat
Nicole Spears Yvette Thompson	Alberta Department of Environment and Sustainable Resource Development – Policy Division

APPENDIX II

Survey Cover Letter and Questions

Introduction

Dear Energy Sector Leaders and Professionals,

We are inviting you to participate in an important and timely survey of the Oil and Gas sector leaders and professionals in Western Canada (Saskatchewan, Alberta and British Columbia) to learn about your perspectives and experiences with impacts and adaptation strategies relating to extreme weather events and other weather-related phenomena that affect your work.

This is the first stage of a project funded by the Science and Communities Environmental Knowledge (SCEK) fund, the results of which will be used to develop programs and other initiatives to assist the oil and gas sector in Canada.

The survey is voluntary, but your participation will greatly aid the sector in working together to develop and apply strategies that will help to mitigate potential weather-related phenomena that could otherwise increase costs and risk mitigation investments.

The survey should take about 20-30 minutes to complete. No individual respondent can be identified unless you choose to include your name.

This project is a collaborative effort between industry associations, government, and others (see below for full list) and is aimed at contributing to economic certainty, environmental protection, and 'social license' for the energy sector in Western Canada. This project is lead by Resources North Association, a multi sector not-for-profit organization based in Prince George, British Columbia (www.resourcesnorth.org) in collaboration with Trout Creek Collaborative Solutions (www.tccsolutions.ca).

Results of the project will be available by December, 2014, by contacting a project team member (see emails below).

The survey will close at 7 p.m. on March 21st, 2014.

Please do not hesitate to contact Al Wiensczyk (alan@tccsolutions.ca) or Melanie Karjala (melanie@resourcesnorth.org) for more information.
Thank you for your participation.

For statistical analysis purposes we respectfully request that you please **do not forward** this survey to others. If there is someone else within your organization who you think should be invited to participate in this survey either in addition to yourself or instead please send an email to either Al or Melanie and we will ensure that they receive a link to the survey.

The following partners are also involved in this project:

- Canadian Association of Petroleum Producers (CAPP)
- Canadian Energy Pipeline Association (CEPA)
- Saskatchewan Ministry of Environment, Climate Change Branch
- Alberta Environment and Sustainable Resource Development – Air Policy and Climate Change Branch
- BC Ministry of Environment Climate Change Secretariat
- BC Oil and Gas Commission (BC OGC), and
- Fraser Basin Council (FBC)

Business Information

1. Which of the following best describes your involvement in the oil and gas sector?
 - a. Oil and gas sector company employee
 - b. Consultant to the oil and gas sector
 - c. Operational contractor to the oil and gas sector
 - d. Other (please specify)

2. Which of the following best describes your company's or your clients' primary business area?
 - a. Oil Transmission pipeline
 - b. Gas Transmission pipeline
 - c. Conventional oil production
 - d. Unconventional oil production
 - e. Conventional gas production
 - f. Unconventional gas production
 - g. Oil and gas exploration
 - h. Other (please specify)

3. How many people does your company employ?
 - a. Less than 100 employees
 - b. 100 - 500 employees
 - c. More than 500 employees

4. In which province(s) does your company or your client's company operate? (select all that apply)
 - a. British Columbia
 - b. Alberta
 - c. Saskatchewan
 - d. Other (please specify)

Extreme weather events

5. Have you observed any weather events in your company's or your clients' geographic operating area in the past two years that you would consider as "extreme events"?
 - a. Yes
 - b. No

If yes, please describe

(Respondents answering "No" to question 5 were not required to answer questions 6-10 and were automatically directed to question 11)

Weather-related impacts

6. In which of the following ways did those event(s) affect your company's or your clients' business activities?

	Slow down	Suspend temporarily	Shut down permanently	No effect
Administrative activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Planning activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exploration activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Development activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Environmental activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decommissioning activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Product transportation to market	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Comments:

7. If the event(s) slowed down or suspended any activities, for how long? (please select longest period if there was more than one)
- a. Less than a day
 - b. 1-7 days
 - c. More than a week but less than a month
 - d. More than a month
 - e. Not sure

Comment: Please indicate which activity from question 6 was slowed down or suspended.

Extreme weather and climate

8. Do you think that the extreme weather event(s) you observed is/are a result of a changing climate?
- a. Yes
 - b. No

Please explain:

9. Do you anticipate that there may be more frequent and/or severe weather events in the future than would have occurred without climate change?
- a. Yes
 - b. No
 - c. Not sure

Please explain:

10. How far into the future do you think will be the onset of more frequent and/or severe weather events?
- a. 0-5 years
 - b. 6-10 years
 - c. 11-20 years
 - d. Greater than 20 years
 - e. Not sure

Changing Climate

11. Please indicate your level of agreement with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a. I think that climate change is occurring.	<input type="radio"/>				
b. I think that a changing climate could affect my company's or my clients' operations and/or infrastructure in the future.	<input type="radio"/>				
c. I have observed my company or my clients participating in planning activities to prepare for potential impacts of a changing climate on operations and/or infrastructure.	<input type="radio"/>				
d. I have observed my company or my clients implementing changes to operations and/or infrastructure to prepare for a changing climate.	<input type="radio"/>				

12. Does your company or client(s) currently make management decisions in any of the following areas, in response to current or future predicted changes to the frequency and severity of extreme weather events?

	Yes	No	Not sure
When making operational decisions?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When doing long-term forecasting/planning?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When doing risk management planning?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When designing infrastructure?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When developing long term strategic plans	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (Please specify)			

Risk Factors

13. What do you perceive to be some risk factors relating to a change in the frequency and severity of extreme weather events?

Operationally? (Please select all that apply)

- a. Health and safety-related incident increases
- b. Design cost increases
- c. Operational cost increases
- d. Environmental damage
- e. Loss of social license to operate
- f. Other (please specify)

14. To Infrastructure? (Please select all that apply)

- a. Health and safety-related incident increases
- b. Design cost increases
- c. Operational cost increases
- d. Environmental damage
- e. Loss of social license to operate
- f. Other (please specify)

Temperature

15. Scientists anticipate that a changing climate could result in changes to temperatures (highs and lows) which may, in turn, affect permafrost levels, and timing of winter freeze up and/or spring melt.

Please describe specifically how you think such changes in temperature would impact your company's or your clients' operations in the future.

16. Please describe specifically how you think such changes in temperature would impact your company's or your clients' infrastructure in the future.

Precipitation

17. Scientists also anticipate that a changing climate could result in changes in precipitation patterns (timing, amounts and types (rain vs snow)) in some areas which could result in raised or lowered water tables and changes to runoff patterns and timing.

Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' operations in the future.

18. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' infrastructure in the future.

Ecological processes

19. Scientists expect that changes to temperature and precipitation patterns as a result of a changing climate could affect natural disturbances and other processes that are a regular part of our ecosystems. (e.g., frequency and severity of wildfires, frequency of landslides, increased flooding, and increased forest insects and disease damage.)

Do you expect that changes to these types of processes will occur in the future in your company's or your clients' operating areas?

- a) Yes
- b) No
- c) Don't know

(Respondents answering "No" or "Don't know" to question 19 were not required to answer questions 20-21 and were automatically directed to question 22)

Natural process impacts

20. Please describe specifically how you think that these natural process changes would impact your company's or your clients' operations in the future.

21. Please describe specifically how you think that these natural process changes would impact your company's or your clients' infrastructure in the future.

Plant species diversity

22. Scientists also anticipate that changes to temperature and precipitation patterns and ecological processes could also impact the extent and diversity of plant and tree species occurring in our ecosystems.

Please rate your personal level of awareness regarding the impact these changes may have on;

	Very aware	Aware	Somewhat aware	Not at all aware
a. Site reclamation and restoration efforts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Presence of invasive plants.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Company strategies

23. Does your company or your client currently have a strategy or strategies (e.g., operational, insurance, engineering design, planning) to prepare for a changing climate?

- a. Yes
- b. No
- c. Don't know

(Respondents answering "Yes" to question 23 were not required to answer questions 24 and were automatically directed to question 25)

24. Are there any plans to develop such strategies in the near future (6-12 months)?

- a. Yes
- b. No
- c. Don't know

25. How easy to existing government policies or standards make it for your company or your client to modify management practices to adapt to a changing climate?

1	2	3	4	5
Not at all easy				Very easy
<input type="radio"/>				

26. What level of effect would a changing climate have on your company's or your clients' ability to meet current government regulations and policies?

1	2	3	4	5
Significant effect				No effect
<input type="radio"/>				

27. Please rate your level of agreement with the following statement.

Existing government policies or standards create barriers to climate change adaptation.

- a. Strongly agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly disagree

Information needs and sources

28. If you had to make an operational or environmental decision regarding adaptation to a changing climate what types of information would you need to help inform that decision (e.g., climate change projections, monitoring data, predictive models)?

29. Where do you currently go to get information on the potential impacts of a changing climate within your field of expertise? (Please rank from 1-10 where 1 is the most likely to be used and 10 is the least likely.

- Colleagues/co-workers within your company
- Colleagues/peers outside of your company
- Industry Associations
- Independent private contractors or consultants
- College or university researchers
- Government researchers and/or technical specialists
- Non-government organization (NGO) technical specialists
- Scientific literature (e.g., Research reports, journal articles)
- Internet-based information sources (e.g., Wiki's, discussion boards, and forums, etc.)
- Workshops/training sessions.

30. Please describe any other sources of information on the potential impacts of a changing climate that you currently use, if any.

31. What methods/techniques would be the most effective for you to get information on climate change and its predicted impacts? (Please select your top 3)

- Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (email)
- Webinars
- Workshops
- Website
- Research reports
- Extension notes (short 4-5 page documents presenting relevant information on a topic)
- Online discussion forum/blog
- Trade magazine articles
- Other (please specify)

32. What methods/techniques do you think would be most effective in increasing the overall level of knowledge within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure? (Please rank from 1-10 where 1 is the most effective and 10 the least effective)

- Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (email)
- Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (regular mail)
- Online presentations/workshops (i.e., webinars)
- Workshops
- Websites
- Social media (e.g., Facebook, LinkedIn, Twitter)
- Online discussion forum/blog
- Research reports
- Extension notes (short 4-5 page documents presenting relevant information on a topic)
- Trade magazine articles

Demographic Information

33. In which one of the following roles do you spend most of your time for your company or your client's company?
- Management
 - Planning
 - Operations
 - Environment (general)
 - Environment (Climate change specific issues)
 - Other (Please specify)
34. What is your title/position within your company?
35. How many years experience do you have in your current field?
- Less than 5
 - 5-10
 - 11-15
 - 16-20
 - More than 20
36. Which category below includes your age?
- 20 or younger
 - 21-29
 - 30-39
 - 40-49
 - 50-59
 - 60 or older
37. What is the highest level of education you have completed?
- Less than high school degree
 - High school degree or equivalent
 - College diploma or trade school certificate
 - University undergraduate degree
 - University post-graduate degree
 - Other (Please specify)

Appendix III

Interview Questions

- 1) What business area does your company fall into?
Prompt: pipeline transmission, gas production, oil production, exploration, consulting/contracting
- 2) What is your primary province of operations (BC, Alberta, Sask.)?
- 3) Did you complete our survey that was distributed in March 2014?
- 4) **Producers Only:** In our survey, respondents who were producers said they did not think that their operations or infrastructure would be affected by a change in severe weather events. What do you think might be the reason for this?
- 5) Does your company make a concerted effort to prepare for climate variability or extreme weather events?
Prompts: such as flooding, wildfire, invasive plant migration (reclamation)
- 6) In our survey, many respondents listed operational cost and design cost increases as the top risk factors related to climate variability and extreme weather events and the least concern was social license. Do you agree with this? What other risks are there? In your opinion, what could be the magnitude of these cost impacts? Do you think that it is more cost effective to be proactive than to have reactive strategies in place (e.g., insurance)?
Prompt: For costs is it in the \$10K, \$100K, \$1M range?
Prompt: Many cited the Calgary flooding in 2013 as an operational impact to corporate offices.
- 7) Are there activities that your company is currently implementing that could help with preparations for climate variability? Are they preventative or reactive strategies? Can you provide examples?
Prompts: Design modifications (e.g., sprinklers systems for wild fires, road design), monitoring activities (e.g., pipeline, access infrastructure at water crossings), reductions in water use (to deal with drought conditions).
- 8) Our survey revealed that there can be provincial policy and regulatory requirements and also barriers related to implementing adaptation efforts such as inflexibility, and a slow turn around for regulatory approval. Has this been your experience in (BC, Alberta, Saskatchewan)? What types of policy and/or regulatory barriers have you experienced? What changes do you think would allow your business to be more adaptive?

- 9) In our survey, respondents listed things like better long and short term local forecasting and modeling as things that would help them better prepared for extreme weather events. Do you think this would help the industry be more resilient to climate variability?

- 10) Many respondents did not agree that there is a need to prepare for climate variability outside of the known extremes. What do you think can be done to help the industry be more resilient and proactive? What would a resilient industry look like?

- 11) The terminology that is often used by policy-makers is “climate change impacts” - do you feel this is a barrier to advancing the discussion on preparedness for extreme weather events?

Appendix IV

Survey comments received for all questions

Please refer to the survey questions when reviewing the comments received. For some questions, the provision of comments was optional. In addition, some survey respondents chose not to answer questions for which comments were required. The tables below include all comments received from all survey respondents working for a company with operations in British Columbia.

- Q5. Have you observed any weather events in your company's or your clients' geographic operating area in the past two years that you would consider as "extreme events?"**

Theme 1 – Flooding
Flood in Calgary
Calgary Floods
Calgary floods
Calgary flood
Significant flooding in SE Saskatchewan in 2011 (beyond two years ago) and significant flooding in southern Alberta in 2013. Were these events considered extreme? Not sure...
Floods, Fire

- Q8. Do you think that the extreme weather event(s) you observed is/are a result of a changing climate?**

Theme 1 – Difficult to link climate and weather
Connection between climate and weather is difficult to ascertain.
Could be a part of normal fluctuations in weather cycles, could be a pattern of extreme weather due to changing climate.
Not sure anyone can say with any reasonable certainty.
It is hard to put any one weather event in the context of climate change.
Theme 2 – Climate change doubter
It was the 50 year flood which will happen (again).

- Q9. Do you anticipate that there may be more frequent and/or severe weather events in the future than would have occurred without climate change?**

I am not qualified to answer that kind of question. From what I have heard, this is a possibility.
The scientific proof has yet to validate the climate theorists. 2013 was predicted to be open water season in the Arctic when it fact it was the heaviest ice coverage in recent memory. 2013 was also supposed to be a heavy hurricane season, which did not materialize. However, the last 5 week cold snap in Calgary has been unusual. Are these normal 'aberrations' or is it evidence of climate change? Who knows for sure?
I don't know the science behind changing climate so I can't say if it is part of normal climate

fluctuations or not.
Open ended - what time frame is "future"? and How can we attribute those events to changing climate?

Q15. Please describe specifically how you think such changes in temperature would impact your company's or your clients' operations in the future.

Theme 1 – Operational impacts
More emergency response procedures and training will be required. Maybe more technology implemented to isolate the system in the event of extreme weather.
We would have to change the timing of drilling, completion and pipeline projects around the freeze up and spring melt. The areas in which my company operators, have year around access. Spring melt it typically the only time we have reduced access. An early spring melt would cut our winter work short but may also allow us to get back to work sooner in the summer.
Shorter construction season would put stress on completing construction more quickly – potential for safety or environmental incidents, operating interruptions due to flooded sites and access roads, change in chemical use in pipelines due to changes in ground temperature.
We would have to adapt to changing breakup window or build all weather access
We have Northern operations - this could impact work schedules.
Seasons could be prolonged for Arctic shipping which would be a positive. Melting permafrost would make summer operations more difficult. There are pluses and minuses. Is the balance sheet in the red or black. Again, no one knows for certain.
Winter drilling is dependant on the timing of winter freeze up and/or spring melt. It currently is very variable and is expected to remain that way.
The change in temperatures would affect us on the decision making of where we sell the gas to make the most of it.
Theme 2: Climate change doubters
If we observed changes in patterns for break up we would have to adjust. But a couple of years does not set a pattern.
Not at all Scientists anticipate, doesn't mean it will happen. Climate change is a continuum, is has happened continually throughout history with or without the help of humans

Q16. Please describe specifically how you think such changes in temperature would impact your company's or your clients' infrastructure in the future.

Theme 1 – Infrastructure impacts
Changes to topography and runoff, effective slop stability and any shifting in the ground can rupture or fracture a pipeline.
Potential restrict access into infrastructure.
Flooding of infrastructure.
Possible upgrade to roads
This could impact machinery, roads.
It would make Arctic operations more manageable but permafrost activities more difficult. Is our company better off or worse off on balance? Who knows.
Theme 2 – No expected impact

No different than what is currently occurring
Theme 3 – Climate change doubters
Difficult to put significant capital into overdressing for temporary or occasional events
Not at all. See above "Scientists anticipate, doesn't mean it will happen. Climate change is a continuum, is has happened continually throughout history with or without the help of humans" (copied from question 15)

Q17. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' operations in the future.

Theme 1 – Operational impacts
More maintenance on infrastructure.
Higher snow fall could impact access to sites and increase snow removal costs. Larger snow pack could mean a longer spring melt which could delay projects.
Access to wells, sites could be cut off temporarily or permanently.
Could cause seasonal disruption similar to breakup, sometimes happens now and in the past
Lack of water for industrial processes.
We need to more prudent when we think about the operational schedule.
Theme 2 – No expected impacts
Not at all
It might effect oil sands operations, if they used fresh water but increasingly most aren't, so probably no impact.
Right now, we deal with various levels of rain/snow. going forward, we expect variability

Q18. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' infrastructure in the future.

Theme 1 – Infrastructure Impacts
Access to wells, sites could be cut off temporarily or permanently
Changes to topography and runoff, effective slop stability and any shifting in the ground can rupture or fracture a pipeline.
Floods can often ruin roads and bridges.
It would affect the operational schedule of our infrastructures as well.
Could require infrastructure upgrades
Theme 2 – No expected Impact
Not at all
Same as what happens now
It might effect oil sands operations, if they used fresh water but increasingly most aren't, so probably no impact.

Q20. Please describe specifically how you think that these natural process changes would impact your company's or your clients' operations in the future.

Access to sites could decrease

Q21. Please describe specifically how you think that these natural process changes would impact your company's or your clients' infrastructure in the future.

Damage due to fires and flooding.

Q23. Does your company or your client currently have a strategy or strategies (e.g., operational, insurance, engineering design, planning) to prepare for a changing climate?

Theme 1 – Strategies
Not major, but we plan for downtime, which could be weather related
Theme 2 – Climate change doubters
Climate change has happened throughout history, including before man. The majority of the influence is not man caused nor can it be man controlled.

Q25. How easy to existing government policies or standards make it for your company or your client to modify management practices to adapt to a changing climate?

No comment

Q26. What level of effect would a changing climate have on your company's or your clients' ability to meet current government regulations and policies?

Current regulations must be met and are enforceable under the law. A changing climate has no impact on the requirement to meet current regulations.

Q27. Existing government policies or standards create barriers to climate change adaptation.

Some do, some don't. Some of the tech funds spur innovation. Some of the prescriptive regulations stifle innovation.

Q28. If you had to make an operational or environmental decision regarding adaptation to a changing climate what types of information would you need to help inform that decision (e.g., climate change projections, monitoring data, predictive models)?

Theme 1 – Needed information
Climate change projections specific to local areas were operations occur. Monitoring data for local areas. Not general climate change data.
Climate Change projections, predictive models, general adaptation strategies and potential costs
Monitoring data and short term predictors
Historical trends and predictive modelling at a local/regional level
I would start by doing a risk assessment of the specific operation to determine where the vulnerabilities reside and then assess my data needs after that.
Monitoring data compared to historical trends
Theme 2 – Don't know
Not sure
Theme 3 – Climate change doubters
An honest presentation of the facts instead of the presentation of concepts by parties supporting a

cause.

Most climate models are inaccurate from what I have observed. there's not enough unbiased view on this topic.