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Experiences with natural hazards risk assessment in Indigenous coastal communities in British Columbia

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EXPERIENCES WITH NATURAL HAZARDS RISK ASSESSMENT IN INDIGENOUS COASTAL COMMUNITIES IN BRITISH COLUMBIA

Workshop Report

Picture: Sunrise in Ucluelet Harbor (© M. Heideman)

EXECUTIVE SUMMARY

Three Indigenous coastal communities, the Gitga'at First Nation, Tsleil-Waututh Nation, and the Ucluelet First Nation, shared their reflections on community planning and risk assessment in response to the natural hazards each community is facing, at a session during the 2018 Canadian Risks and Hazard Network symposium in Vancouver.

The main goal of the session was to identify gaps and opportunities between science and practice, to help navigate a path forward for different levels of government to work together to assess and plan for natural hazards, thereby creating sustainable and resilient communities.

The reflections of the Gitga'at, Tsleil-Waututh and Ucluelet First Nations showed that each community is at a different stage with regard to hazard/risk assessment and emergency management, and each community has its own concerns and priorities, which were discussed in break-out groups. The main themes from the discussions, which can be viewed as recommendations for future collaboration and projects, are summarized below:

- Community engagement:
  - Start projects from the **bottom up**. This will help build capacity and create an engaged and informed community.
  - Find **community champions**.
  - Form **focus or advisory groups** that are representative of the community.
- Building relationships with Indigenous communities:
  - Allow enough **time**.
  - **Build lasting relationships**.
  - **Coordinate research** requests. Be aware of other research projects in communities.
  - Find a **community liaison** who can help build relationships in the community.
  - Be aware and respectful of **cultural and seasonal activities**.
  - Be aware of **community resources** (human and financial).
- Research development:
  - **Co-develop research goals and objectives** to ensure **relevance** of a project for the community and **reciprocal benefits**.
- Technical information, modeling, and reporting:
  - Create a **community document** that presents scientific and technical information in way that is relevant and useful for the community.
  - **Translate** reports from English to the local language.
  - Plan **community visits** to explain technical information.
  - Use **narratives and scenarios** that adopt a community perspective.
  - Use **geospatial visuals**, like posters or maps, to present information.
- Implementation of adaptation plans:
  - Make sure that the **relevance and implementation** of adaptation plans **resonate** with what people are seeing today.
  - **Visualize** future adaptation plans.
- Funding agencies
  - There is a general **lack of funding** for the implementation of adaptation plans.
- Building on successes
  - **Learn from the experiences and successes of other communities** that are working on risk assessment and adaptation.

Top comments from the session at CRHNet in Vancouver in October 2018, concern the need for **early community engagement** and **building long-term and lasting relationships** in the development of research projects and risk assessment models. It is important that scientists and Indigenous communities **co-develop** (research) projects and models from the **bottom-up**, which will assure that local knowledge and expertise are included, and that the outcomes are useful for the community.

ACKNOWLEDGEMENTS

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DEFINITIONS

This report frequently uses the words '*hazard*' and '*risk*'. To guide the reader, the following definitions apply (UNISDR, 2007):

Hazard: "A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation". Examples of natural hazards are: earthquakes, floods, sea level rise, tsunami, etc.

(Disaster) Risk: "The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability, and capacity."

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1. INTRODUCTION

This report provides an illustration of three Indigenous coastal communities' reflections on community planning and risk assessment in response to the natural hazards each community is facing. The Gitga'at First Nation, Tsleil-Waututh Nation, and the Ucluelet First Nation (Figure 1) shared their reflections at a session during the 2018 Canadian Risks and Hazard Network symposium in Vancouver. The main outcomes of group discussions during this session are presented in this paper. The overarching goal of the paper is to identify gaps and opportunities between science and practice, which can help navigate a path forward for different levels of government to work together to assess and plan for natural hazards, thereby creating sustainable and resilient communities. The remainder of this introductory chapter sets the stage for the session at CRHNet.

Figure 1. Map of British Columbia with the locations of the Gitga'at First Nation (GFN), Tsleil-Waututh Nation (TWN), and Ucluelet First Nation (UFN).

Canada's vast landmass is subject to many natural hazard processes, and while the country is sparsely populated, many communities are at risk from one or more natural hazards. Indigenous and non-Indigenous communities along Canada's west coast are at risk of experiencing a damaging earthquake, and the effects from climate change are felt in coastal communities on the entire Canadian coastline. Indigenous oral histories describe the impacts of several major events before the arrival of the colonists, such as the AD 1700 subduction zone earthquake and subsequent tsunami, as well as others, along the BC coast (Hutchinson & McMillan, 1997; Hakai Magazine, 2015). Oral history from the Nisga'a First Nation in British Columbia details one of the last known volcanic eruptions in Canada; the eruption of the Tseax volcanic cone approximately 300 years ago, which led to the destruction of two Nisga'a villages and the demise of 2,000 people (Nisga'a Lisims Government, n.d.).

Several major natural disasters have occurred in Canada's recent history, notable examples along the British Columbia coast include the 1946 earthquake on Vancouver Island, and the 1964 Alaska earthquake and

resultant Port Alberni tsunami (Public Safety Canada, 2013). The last decades of the twentieth century and the twenty-first century have also seen major weather-related events in Canada, some or all of which can be attributed to changes in global climate, like the Fort McMurray wildfire of 2016 (Public Safety Canada, 2013).

Global changes in the Earth's atmosphere, including the general warming of the Earth's climate, have been observed since the mid-nineteenth century (IPCC, 2013), and have resulted in the rise of global sea level and major changes in the occurrence and intensity of weather-related events. Sea-level rise, storm-surge flooding, changing precipitation patterns, and marine ecosystem changes are the main impacts of climate change that will be affecting British Columbia's coastal communities (Vadeboncoeur, 2016).

Communities experience various challenges when it comes to natural hazards, climate change and sea level rise. Some of these challenges are a direct, or indirect, result of Canadian history and colonial policies, which resulted in the relocation of Indigenous peoples to (small) reserves, and submitted communities to non-Indigenous worldviews, values and customs. As a result, some communities struggle with social and development pressures. Various other challenges communities face, are related to the physical location of each community, such as remoteness, landform, or geology.

Globally, current disaster risk management and risk reduction research and initiatives focus strongly on creating and increasing resilient communities (UNISDR, 2015a), but the focus is mostly on cities, as that is where the majority of the globe's population lives (e.g. '100 Resilient Cities' (Rockefeller Foundation, n.d.) , 'Making Cities Resilient' campaign (UNISDR, 2015b)). However, small communities are similarly exposed to natural hazards and climate change impacts. In Canada, many of these small communities are Indigenous communities that often lie in the more remote or isolated parts of the country, and that differ from urban areas with respect to: access to essential services, such as banks, hospitals, emergency and government services etc.; dependence on (single) resource-based economies, like fishing or forestry; and, different cultural and social norms and relationships.

The 'Sendai Framework for Disaster Risk Reduction' (UNISDR, 2015a) provides a rationale and voluntary commitments for (global) governments and communities to perform risk assessments, and includes four priorities:

1. Understanding disaster risk;
2. Strengthening disaster risk governance;
3. Investing in disaster risk reduction for resilience; and,
4. Enhancing disaster preparedness.

Risk assessments can help communities understand who and what are exposed to disaster risk and what the impacts may be. This allows communities to prepare, respond, mitigate and/or adapt to a possible hazard threat. The information from a risk assessment allows governments to be better prepared for possible disasters, and spend their resources where most needed. Risk assessments furthermore help communities with disaster preparedness, and help inform response and recovery plans, as well as (re)construction efforts.

Given that risk assessments can help build a foundation for sustainable and resilient communities in relation to natural hazards and climate change, what is the experience of Indigenous communities in British Columbia in assessing their risk in relation to natural hazards? Are current risk assessment tools and processes suited to address issues at play in Indigenous communities?

2. RISK ASSESSMENT IN INDIGENOUS COMMUNITIES

On October 31, 2018 representatives from three coastal communities in British Columbia shared their experience with risk assessment in a session on 'Natural Hazard Risk Assessment in Indigenous Coastal Communities in British Columbia' that was held during the Canadian Risk and Hazards Network (CRHNet) in Vancouver.

In this session, representatives from the Ucluelet First Nation, Tsleil-Waututh Nation and Gitga'at Nation each detailed their communities' experiences with natural hazard risk assessment, community assets and values, and opportunities for risk reduction. After their reflections, the session participants self-organized into four break-out groups to discuss and gain input on some of the issues Indigenous groups are dealing with in their communities. The intent of the session was two-fold:

1. To hear from Indigenous communities that are dealing with coastal hazards, and the impacts of those hazards and the associated risks on their communities. The session highlighted the work communities have done up to date, and their successes and challenges. The experiences from the three communities provide other Indigenous communities with helpful information and insight into the process of risk assessment, and could inform (future) community planning and disaster risk reduction. In addition, the outcomes of the session may help other non-Indigenous organizations to identify gaps and opportunities in relation to risk assessment processes and programs available to Indigenous communities.
2. Through break-out groups the session invited the audience to provide input to the main issues each of the communities are dealing with. The representatives were hoping to learn from others' experiences, thoughts and ideas to build on current hazard and risk assessment research and practices in their communities.

2.1 INTRODUCTION TO COMMUNITIES

UCLUELET FIRST NATION – *PEOPLE OF THE SAFE HARBOUR*

Representative – Celena Cook: *Coordinator Emergency Management, First Responder, Deputy Director EOC, UFN administrative assistant*.

The Ucluelet *(Yuułuʔiłʔatḥ)* First Nation (UFN) lies on the west coast of Vancouver Island, and about 230 members of the UFN live on the reserve near Ucluelet. There is only one way in and out of the community, and that road is likely to wash out in the event of a major earthquake and/or tsunami.

At the time of the CRHNet symposium (October 2018), the community was focussing on updating their emergency plans. One of the main issues the community is dealing with is motivating people to participate in emergency management activities. In addition, the community is hoping to train people in emergency management and preparedness. The community is relatively new to emergency management and preparedness and there is currently not a lot of support from community members. The UFN works with the District of Ucluelet in monthly meetings, where they share experiences, information and training opportunities.

The community holds regular evacuation drills, and successfully evacuated in 36 minutes in response to the tsunami evacuation alert following the Alaska earthquake on January 23, 2018.

During the break-out session, Cook chaired a small group to address her main concern for the Ucluelet First Nation with regard to hazard management and emergency preparedness: how to get the community more involved in emergency management and emergency preparedness activities.

TSLEIL-WAUTUTH NATION – *PEOPLE OF THE INLET*

Representative – Sarah Dal Santo: *Natural Resources Planning Manager in the Tsleil-Waututh Nation Treaty Lands and Resources Department. Dal Santo has a community and environmental planning background and she is working to advance and implement the Nation's Stewardship Policies, Burrard Inlet Action Plan, Park Management Plans and Climate Change Resiliency Plan*.

The Tsleil-Waututh Nation (TWN) have lived along the shores of Burrard Inlet for an estimated 10,000 years. Once numbering in the thousands, the current TWN population consists of around 500 people many of whom reside in the Burrard Inlet Reserve #3 or "Tsleil-Waututh" located on the north Shore of Burrard Inlet.

Climate change is an important issue for the TWN, and the effects of climate change have already been felt by the community. As a coastal community that is particularly vulnerable to sea level rise, coastal flooding, and erosion, the TWN is taking a proactive stand to prepare for and reduce community risk from climate change. TWN hosted a Climate Summit in July 2018 to encourage information sharing and collaboration on climate change, and the Nation continues to be involved at various levels to provide input to inter-governmental policies and programs related to climate change. In January 2018, with funding assistance from the Federal First Nations Adapt Program and the Real Estate Foundation of BC, TWN retained Kerr Wood Leidal Consultants to prepare a Community Climate Change Resiliency Plan. The hazard assessment by the TWN consisted of two components: analytical approaches, including modeling for some hazards (e.g. creek flooding and coastal erosion), and a literature review for other hazards (e.g. wildfire hazard). The Swinomish Climate Change Initiative from the Swinomish Tribal Community (Washington State, USA), played a big role in the approach the TWN took in the vulnerability assessment. To date (October 2018), an inventory of potentially impacted community assets and values; and detailed hazard assessments of four key hazards, sea level rise, precipitation, temperature change, and ocean changes, is now complete. The next step entails development of a comprehensive vulnerability assessment that will address community vulnerability to hazards across six core sectors: environmental/natural habitats, land use/real estate, infrastructure, economic health, and social and cultural health. In the final step, a preliminary set of climate change adaptation measures will be developed for TWN consideration. The Climate Change Hazard and Vulnerability Assessment report is anticipated to be completed by the end of March 2019. A copy of Dal Santo's reflections can be found in Appendix A.

To further build on the recent hazard and risk assessments by the TWN, Dal Santo led a discussion group in the break-out session to solicit input on how to successfully implement results of adaptation plans to reduce community risk in the long term.

GITGA'AT FIRST NATION – *PEOPLE OF THE CANE*

Representative – Roger Sterritt: *Manager, Gitga'at Emergency Response Team*.

The Gitga'at Emergency Response Team ("the Team") was established in 2015. The Team is responsible for fire protection, medical response, marine search and rescue, emergency management and environmental response. The Team consists of two full-time employees, 18 response volunteers and 10 emergency management volunteers. Some of these volunteers live in Prince Rupert and can provide off-site (logistical) support if needed.

The Team has successfully applied for funding (from Indigenous Services Canada) to update their emergency management supplies and training, including updating their emergency preparedness plan.

The Team used the online Hazard Risk and Vulnerability Assessment (HRVA) tool from Emergency Management British Columbia (EMBC) to identify and rank possible future human or natural caused emergencies. A high-water event, a tsunami caused by either a seismic event or a landslide into the Douglas Channel, was identified as a priority event for which to prepare. In addition, the Team has successfully applied for funding from the National Disaster Mitigation Program (NDMP) to perform a more in-depth assessment of the risks and potential impacts of a high-water event from either a tsunami or a flood coming from the lake above the village. The NDMP project is still on-going and will be complete in early 2019. The outcomes of the project will help the Team to identify priorities in infrastructure upgrades, and spending related to emergency management.

Sterritt has further been involved in a project by EMBC to make their online Hazard Risk and Vulnerability Assessment (HRVA) tool more user-friendly, for example by including historical accounts of natural disasters based on Indigenous knowledge in a given area. A copy of Sterritt's reflections can be found in Appendix A.

Sterritt has found that there are many reports and studies available from various government bodies that address natural hazards and risk. His main concerns with regard to these studies are that, first, the documents are often overly technical; and second, each of these studies often have a slightly different scope. While most research is welcome, it is confusing and time consuming for Sterritt and his team to tease out the relevant information. During the break-out session, Sterritt led a discussion on how to address the aforementioned issues.

GEOLOGICAL SURVEY OF CANADA

The Public Safety Geoscience Program of the Geological Survey of Canada (GSC) is a research program that studies various aspects of the impacts of natural hazards on society, the economy, and the environment. Part of the program focuses on working with Indigenous communities, and learning from their local knowledge and experiences with regard to natural hazards. A fourth break-out group, led by Marit Heideman, discussed how (government) scientists can improve their working relationships with Indigenous communities.

2.2 SUMMARY OF CRHNET SESSION

The communities represented in this session are each working on community risk assessment, and/or emergency management and preparedness through various means, for example through successful funding applications, use of consultants, or community volunteers. Each of the communities is at a different stage in their risk assessment process. Discussions in the break-out groups revealed some common threads (Figure 2), which are further discussed below.

Figure 2. Most commonly used words in discussions during the break-out sessions.

COMMUNITY ENGAGEMENT

One overarching theme of the discussions was community engagement. Regardless of whether projects focus on data collection, risk assessment, or adaptation of plans, projects need to start from the **bottom-up**. This will help **build capacity** and create an **engaged and informed community**. Community members may also have ideas or thoughts that would otherwise go unnoticed.

One way of engaging the community, is to find **community champions** who can help carry the project. In addition, engagement should focus on all age groups, including youth and elders. This ensures that a diverse group of people is involved in the project or action. Similarly, **focus or advisory groups** need to be representative of the community. In addition, a strong dissemination strategy is needed to promote a project through various media, for example, door-to-door calls, online and print advertisement, social media, etc.

BUILDING RELATIONSHIPS WITH INDIGENOUS COMMUNITIES

There is a general need for training with regard to Indigenous engagement and relationship-building. Such training should help increase acknowledgement of Canada's colonial history and the lasting impacts on Indigenous peoples and communities. In addition to the general history, people/organizations wishing to work with Indigenous communities should be familiar with the specific history and customs of the community they wish to work with, as each community is different.

Relationship building takes time and one should **allow enough time** to do so. Relationship building and engagement needs to be done from the beginning of a project, not presented at the end or to tick off a box on a project checklist. For example, one cannot approach a community for a letter of support one week prior to a deadline for a project proposal. Moreover, scientists and others often work with a community on a particular and

relatively short-lived project, leaving communities once their projects are finished**.** Make sure to **build lasting relationships**!

Some Indigenous communities are flooded with research requests. There is a need for a **coordinated approach**, within the federal government and elsewhere, to work with Indigenous communities such that organizations/project leaders know what research has already been carried out in the community. Within Natural Resources Canada (NRCan) there is currently is no central regional contact that oversees Indigenous relationships. Also, there are no clear policies and guidelines within NRCan on how to establish Indigenous relationships.

When wishing to work with a particular community, a person/organization needs to:

- Find a **community liaison** who can help build relationships in the community. This can be a person in the community (e.g. local emergency manager), an external agency (e.g. consultant), or someone who has worked with the community before. If you are talking to someone in the community, find out who this person is, and what his/her role in the community is, both socially (e.g. hereditary lineage) and professionally. Find out if this person is authorized to speak on behalf of the community, and how the Chief, Council, Elders, and others are involved in decision-making.

- Be aware of and respect **cultural and seasonal activities** (e.g. hunting, fishing, harvesting in summer and fall) in communities that may take precedence over professional activities.

- Be aware of **community resources** and individual responsibilities or 'hats'. Community members might take on various professional and/or volunteer roles in their community. Human and financial resources are often limited in communities, and therefore, projects need to be relevant to communities to justify spending their resources on them.

RESEARCH DEVELOPMENT

Co-develop research goals and objectives to ensure **relevance** of a project for the community and reciprocal benefits. Ensure the community has power in the project. To do this, a shift in research culture is needed: from top-down to bottom-up. Start with the people and collect data differently. Also, ensure that **all who have an interest** in the issue are in the room at the right time.

TECHNICAL INFORMATION, MODELING, AND REPORTING:

Technical and scientific information needs to be accompanied by a **community document** that presents communities relevant and useful information. There are various ways to present technical and scientific information in a meaningful and relevant manner, for example:

- Reports can be **translated** from English to local language;
- **Community visits** to explain research have been found very helpful to understand the information; and,
- Use of **narratives and scenarios**, based on a community perspective, can help to highlight the relevance of project/science. For example, by using profiles of representative community members and building storylines around them, the impacts of potential hazard events can be explained.
- Use **geospatial visuals** (maps, posters, etc.) to represent the issue of concern in a place-based manner to help people understand where and what is affected.

Again, avoiding a top-down approach, the development of **relevant tools and information** for Indigenous communities, such as risk assessment methods or hazard and risk information, should be **co-developed** with community input in order to be useful. Risk models, and subsequent guidelines, methods and information**,** are based on general assumptions. Indigenous communities are all different, have different capacities, and are at different stages of risk assessment and preparedness. **General assumptions will not apply to Indigenous communities**, as they are based on the dominant urban society and a colonial point of view. In addition, communities have their own **interpretation of risk**, which may not necessarily be the same as a researcher's interpretation.

IMPLEMENTATION OF ADAPTATION PLANS

Since most people find it difficult to think and talk about problems that are a few years away, it is hard to instill (long-term) behavioural change. The **relevance and implementation** of adaptation plans will be most effective if they resonate with what people are seeing today. This can be done by for example, providing illustrations of the impacts [of sea level rise] on communities and homes. By **visualizing** future plans such that people understand the impacts, community understanding of the hazard and personal and communal risk will increase, and so will the uptake and implementation of (adaptation) plans or measures.

FUNDING AGENCIES

Workshop participants noted that there is a **lack of funding** that is specifically available to the **implementation** of (adaptation) plans, most funding is available for planning and assessment. Most funding is ad-hoc (i.e. on a case-by-case basis), and there is no consistent stream of funding that supports projects from the initial planning phase through to the implementation phase. It could be informative for communities if funding agencies provide an annual synopsis of (successful) past funding recipients or projects.

BUILDING ON SUCCESSES

Communities can learn from the experiences and successes of other communities that are working on risk assessment and adaptation. The session participants mentioned a couple examples of successful adaptation plans by Indigenous communities:

- Swinomish Climate Change Initiative – importance of community values, prioritizing actions (Swinomish Indian Tribal Community, 2010).
- James Town S'Klallam Tribe, US – Climate Vulnerability Assessment and Adaptation Planning (Jamestown S'Klallam Tribe, 2013).

3. REFLECTION AND OPPORTUNITIES

The reflections of the Gitga'at, Tsleil-Waututh and Ucluelet First Nations demonstrate that each community is at a different stage with regard to hazard/risk assessment and emergency management, and each community has its own concerns and priorities. Some of these concerns are related to their geographic locations and the hazards each community faces, while others are related to community support or capacity. Each of the three communities has approached hazard/risk assessment quite differently, for example, the Gitga'at Nation has successfully applied for funding and is using the NDMP process to evaluate their hazards and risks. The Tsleil-Waututh Nation has also applied for funding and is modeling its climate change assessment by looking at other Indigenous community, like the Swinomish Tribe in Washington State (US), which perhaps hints at a lack of suitable models or examples from within Canada. The Ucluelet First Nation's focus has mostly been on emergency management and community preparedness and engagement.

RISK ASSESSMENT

Risk assessment is widely seen as a necessary step to understand the hazards and risks communities face, and can aid in reducing disaster risk and inform policies and practices aimed at building more resilient and sustainable communities (see Appendix B for further information on risk assessment). All Canadian provinces and territories have developed risk assessment methods, and there are several other methods that have been developed within Canada that are currently available for use by communities (see Appendix C). The Aboriginal Disaster Resilience Program (Justice Institute of British Columbia, 2015) is currently the only method that is developed for Indigenous communities in collaboration with Indigenous consultants, while the risk assessment model of the Northwest Territories (Appendix C) mentions the importance of traditional knowledge (Pearce, 2016).

Reviews of risk assessment models by others (Appendix C; Journeay et al., 2015; Pearce, 2016; Lyle & Hund, 2017) have shown that there is a need for new or improved risk assessment models at the local level. Suggested needs and improvements range from analytical improvements to the models, to recommendations of a more practical nature.

In relation to the relevance and usefulness of (science) projects and (risk assessment) models, session participants at CRHNet found, in general, that technical information can be confusing or simply too much to digest. Especially, when multiple, similar projects are carried out, it can be difficult to tease out the relevant information for a community. With respect to the development of risk assessment models in particular, Pearce (2016) rightfully points out that the use of technology in models (e.g. GIS capacity) needs to reflect what is available in communities. Again, to align the efforts by the science community with the needs of local communities, co-development and collaboration is needed from the start of a project. By doing so, not only can local community input and knowledge help and inform and shape the project or model, but it will also help formulate what is needed at the local level to support the project or model, such as translation of knowledge in a local language, visualizations of outcomes, community visits, etc.

COMMUNITY ENGAGEMENT & COLLABORATION

Other recurring themes in the CRHNet session not so much addressed technical issues or model design issues, but rather involved human interaction and the processes of building relationships, collaboration and engagement, and coordination. Given social and cultural differences between the science community and the dominant urban community on the one hand, and Indigenous communities on the other, it is important to invest

time and resources in these processes, as it will lead to a better mutual understanding and appreciation for each other. In building relationships, it is important for scientists, and other externals, not only to know the person(s) they are working with and what his/her professional, and social and cultural responsibilities are, but also appreciate the social and cultural norms and events of the community. Especially in smaller communities, members may serve their community in various roles, and so the risk manager may also be part of the fishing fleet, and as such be absent for days or weeks during the fishing season. In addition, building relationships within a community will help to involve all community members who have a professional or personal interest in the project (e.g. council members, the chief, elders, youth). Having good relationships with a community and having an understanding of local social and cultural norms and practices, is important to the co-development of projects and engagement of community members, and ultimately to the outcomes or success of a project.

While building relationships with Indigenous communities is important, several participants at the CRHNet session echoed the need for (improved) coordination of scientists, and other externals, working with Indigenous communities. Scientists in the session explained that it is sometimes difficult to find the right person in a community, or figure out who has worked with the community before them. Some communities, on the other hand, receive so many requests to collaborate on (research) projects that they are simply overwhelmed and do not have the time or resources to participate, and only choose to collaborate on those projects that are directly relevant to the community. It thus appears there is a need from both sides, for some form of (central) coordination systems or agency that can coordinate and facilitate working relationships. Within the federal government [NRCan] a 'Regional Indigenous Engagement Working Group' has been established (pers. comm. W. Hirlehey, Nov. 6, 2018) to enhance the coordination with Indigenous communities in British Columbia, in relation to federal emergency management engagements. Participating members come from a variety of federal agencies. Ideally, such a coordinating body would oversee all federal engagement with Indigenous communities, and not only in relation to emergency management activities. Furthermore, there are many other institutes and organizations (e.g. provincial governments, universities, planners, consultants, etc.) that are working with Indigenous communities, and they too build relationships and (co-)develop knowledge. In British Columbia, there is currently no oversight on what is being done. In contrast, the Nunavut Research Institute (NRI) presents itself as the "Gateway to scientific research in Nunavut!" (Nunavut Research Institute, 2015), and could possibly offer a model to better coordinate working relationships and research in other provinces. The history of the NRI goes back to 1984, and among other things, the NRI is responsible for coordinating and licencing scientific research in Nunavut. Furthermore, the NRI provides a clearing house of information on research carried out in Nunavut (Nunavut Research Institute, 2015). The NRI is linked to the Nunavut Arctic College, which language and cultural program oversees an oral history program. On a federal level, Polar Knowledge Canada (POLAR) similarly provides a coordinating role for researchers and decision-makers, and aims to facilitate collaboration and partnerships in the polar regions (Government of Canada, 2018a). Both the NRI and POLAR illustrate that coordinating bodies already exist in Canada, and perhaps it is time to learn from their experience, and initiate similar regional initiatives in other parts of Canada.

4. CONCLUSIONS

This report documents the experiences and efforts of three coastal Indigenous communities with hazard and risk assessment. The reflections of the Gitga'at, Tsleil-Waututh and Ucluelet First Nations demonstrate that each community is at a different stage with regard to hazard/risk assessment and emergency management, and each community has its own concerns and priorities, which highlights the need for locally relevant, and thus flexible, risk assessment models and tools.

Top comments from the session at CRHNet in Vancouver in October 2018, concern the need for **early community engagement** and **building long-term and lasting relationships** in the development of research projects and risk assessment models. It is important that scientists and Indigenous communities **co-develop** (research) projects and models from the **bottom-up**, which will assure that local knowledge and expertise are included, and that the outcomes are useful for the community. While the need for building relationships, collaboration and co-development are recognized at the federal government level (e.g. Indigenous working group at NRCan, POLAR) and elsewhere (e.g. Nunavut Research Institute), regional coordinating bodies are needed to ensure a consistent and coordinated approach to engage with Indigenous communities in the various provinces and territories. Ideally, such central bodies do not solely focus on the research community, but also include other organizations and professions.

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SPEAKING NOTES PANEL DISCUSSION – CHRNet Conference
INDIGENOUS DISASTER RISK ASSESSMENT SESSION

By Sarah Dal Santo Natural Resources Planning Manager, TWN

Tsleil-Waututh Nation
PEOPLE OF THE INLET

Oct 31, 2018

TWN Climate Change Hazard and Vulnerability Assessment

Introduction to the Nation

- The Tsleil-Waututh are one of many groups of Coast Salish peoples living in the Pacific NW.
- Many generations of Tsleil-Waututh people have used, occupied and governed the waters and land areas draining into Burrard Inlet for thousands of years.
- Tsleil-Waututh means the "People of the Inlet" and the name celebrates the Nation's close relationship with the waters in the Inlet.
- Recognizing that the health of the TWN people is interconnected with the environment in which we live, the Nation has a deep sacred obligation to care for and restore the health of their territory.
- Sleil-Waututh (IR#3) is located on Vancouver's North Shore, reaching from Maplewood

Mudflats (west) and Whey Ah Whitchen/Cates Park (east). TWN also has 2 smaller reserves at the head of Indian Arm.

Climate Change Impacts for the TW Nation

- Today, I am here to talk about the TWN approach to assessing impacts and developing a response to climate change.
- Climate change presents an important and growing contribution to cumulative effects that are threatening the TWN's ecological and cultural resources, and community wellbeing.
- Key climate change hazards facing the TWN include:

- extreme storm events and inland flooding that pose direct risks to the integrity of TWN community homes and infrastructure (e.g. roads, water mains, sewage, cemetery, etc.), increased threat of landslides etc.

- rising sea levels and coastal erosion TWN elders have observed 10m+ of erosion along the foreshore. SLR and erosion threatens TWN waterfront lands and properties, archaeological sites, cultural heritage resources, ancestral remains; and have degraded ecological habitat and impaired habitat restoration and stewardship efforts.

- hotter, drier summers that bring periods of drought and low base flows in local creeks, heightened risk of interface fires, poor air quality conditions coinciding with seasonal forest fires, increased risk of heat stroke and heat exhaustion.

- changing (air/ocean) temperature and climate that pose a threat to sensitive ecological habitats, and the abundance and biodiversity of natural resources (ex.

  salmon, forage foods, shellfish, wildlife and plants), and increased spread of invasive species.

Steps to Address Climate Change

- TWN has joined the ranks of FN and other communities that are tackling this issue head on, finding new and creative ways to deal with climate change, and learning as we go.

- The TWN has made significant strides towards understanding climate change threats by:
  - participating in National and International forums and consultation on climate change regulations and strategies,
  - sharing knowledge and learning from the experience of other Nations,
  - hosting a Climate Change Summit (July 2018), and
  - integrating climate change strategies in the new draft TWN Land Use Plan.

- In early 2018, the TWN retained KWL consultants to conduct a climate change hazard and vulnerability assessment with a focus on coastal and creek hazards in reserve lands, and specifically their impact on the following sectors:

  - land/real estate, environmental/natural habitats, infrastructure,

  - social and cultural values, and economic health.

Key Drivers for Doing Hazard and Vulnerability Assessment

- take stock of what resources (land, ecological values, archaeological values etc.) are present now; how these resources have already been impacted (ancestral knowledge and science) and projecting future potential impacts from climate change;

- build an understanding of the level of impact and risk to guide the community in taking action reduce risk;
- build community awareness, capacity and resiliency (ultimately working to develop a Climate Change Resiliency Action Plan);
- identify opportunities for collaboration and partnership recognizing no one community can address climate change on its own.

Approach to Doing Hazard and Vulnerability Assessments

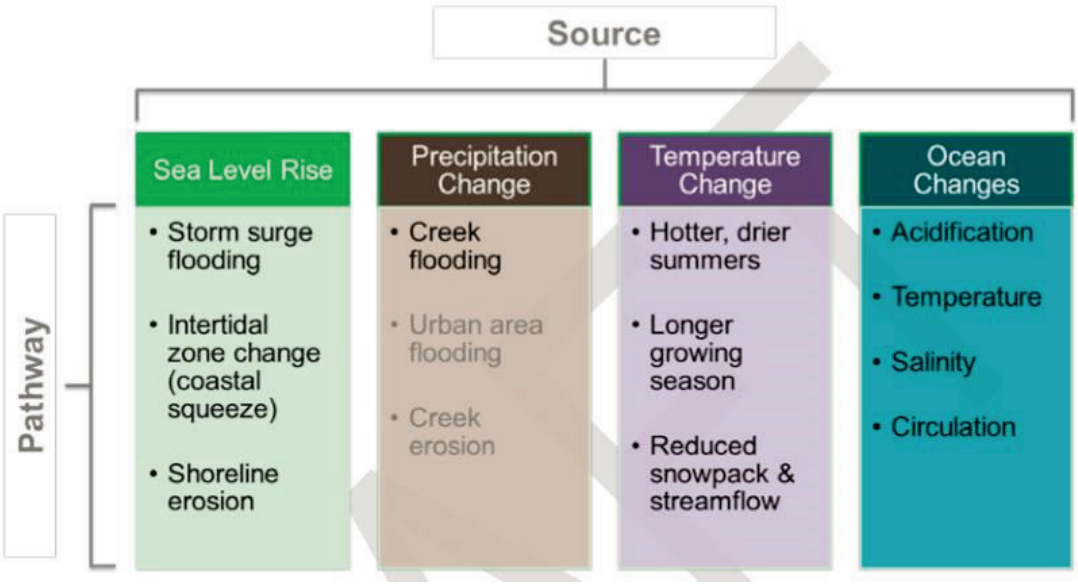
- Reporting on work done to date. This work is still in progress and will be complete by the end of March 2019.
- 4 key steps:

Step 1: Data and Knowledge Inventory

- inventory and mapping of the foreshore area of Burrard Reserve to identify infrastructure, property, natural habitat, and cultural resources potentially at risk.
- involved collecting spatial data from existing desktop sources with targeted fieldwork on n bio-physical features including shoreline geometry, sediment characteristics, and intertidal habitat.

Step 2: Hazard Assessment

- focused on analyzing & mapping 4 key climate change hazards & associated hazard pathways:



- Sea level rise hazards were assessed based on the Province's linear rate of sea level rise of 1 m by the year 2100 and 2 m by the year 2200.

- Coastal flooding was assessed by estimating the extent of inundation for an extreme coastal flood event (200-year return period) under no sea level rise (current), 1 m of sea level rise, and 2 m of sea level rise scenarios. Flood inundation maps identified areas located below the peak water level surface elevation of the coastal flood event. Coastal flood levels were estimated based on joint probability coastal water level analysis tool.

- Shoreline erosion was assessed by 3 methods:

    - a mapping exercise identifying areas of lower, moderate, and higher shoreline erosion sensitivity to sea level rise based on shoreline geometry (slope), wave exposure, and shoreline sediment.

    - morphodynamic numerical modelling (CSHORE model) to provide an indication of potential shoreline shape change when waves impact the shoreline at a higher elevation due sea level rise.

    - field based mapping of shoreline vegetation to identify sensitivity to increased saltwater spray due to higher sea levels.

- Increased Precipitation Hazards: were assessed based on predicted changes to rainfall intensity under the IPCC RCP8.5 (representative concentration pathway) climate change scenario i.e. the 'status-quo' scenario in which greenhouse gas emissions continue to grow.

- Creek flooding was assessed by creating flood inundation maps for an extreme event (200-year return period)

- Increased Temperature Hazards: were identified on the basis of future air temperature projections provided by the Pacific Climate Impacts Consortium (PCIC) for the Lower Mainland region.

    - PCIC provided increased temperature hazard predictions for mid-century (approx. Year 2050) in the following terms: (number of hot days above 25 C, number of growing season days, % change in snowpack0)

- Predictions of Ocean change hazards were identified by conducting a literature review on the following hazard pathways: Acidification, Increased temperature, Salinity, Circulation.

Step 3: Vulnerability Assessment

- The vulnerability assessment followed methodology based on the Source-Pathway-Receptor model.

- Start by identifying key community elements potentially affected under each of the following 6 community sectors/community values.
- Identification of elements was informed by initial discussions with staff and community members approximately 60 elements were selected across the 6 sectors.

- A structured evaluation matrix will be used to produce an overall vulnerability rating for each element across each hazard pathway.
- For each element, vulnerability will be determined based on assessed level of exposure, sensitivity, and adaptive capacity defined as follows:

Exposure = how much an element is exposed, spatially or indirectly, to hazard (hazard maps)

Sensitivity = potential level of impact on exposure to the hazard (professional judgement) **Adaptive Capacity** = inherent ability of the element to adapt and the in-house capacity of TWN to support adaptation.

- The vulnerability matrix produced a ranked list of elements by overall vulnerability to be further refined through community engagement and review with TWN staff.

Step 4: Adaptation Measures Development

- Adaptation measures will be defined for the vulnerabilities considered to be high priorities by TWN.
- Informed by adaptation measures from progressive and comparable jurisdictions.

Tools, Knowledge, Collaboration and Funding to Support the Project

- The TWN uses vast traditional knowledge accumulated over thousands of years of inhabiting our territory to help guide community obligation to our lands, waters, and resources.
- TWN also seeks to supplement traditional knowledge—with creative tools, non-traditional approaches, western science, and technical expertise—to achieve a more holistic approach to natural resource stewardship.

- Project builds on existing available resources and innovative ideas for assessing climate change:

    - Swinomish Climate Change Initiative; o Source-Pathway-Receptor-Consequence model; and

    - International Panel on Climate Change (IPCC) Vulnerability Framework

- In this project, scientific research and modelling was undertaken by a qualified consulting team (with engineering and planning skills) with previous experience doing this type of work. (Patrick Lilley (lead), Amir Taleghani (modelling), Robin Hawker (engagement)

- Core project team – members of the TWN community, TLR staff (project leads) and other inter-departmental staff (Public Works, Lands, Health, Communications etc.) – provided guidance on project scope and direction, and community context/values.

- Community engagement – The project engagement includes opportunities for 2 focus group meetings with community representatives, and community event and an online community survey. Dovetailing w/ other events to prevent engagement fatigue.

- Elders – provide historic knowledge as well as connection and parallels to events in the past. Staff have/and continue to consult with elders at key intervals in the project. These discussions offer grounding in deep rooted community values, importance of connection to stewardship principles. Stories, traditions, and knowledge also offers insights to how cumulative effects have affected TWN environmental and cultural resources over time.

- Youth – future of the Nation. Important to have as part of the discussion but hard to reach. Climate Change Intern organized a community art project – canoes remind community of a time of great flood and inspire people to prepare themselves for climate change.

- Funding - This project would not have been possible without the availability of funding support. TWN received funding from FN Adapt and Real Estate Foundation of BC to do this work.

Outcomes and Uses for the Hazard Assessment

On completion of the Climate Change Hazard and Vulnerability Assessment, TWN will use this report to:

- Build on this information to develop a Climate Change Resiliency Action Plan that identifies key priorities for action and a framework for measuring progress on community capacity building and resiliency to climate change

- Form strategies to mobilize funding, collaboration and partnerships to implement priority actions

- Monitor progress towards achieving adaptation actions

Reflections on What Has/Hasn't Worked so Far

- So for, hazard and vulnerability assessment has been applied successfully to the TWN Reserve Lands occupied by TWN community.

- Expanding this approach more broadly to cover any of the following areas of importance to TWN: Burrard Inlet, Say Nuth Khaw Yum/Indian River Provincial Park, (TWN co-

  manages with BC Parks), Indian River Watershed etc. would be prohibitively expensive. Current model works well for smaller communities.

- Is a data intensive and costly - difficult to conduct on a repeat basis.

- Modelling has some inherent limitations/uncertainties – climate change conditions (sea level rise, temperature rise, level of precipitation etc.)

Recommendations for other Organizations Under Taking Similar Assessments

For now, suggest that organizations take advantage of existing research, large body of work on climate adaptation/hazard assessment.

- Key is to identify community values – what's important to your community, what are you seeking to protect – provides framework for evaluation of impacts and adaptation measures. Community and traditional knowledge from elders is key to that discussion.

How do we make science more accessible?

- Science tends to be very dry, loaded with numbers, technical terms and complex charts that appeal to science nerds but are not within grasp or quickly loose the attention of general community/audience. Need to simplify.

- Need to "humanize" science - reflects impacts to real people.

- Picture is worth a thousand words – photo of a flood, storm event, map of sea level rise – really grabs attention. Use to supplement facts and charts.

CRHNet Presentation

My name is Roger Sterritt and I represent the Gitga'at First nation. I'd like to give you brief overview of where we started and how we got here today.

The Gitga'at First Nation, also known as Hartley Bay, is located in the heart of the Great Bear Rain Forest along BC's north coast. It is approximately 140kms south of Prince Rupert and approximately 50kms southwest of Kitimat. The community is only accessible by boat, floatplane or helicopter.

The population of Hartley Bay fluctuates between 130-150 and there are about 50 homes and several public buildings.

In 2015 the Gitga'at Emergency Response Team was established. The goal of the program was to consolidate all of the emergency services within the community under one umbrella organization, those services include: fire protection, emergency medical response, marine search and rescue, emergency management and most recently environmental response.

To launch and manage the program 2 full-time positions were created, the Director, Edward Robinson and myself as the manager. In the emergency response fields, we have 18 community volunteers that provide those services.

In the emergency management area, we have 10 community volunteers that fill those roles (in a community of 140, that gives us 20% of the population that is looking out for the safety of the community in one way or another, which is quite an accomplishment in itself). A few of those band members on the EM side actually live in Pr. Rupert and that is by design, the reasons we wanted to include membership that don't live in the community year-round, was to give us off-site personnel should we need off-site logistical support and also in the event that an extended emergency situation we would be able call upon those members could come in to spell off local emergency management staff. As an added benefit, in the event of a large-scale incident, the volunteers will be able to provide updates to families living in Pr. Rupert to ease their minds knowing that their family members living in HB are ok.

Because of the remoteness of Hartley Bay on the north coast and the high amount of pleasure craft and commercial traffic transiting the coast, the community is often called upon to assist the CCG to help those in need. That help can come in the form of responding to vessels experiencing mechanical issues, lost mariners, and pleasure crafts running aground.

One of the most significant responses was in 2006 when the BC Ferry, Queen of the North, ran aground and sank leaving 99/101 passengers needing rescue. The community was made aware of the accident by VHF, which almost all homes are equipped with out of necessity for a stable form of communication. Members of the community headed out in private fishing and pleasure boats in the middle of the night and brought the majority of the passengers back to the community, where they were provided shelter, dry clothing and warm food at the community's cultural centre. The remaining passengers were taken on board a Coast Guard vessel once it arrived.

This event highlighted the culture of responding to emergencies and those in need that is a part of Hartley Bay simply by default, because there's often no one else there to do it, but from a moral perspective it must be done; we have to help those in need! This event was a defining moment for the community and I think was one of the most significant driving factors that got us where we are today and will get us to where we want to go in the future.

In that first year of establishing the consolidated emergency program back in 2015, we submitted a successful funding application to the Emergency Management program of INAC (now known as ISC). This funding provided us with basic emergency management training for our EOC staff, a tsunami siren, emergency generator that powers our EOC in the event of a power outage, tsunami evacuation route signage, and an MSAT satellite telephone system to provide emergency communications to the community. This was a good jump-start for the emergency management program.

The community also took it upon themselves to purchase with our own resources, an Emergency Operations Centre kit from Marc D'Aquino of Holistic Emergency preparedness and Response. The kits contain portable workstations for the various positions within an EOC. (each station has a laptop, EP plan, EM forms, stationary etc., all contained within protective pelican cases that can be transported anywhere to establish an emergency operations centre)

The community did have an emergency preparedness plan that was developed with the assistance of FNESS a few years earlier, but it did require significant updating as it had not been used beyond the initial development and was basically sitting on a shelf just waiting to be dusted off.

Prior to the initial emergency management training provided by Marc at Holistic EPR, our first steps were to update the emergency preparedness plan and then perform a Hazard Risk and Vulnerability Assessment. With Marc's assistance, we accomplished this by utilizing the HRVA tool from EMBC.

While the original EMBC HRVA online tool and process was a bit clunky and not super user-friendly, it did still provide us with the ability to identify and rank the possibility of occurrence of all foreseeable emergencies, natural or human caused.

With the HRVA in hand we assessed the resources at our disposal and what disasters we could actually respond too, we determined that we should start preparing the emergency management team and the community for a high water event, such as a tsunami generated by a seismic event or a landslide into the channel.

After the training of the EOC staff, we held a community evacuation drill. We invited representatives from INAC and EMBC to participate and the drill was very successful. Out of the approximately 120 people that were in the community at the time we had 111 people evacuate to high ground within 12 minutes. We followed this up a year later with another community evacuation drill, and this too was very successful with over 90% participation by community members.

The intent of the community evacuation drills was to prepare the community for a high water event and that scenario became a reality on January 23, 2018 when there was a real evacuation warning for the entire BC coast, due to the threat of tsunami caused by an earthquake off the coast of Alaska. The tsunami never came, but at 1:00 in the morning the scenario rolled out and all but 2 households evacuated the low-lying areas and headed to high ground until about 5:00am.

The community members knew what to do and so did the responders, and it was another successful evacuation. By performing the drills, the community knew what to expect and what was expected of them. Are we perfect yet, not at all, but each time we do this, it fine-tunes the process and we learn new things that we may not have otherwise thought of until we went through the motions. Classroom training and tabletop exercises only get you so far. At some point you must go through the motions and challenge people, both community members and responders. This may cause some emotions to run a little high in the heat of the moment, but those are the things that will make your

program stronger in the end if you capture those situations and review them with a calm mind afterwards in an effort to see how we can do things better the next time, you are creating an opportunity for growth.

Over the last year or so, I have had the privilege of participating in a very worthy project initiated by EMBC to revamp their Hazard Risk and Vulnerability Assessment online tool for communities to use to assess their own risks and hazards. Their goal is to have a much more user-friendly tool that will identify the usual suspects that pose risks to communities, but will also factor in historical accounts of natural disasters based on indigenous accounts for any given area. From what I've seen so far, we are on the right track and this tool will enable communities to strengthen their local emergency preparedness plans by identifying and ranking the possibility of occurrence for the risks and hazards specific to their situation and also allow the province to have a better understanding of the larger picture as it relates to risks on a provincial scale.

Along with INAC funding and own-source revenue to launch and sustain our emergency management program, we have also recently tapped into another source of supplementary funding. This summer we were again successful in a funding application but this time it was from the National Disaster Mitigation Program to perform a more in-depth assessment of the risks and potential impacts of a highwater event either from a tsunami or even a flood coming from the lake above the village. This NDMP program combines federal and provincial funding to assist communities to do this front-end work.

One of the things we've found is that there are many studies and reports out there from various government agencies on the risks of natural disasters, such as earthquakes, tsunamis and floods. There are a couple of challenges with those studies. The first is that these are very technical documents, which to the layperson can be very confusing and actually amount to jibberish if you do not know what you are looking at. The second challenge is that there are several of these projects and they were all done at different times with a slightly different scope of work based on the interests of the sector. So our first task is to corral all of these documents and have them translated into laymen's terms into one collective document, because as the cliché goes "there's no need to reinvent the wheel" and we definitely did not want to waste our time on that.

The next phase was to have fieldwork performed by engineers and surveyors to mark points throughout the community that would give us exact coordinates and elevations above sea level. As it turns out, another project that was already completed by the Gitga'at with the Hakai Institute for another department, was to utilize drones to create 3D mapping of the community. Our hope is to combine the 2 efforts to give us a final product that will be something extremely useful and hopefully very cutting edge combining various technologies to produce mapping tools for both emergency planning and community land use planning for future development.

As part of the NDMP project, we have also collected the insurable value of all the public assets and infrastructure to give us a sense of what the dollar values are for potential impacts and damage caused by a large-scale emergency.

This project will be complete early in the New Year and will help us to identify priorities in infrastructure upgrades and spending in the emergency management area and again, also community land use planning. This work will also provide us with some baseline data to determine the potential effects of climate change with respect to sea levels and everything impacted by changes in that regard.

Long story short, if an emergency program is to be successful, you have to be creative and be able to leverage support from various sources and know that as a community you will be the biggest investor as there is no one government sector that will provide you with all the resources required to accomplish this very important and evergreen initiative that is so essential to the well-being of your community.

Hamiyaa (thank you)

APPENDIX B - RISK-BASED PLANNING AND RISK ASSESSMENT

Risk-based planning, whether for emergency management, pro-active mitigation, or adaptation, straddles the lines between society, policy and science (Figure B-1). The input from community members, (local) elected government members and policy-makers, as well as from scientists informs the various stages of the process.

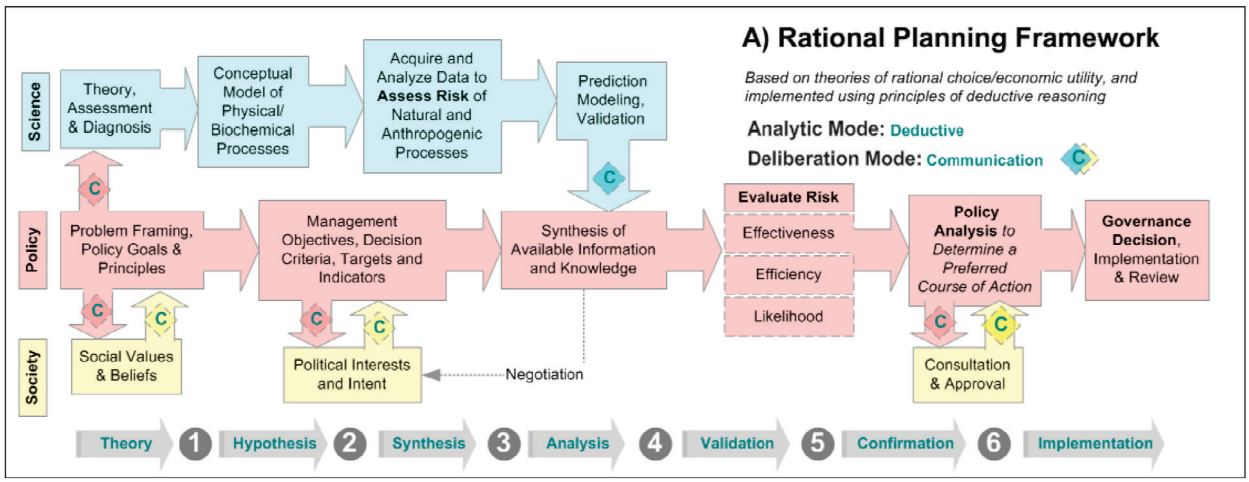


Figure B-1. Graphic representation of the inputs from society, policy and science in a theoretical (risk-based) planning process (source: Journeay et al., 2015).

The Pathways Framework (Journeay et al., 2015) outlines a process for community risk-based planning that involves four steps: establish context, risk analysis, risk evaluation and risk treatment. Each of these stages consist of various steps and tasks (Figure B-2). In short, in the first stage, *establish context*, a community determines the goals and objectives of the risk-based planning process. For example, the community may want to identify the hazards they face, and how they can best prepare for these hazards, or what adaptation measures they can take to prevent, or protect themselves, from future harm. In the second stage, *risk assessment*, the community gathers, and analyses, the necessary data on the hazards and the community assets and population. The analysis can be done in two ways, either through quantitative risk modelling, or through a qualitative (or semi-quantitative) risk assessment (the remainder of this appendix discusses the differences between these two types of risk analyses, and existing models in Canada). In the third stage, *risk evaluation*, the results from the risk analysis are assessed and weighted against priorities, and various mitigation or adaptation strategies are formulated. In the fourth stage, *risk treatment*, a mitigation or adaptation plan is approved and acted upon.

Figure B-2. Schematic representation of the Pathways Framework using spatial decision support systems (i.e. GIS software) to assess community risk (source: Journeay et al., 2015).

What is a Risk Assessment?

Local governments, including Indigenous communities, are responsible to undertake risk assessments. The sections below, first, provide a theoretical overview of the different methods of risk assessment. Second, current methods and tools of risk assessment that can assist local and regional communities having to plan for, and adapt to, hazard and risk in their communities are reviewed. And finally, based on the overview of existing Canadian methods and tools for risk assessment the limitations of these methods and tools for Indigenous communities are outlined.

In Canada, emergency management, including pre-event risk assessment, is primarily the responsibility of local and regional governments (Journeay et al, 2015; Pearce, 2016), as stipulated in the Emergency Management Act of 2007 (Government of Canada, 2018b). The federal government is responsible for emergency management in areas that fall under federal jurisdiction. Furthermore, the federal government assumes responsibility when the capacities of local and regional governments is exceeded in emergencies.

The key to any risk assessment, is to find and evaluate (local) information on:

1. The potential hazard: its dynamics or how the hazards happens, how often the hazard may occur (based on historical events), and the possibility for other hazards to happen as a result of the hazard event (for example, severe rainfall events can lead to flooding, and may cause landslides);

2. The people affected by the hazard: their whereabouts and social and community characteristics; and,

3. The assets (e.g. buildings and infrastructure) that lie in the potential path of a hazard.

Risk assessments require the input from various knowledge holders and sources, for example: planners, (Indigenous) community members (including elders), emergency managers, economists, (natural hazard) scientists, and census bureaus amongst others.

There are two main methods to perform a risk assessment, a quantitative or qualitative analysis, which each have their own advantages and disadvantages (see the sections below for more details on either method). Whichever method you choose is dependent on what question you are trying to answer, or what kind of information you are looking for. For example, are you interested in the effects of sea level rise along the coast of BC or in a particular community? Do you want to know more about the hazard itself; how often will flooding occur, how deep will the water be, or how fast will the water flow? Or do you want to know what the impacts will be on your community and how your community can plan for the hazard? In most cases, a risk assessment will require a combination of a quantitative and qualitative methods to get all the answers you are looking for.

Quantitative risk assessment

A quantitative risk assessment (Table B-1) aims to measure the risk to a community based on statistical data about the people and assets impacted, and based on detailed information about the hazard. There are two general methods to do so. The first method uses a specific event scenario to model or calculate risk, for example an earthquake of a certain magnitude in a specific area, or a flood of a certain size. This method is called a 'deterministic' risk assessment. The second method takes a range of varying hazard events and frequencies into account, and expresses risk as an annual chance of occurrence. This method is known as 'probabilistic' risk assessment.

As a quantitative risk assessment is based on statistics, as such these types of assessment can be viewed as on objective method to measure risk. The end result of a quantitative risk assessment can be expressed in, for example, dollar amounts (e.g. potential damage to communal infrastructure or personal property), number of people affected (e.g. deaths or injuries), or number of businesses lost, etc. Quantitative risk assessments often involve a lot of data, and may require significant computer power.

Qualitative risk assessment

A qualitative risk analysis adopts a more people-centred approach to assess risk, allowing for personal experiences and anecdotal evidence to be included into the analysis (Table B-1). Often qualitative assessments comprise checklists that allow communities to assess risk, for instance by applying ranking (e.g. 'high-medium-low' or a score from 1-5) to hazard, exposure or vulnerability conditions within the area or community under assessment. Anecdotes can help to illustrate the experiences with the hazard or risk. The outcome from a qualitative risk analysis is often somewhat dependent on the hazard experience of the person or entity performing the assessment, and can therefore be considered 'subjective'.

One advantage of qualitative risk assessment is that governments do not have to buy or obtain extensive, and often expensive, data sets, or hire the help from highly trained (external) risk experts, consultants, or scientists. However, qualitative data can be more complicated to assess and interpret as the data is based on individual risk perceptions and experiences. For example, one assessor may rate risk as low, and another person may perceive the same risk as high.

Scientists have traditionally preferred quantitative research and risk assessments over qualitative research, as quantitative methods provide conclusive numbers, which allows for comparison of risk between various hazard scenarios or between communities, subsequent policy setting and justification of government spending. Qualitative assessments can be better suited to address tacit or sensitive community (vulnerability) characteristics that are otherwise hard to measure (Cox, 2015; Cutter, 2016), or to solicit other forms of information, such as anecdotal information, regarding the risks faced by a community.

Table B-1. Characteristics of quantitative and qualitative risk assessment.

	Quantitative	Qualitative
Style	Objective	Subjective
Focus	Measureable aspects of hazard, exposure and vulnerability (i.e. indicators)	People-centred: (personal) experiences, anecdotal evidence, etc.
Approach	Deterministic – scenario modelling Probabilistic – likelihood modelling	No modelling or assumptions, based on actual experience
Data sources	• Hazard history: frequency & magnitude of events • Exposure data • Vulnerability/ resilience data: Census data	• Local & Indigenous knowledge • Questionnaires & surveys • Experience, history & anecdotal evidence

Data input: indicators versus experience

A risk assessment or risk model should be seen as an approximation of risk to society, as they will never capture the full picture of risk to a community. However, depending on the data used, a risk assessment or model will be able to paint a very detailed picture of the hazard event that might happen, and who and what are at risk.

So, what kind of data is needed to perform a risk assessment? Quantitative models to assess risk typically consist of indicators for each risk component (e.g. hazard, exposure, vulnerability and resiliency). Indicators are measures, estimates or rankings that describe a risk component, based on the best available data and/or science. *Hazard* indicators are often based on actual measurements of historic hazard events, or on probabilistic or deterministic scenario modeling, for example: storm surge for a certain wind speed, inundation depth for a certain discharge, or an earthquake of a particular magnitude. Similarly, estimates of *exposure* are relatively easy to determine or quantify, typically, this can be done by assessing the number of people who live, or counting the number of structures, in a hazard zone. However, indicators that reflect the strength of a community, its vulnerabilities and its resilience, are somewhat more difficult to specify in models, since relevant indicators can vary widely depending on the community and its cultural values, and its socio-political views and actions (Cox, 2015).

To create a measure or index of a community's social characteristics, often referred to as its 'social vulnerability', national census data, or other statistical data about the community, is often used. Using this kind of data can provide measurements for certain societal characteristics (or indicators) such as employment, income, population density or education. While these quantitative measures of vulnerability provide useful information for a risk assessment, using only these indicators ignores those community characteristics that do not lend themselves

for measurement (Cox, 2015), but that also contribute to the complex web of social, economic, political and environmental factors that make up a community and that contribute to the resiliency of a community. As such, the selection of indicators itself is surrounded by ambiguity and debate. For example, is poverty properly reflected by an estimate of income (Cox, 2015)? Or, is 'sense of community belonging' measured by the number of community centres in a community or the number of people who actually use such a centre?

To select indicators for risk assessment, the following guidance can be helpful (e.g. Birkmann, 2006; Villagrán de León, 2006; Cutter, et al., 2008). Indicators should be:

- relevant to the scope and context of the community under assessment;
- based on available data;
- easy to interpret;
- valid and accurate (i.e. does the indicator actually measure what is being assessed?);
- objective and reproducible (when conditions change); and,
- analytically and statistically sound;

Overview of risk assessment methods in Canada

Many models, guidelines and tools that assess risk to natural hazards already exist in Canada, resulting from previous research and policy efforts. Various authors (e.g. Journeay, Talwar, Brodaric, & Hastings, 2015; Pearce, 2016; Lyle & Hund, 2017) have provided an overview of these qualitative and quantitative risk models available in Canada, including some global models, and thus such a review does not need to be duplicated here. What follows below is a summary of some of the main findings of these studies.

Provincial and Territorial risk assessment models

Pearce (2016) provides an overview of provincial and territorial risk assessment models in Canada (Table B-2), which are all community-based models, except for Nunavut. Seven of the provincial and territorial models assume a qualitative risk assessment approach, whereas five models combine qualitative and quantitative risk assessment, and for one model the format is unspecified. Most Canadian models are relatively new, only New Brunswick, Québec, and British Columbia have models that date prior to 2010. The focus of all provincial or territorial models is on the community, with the exception of the Nunavut model, which focuses on the family instead. The majority (69%) of the provincial and territorial models is publically available, except the models of Alberta and the Yukon. Interestingly, all of the provincial, territorial and Indigenous models lack (basic) GIS (Geographic Information System) mapping as part of their analysis, in contrast to many other (global) models. However, the provincial, territorial and Indigenous models do often recommend the input of GIS experts in hazard, risk, vulnerability analysis.

Other risk assessment tools and frameworks available in Canada

Various other risk assessment models and frameworks have been assessed by Journey et al. (2015; 21 models), Pearce (2016; 49 models, including Canadian provincial and territorial models), and Lyle & Hund, 2017; 8 models). These models range significantly in ease of use, availability (e.g. proprietary, freely available, open-source based), level of expertise required, spatial scope (local to global), hazards, and purpose and outcomes. All three

reviews (see Table B-2 for a list of all reviewed models) were done to inform policy-making and development of risk assessment strategies and tools at the national level, therefor not all the reviewed models are directly applicable at the local level. User needs were taken into account by Lyle & Hund (2017), though they only focused on quantitative risk assessments. In addition, Pearce's review (2016) set out to explore potential best practices for local governments with regard to risk and resiliency assessments. Forty-three of the models reviewed by Journeay et al. (2015), Pearce (2016), and Lyle & Hund (2017), are of use to local communities (e.g. planners, emergency managers, decision makers etc.; Table B-2), and focus on the local to regional scale. Some international models (e.g. HAZUS, UNISDR, NERAG) are included in Table B-2 as they illustrate examples of potential tools or methods that can be applied at the local scale. Twelve models take a quantitative approach, thirteen models take a qualitative approach, and sixteen models take a combined qualitative and quantitative approach to risk assessment. Of all reviewed models only the ADRP is specifically designed for use by Indigenous communities (see below for further discussion).

All three reviews present limitations and/or recommendations with regard to the development of future risk models. Journeay et al. (2015) mostly address the analytical capacity of the models, and identify (over-) simplification of models, lack of forward/future-looking models, disconnect between risk analysis and risk evaluation, and a lack of decision-analysis techniques. Pearce (2016) provides a list of over 40 recommendations, which are summarized under: technology & expertise; accessibility; validity; use of data sets and resources; community engagement; planning outcomes, process and linkages to land use planning; hazard identification; exposure; estimating risk & determining risk tolerance; dealing with uncertainty and risk communication; vulnerability; impact analysis; assessing resiliency; and risk management and mitigation. Lyle & Hund (2017) conclude that there is a lack in capacity for quantitative risk assessment in Canada, which they attribute to a lack in available datasets and a lack in professional capacity. They furthermore conclude that there is a need for a federally-supported risk assessment model for local governments, which is simple to use, locally relevant, but provides a high-level (property-level) standardized method for risk assessment.

Table B-2. Overview of risk models, relevant to the local-regional scale. Sources: Journeay et al., 2015; Pearce, 2016; Lyle & Hund, 2017.

Model or Framework	Reviewed by	QN/QL*	Model or Framework	Reviewed by	QN/QL*
Aboriginal Disaster Resilience Program (ADRP)	Pearce, 2016	QL	**Northwest Territories Hazard Identification and Risk Assessment (NWT-HIRA)**	Pearce, 2016	QL & QN
Alberta Hazard Identification Risk Assessment (AB-HIRA)	Pearce, 2016	QL & QN	**Nova Scotia Hazard Risk Assessment (NS-HRA)**	Pearce, 2016	QL
Awareness and Preparedness for Emergencies at the Local Level (APELL)	Pearce, 2016	NS	**Nunavut Family Preparedness (N-FP**)	Pearce, 2016	NS
British Columbia Hazard, Risk and Vulnerability Assessment (BC-HRVA)	Pearce, 2016	QL & QN	**Ontario Hazard Identification and Risk Assessment (ON-HIRA)**	Pearce, 2016	QL & QN
Capability Based Planning – Target Capabilities List (CBP-TCL)	Pearce, 2016	QL & QN	PDRA – Participatory Disaster Risk Assessment	Journeay et al., 2015	QL
Community Resilience Model (CRM)	Journeay et al., 2015	QN	**Prince Edward Island Hazard Risk Assessment (PEI-HRA)**	Pearce, 2016	QL
Disaster Resilience by Design – Pathways Framework (DRD-PATH)	Pearce, 2016	QL & QN	**Québec Gestion des risques en securité civile (QUE-GR)**	Pearce, 2016	QL & QN
Emergency Management Australia- National Emergency Risk Assessment Guidelines (NERAG)	Pearce, 2016	QL & QN	**Rapid Risk Evaluation – Earthquake (RE2-Earthquake)**	Lyle & Hund, 2017	QN
FEMA Comprehensive Preparedness Guide/ Threat and Hazard Identification and Risk Assessment Guide (FEMA-CPA/THIRA)	Pearce, 2016	QL & QN	**Rapid Risk Evaluation – Flood (ER2-Flood)**	Lyle & Hund, 2017	QN
GNS Risk-based Land Use Planning for Natural Hazard Risk Reduction (GNS)	Pearce, 2016	QL & QN	**Risk-based Land Use Guide (RBLUG)**	Pearce, 2016	QL & QN

Model or Framework	Reviewed by	QN/QL*	Model or Framework	Reviewed by	QN/QL*
Hazard Impact Risk & Vulnerability Model (HIRV)	Journeay et al., 2015 Pearce, 2016	QL	RiskScape	Lyle & Hund, 2017	QN
Hazard Vulnerability Risk Assessment Model (HRVA)	Journeay et al., 2015	QL	**Rural Disaster Resilience Program (RDRP**)	Pearce, 2016	QL
HAZUS – FEMA Multi-Hazard Loss Estimation Methodology	Journeay et al., 2015 Pearce, 2016	QN	**Saskatchewan Hazard Risk Analysis and Risk Assessment (SK-HARA)**	Pearce, 2016	QL
HAZUS Canada	Pearce, 2016 Lyle & Hund, 2017	QN	Social Vulnerability Index (SoVI)	Journeay et al., 2015 Pearce, 2016	QN
InaSAFE	Lyle & Hund, 2017	QN	Swiss RIKO risk plan (RIKO)	Pearce, 2016	QN
Manitoba Hazard Analysis (MAN-HA)	Pearce, 2016	QL & QN	UNISDR Making Cities Resilient (UNISDR)	Pearce, 2016	QL & QN
NOAA Community Vulnerability Assessment Tool (CVAT)	Pearce, 2016	QN	USGS Land-Use Portfolio Model (LUPM)	Journeay et al., 2015 Pearce, 2016	QN
New Brunswick Hazard Analysis (NB-HA)	Pearce, 2016	QL	Vizonomy - ASTERRA	Lyle & Hund, 2017	QN
New Zealand Risk Management Approach (NZRM)	Pearce, 2016	QL & QN	Vulnerability and Capacity Assessment (VCA)	Pearce, 2016	QL & QN
Newfoundland and Labrador Hazard, Risk and Vulnerability Analysis (NL-HRVA)	Pearce, 2016	QL	**Yukon All Hazard Risk Assessment – Enterprise Risk Assessment (YK-AHRA)**	Pearce, 2016	QL
NOAA Risk and Vulnerability Assessment Tool (RVAT)	Journeay et al., 2015	QL			

Note: models that have a local to regional focus, models that have been developed in Canada are in **bold**. * QN= Quantitative; QL = Qualitative; NS = Not Specified

Risk assessment tools for Indigenous communities - Aboriginal Disaster Resilience Planning (ADRP)

To date, there is only one risk assessment tool available in Canada that is particularly geared toward Indigenous communities. The Justice Institute of British Columbia (JIBC) has created the Aboriginal Disaster Resilience Program (ADRP) approach (Justice Institute of British Columbia, 2015; included in the review by Pearce (2016)), which is based on their Rural Disaster Resilience Program approach (RDRP).Where the RDRP is a qualitative tool intended for use in small, remote communities (Justice Institute of British Columbia, n.d.), the ADRP focusses on Indigenous communities and the challenges that are relevant to Indigenous communities, but are less common elsewhere, for example food insecurities, access to services, and water contamination or shortages (Justice Institute of British Columbia, 2015; Marteleira, 2017). The objective of the ADRP is to build a resilience plan for the community.

The ADRP, and the RDRP, use series of questions, that can be answered with 'yes', 'no', 'needs more info' or 'not applicable', to guide users and enable them to rate their local risk and community resilience based on their own (local) experience, observations, Indigenous knowledge and history. The strength of both the RDRP and the ADRP lies in their citizen engagement and whole-of-community approach (Cox & Hamlen, 2015). The ADRP and RDRP are both accessible on-line and in print, and provides resources to complete the assessment.

Practical limitations of existing models for Indigenous communities

Based on the overview of risk assessment methods and tools presented above, and the limitations and gaps identified by Journeay et al. (2015), Pearce (2016), and Lyle & Hund (2017), several limitations of existing models may present difficulties for use by Indigenous communities, some of which are highlighted below.

First, there is a general lack of consideration in most models and tools for use by Indigenous communities. The ADRP is the only model that has been specifically adapted to meet the community characteristics and capacities of Indigenous communities. In addition, Marteleira (2017) investigated if the Resilient-C tool can be applied to Indigenous communities, and recommended adaptations to the indicators the tool applies. With the exception of the ADRP, the models provide few to no options to include Indigenous or local knowledge in the risk assessment.

Second, quantitative analyses (e.g. Hazus) that form part of some risk assessments are often based on input from census data. While this is a useful source for larger, urban, population centers, census data is often limited to very basic information for small communities. In addition, some Indigenous communities have chosen not to participate in the national census, and statistical data for these communities may thus not be available.

Third, some models have technical/computing requirements, or suggest the use of Geographical Information Systems (GIS). These requirements may proof difficult to fulfill for some Indigenous communities, especially those communities which are less technologically advanced, have no reliable access to internet, or those which have fewer human or financial resources.

And finally, in relation to process design, some models are based on a quite detailed and laborious risk assessment process (e.g. ADRP) or have a profound scientific approach (e.g. Disaster Resilience by Design). Such lengthy and detailed approaches will require prolonged time and input from various community members, which may not be a practical or desirable approach for small communities with few resources.

Other Guidelines, tools and models to inform risk assessment

Various other resources exist in Canada that provide information about certain hazards, or that can help inform a risk assessment. Some examples of these, publicly available, resources, relevant to the context of coastal British Columbia, are:

- **BC's coastal flood hazard guidelines**: The government of British Columbia published guidelines to assist in the correct estimation of the various components (i.e. higher high water level tide (HHWLT), sea level rise, storm surge, wave effect, freeboard) that contribute toward the development of Flood Construction Levels (FCLs; Kerr Wood Leidal Associates Ltd., 2011).

- **CanCoast**: CanCoast is a national scale database that can be used as a tool for assessing coastal sensitivity to sea-level rise and climate change, by allowing users to analyze the sensitivity of the coastline to inundation, and erosion (Figure B-3; Atkinson, Forbes, & James, et al., 2016). CanCoast is meant to inform coastal adaptation planning on a national scale, and currently does not provide coastal sensitivity information on a detailed, local scale, but CanCoast can be explored to gain a general sense of sensitivity in a region.

- **Resilient-C**: A relatively new online platform which uses the Hazards Vulnerability Similarity Index (HVSI) to measure similarity between coastal communities that are vulnerable to coastal hazards (Resilient-C, 2016). Currently, the Resilient-C platform is focused on communities in the Strait of Georgia in British Columbia (Resilient-C, 2016), but the platform does not include Indigenous communities. However, based on a study with the Musqueam First Nation in British Columbia, Marteleira (2017) provided recommendations to modify certain indicators, apply different methods of data collection, and to expand the resource library, to adapt the Resilient-C platform for Indigenous communities.

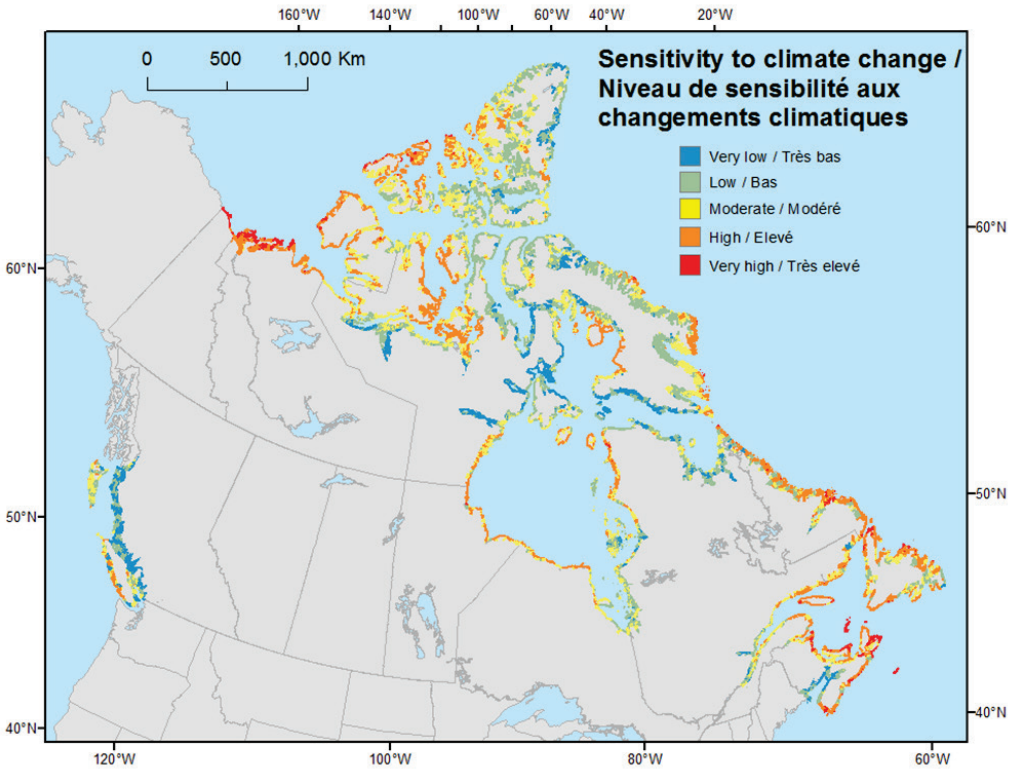


Figure B-3. CanCoast: sensitivity to climate change (Atkinson, Forbes, & James, 2016)

APPENDIX C – RISK MODELS

List of risk models, in alphabetical order, reviewed by Journeay et al. (2015), Pearce (2016), and Lyle & Hund (2017). Note: Acronyms have been copied from the authors.

Model Name (& Acronym)	Journeay et al., 2015	Pearce et al., 2016	Lyle & Hund, 2017
A structured approach to Enterprise Risk Management (ERM) and the requirements of ISO 31000 (ISO-31000)		✓	
Aboriginal Disaster Resilience Program (ADRP)		✓	
Alberta Hazard Identification Risk Assessment (AB-HIRA)		✓	
All Hazards Risk Assessment Methodology Guidelines (AHRA)		✓	
Applied Multi-Risk Mapping of Natural Hazards for Impact Assessment (Armonia)	✓		
Australian Geomechanics Society (AGS)	✓		
Awareness and Preparedness for Emergencies at the Local Level (APELL)		✓	
British Columbia Hazard, Risk, and Vulnerability Analysis (BC-HRVA)		✓	
Canadian Standards Association Z1600 (CSA Z1600)		✓	
Capability Based Planning – Target Capabilities List (CP-TCL)		✓	
Catastrophe Modeling for Insurance/ Reinsurance Sectors (CAT)	✓	✓	
Community Resilience Model (CRM)	✓		
Deutsche Gezellschaft für Technische Zusammenarbeit (GTZ)	✓		
Disaster Resilience by Design: Pathways Framework (DRD-PATH)		✓	

Model Name (& Acronym)	Journeay et al., 2015	Pearce et al., 2016	Lyle & Hund, 2017
Disaster Risk and Management Indicators for the Americas (IDEA)	✓		
Disaster Risk Index (DRI)	✓		
Economic Commission for Latin America and the Caribbean (ECLAC)	✓	✓	
Emergency Management Australia - National Emergency Risk Assessment Guidelines (EMA/NERAG)	✓	✓	
EmerGeo	✓		
European Spatial Planning Observation Network (EPSON)	✓		
FEMA Comprehensive Preparedness Guide/ Threat and Hazard Identification and Risk Assessment Guide (FEMA – CPA/THIRA)		✓	
FEMA Multi-Hazard Loss Estimation Methodology (HAZUS)	✓	✓	
FEMA National Response Framework (FEMA)		✓	
Geoscience Australia National Exposure Information System and Risk and Impact Analysis (NEXIS)		✓	
GeoScience Australia: Risk and Impact Analysis Program (GA)	✓		
Geoscience New Zealand Hazards and Society Program (GNS)	✓		
Global Earthquake Model (GEM)/ OpenQuake			✓
GNS Risk-Based Land Use Planning for Natural Hazard Risk Reduction (GNS)		✓	
Hazard Impact Risk & Vulnerability Model (HIRV)	✓	✓	
Hazard Vulnerability Risk Assessment Model (HRVA)	✓		

Model Name (& Acronym)	Journeay et al., 2015	Pearce et al., 2016	Lyle & Hund, 2017
Hazus Canada		✓	✓
InaSAFE			✓
Indicators of Disaster Risk and Risk Management – Disaster Deficit Index (DDI)		✓	
Indicators of Disaster Risk and Risk Management – Local Disaster Index (LDI)		✓	
Indicators of Disaster Risk and Risk Management – Prevalent Vulnerability Index (PVI)		✓	
Indicators of Disaster Risk and Risk Management – Risk Management Index (RMI)		✓	
LIRA			✓
Manitoba Hazard Analysis (MAN-HA)		✓	
National Fire Protection Association Standard on Disaster/Emergency Management and Business Continuity / Continuity of Operations Programs (NFPA-1600)		✓	
Natural Disasters Hotspots (NDH)	✓	✓	
New Brunswick Hazard Analysis (NB-HA)		✓	
New Zealand Risk Management Approach (NZRM)		✓	
Newfoundland and Labrador Hazard, Risk and Vulnerability Analysis (NL-HRVA)		✓	
NOAA Risk and Vulnerability Assessment Tool (RVAT)	✓		
NOAA Community Vulnerability Assessment Tool (CVAT)		✓	
Northwest Territories Hazard Identification and Risk Assessment (NEW-HIRA)		✓	

Model Name (& Acronym)	Journeay et al., 2015	Pearce et al., 2016	Lyle & Hund, 2017
Nova Scotia Hazard Risk Assessment (NS-HRA)		✓	
Nunavut Family Preparedness (N-FP)		✓	
Ontario Hazard Identification and Risk Assessment (ON-HIRA)		✓	
Participatory Disaster Risk Assessment (PDRA)	✓		
Prince Edward Island Hazard Risk Assessment (PEI-HRA)		✓	
Québec Gestion des risques en securité civile (QU-GR)		✓	
Rapid Risk Evaluation – Earthquake (ER2-Earthquake)			✓
Rapid Risk Evaluation – Flood (ER2-Flood)			✓
Risk-based Land-Use Guide (RBLUG)		✓	
RiskScape			✓
Rural Disaster Resilience Program (RDRP)		✓	
Saskatchewan Hazard Analysis and Risk Assessment (SK-HRA)		✓	
Social Vulnerability Index (SoVI)	✓	✓	
Sustainability Science Model (SUST)		✓	
Swiss RIKO RiskPlan (RIKO)		✓	
UNISDR Making Cities Resilient (UNISDR)		✓	
United Kingdom Keeping the Country Running: Natural Hazards and Infrastructure (UKNH&I)		✓	
Urban Seismic Risk Index (USDRi)	✓		
USGS Land-Use Portfolio Model (LUPM)	✓	✓	

Model Name (& Acronym)	Journeay et al., 2015	Pearce et al., 2016	Lyle & Hund, 2017
Vizonomy – ASTERRA			✓
Vulnerability and Capacity Assessment (VCA)		✓	
World Meteorological Organization Comprehensive Risk Assessment for Natural Hazards (WMORA)		✓	
Yukon All Hazards Risk Assessment – Enterprise Risk Management (YK-AHRA)		✓	