Frequent Spring Flooding Impacts, Evacuation Experiences, and Perceived Adaptive Capacity of Kashechewan First Nation, Northern Ontario

by

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A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

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Abstract

Kashechewan First Nation, located in the southwestern James Bay (Subarctic) region of northern Ontario, is frequently affected by the flooding risk and recurring evacuations. Residents have been evacuated 14 times since 2004 (consecutively from 2004-2008 and 2012-2019) to at least 22 different host communities across Ontario. This dissertation provides valuable insights into the nature of spring flooding and its impacts from the perspectives of Kashechewan residents. The aim of this research is to examine how Kashechewan First Nation is affected by and responds to floods. Specific objectives are to explore First Nation's flood-related observations on changes in frequency and intensity of floods, to examine residents' experiences of impacts of frequent flooding risk and recurring evacuations, and to determine the community's perceived adaptive capacity to spring flooding.

Through a collaboration with Kashechewan First Nation, data were collected from 155 participants using mixed methods research. The qualitative methods included semi-structured interview and participatory flood mapping, including on-site walk and photography. Qualitative data were collected to understand the increased flooding risk, flooding impacts, and evacuation experiences of residents. Quantitative data were collected through survey research to assess perceived adaptive capacity. This research included all subgroups of the community, such as socioeconomic, sociocultural, and demographic. Qualitative data were analysed using NVivo, ArcMap, GIS, and Google Earth. The semi-structured interview data were coded and analysed using a mix of descriptive and analytical coding schemes. Categories were made using the words of participants, which were commonly used. Analytical codes were also derived from the research literature, previous studies, and the researcher's understanding of the rich qualitative data collected. The data collected using flood mapping workshops and on-site walks were analysed in ArcMap, GIS and Google Earth to produce scaled maps. The survey data was analysed in SPSS and used descriptive and inferential statistics. The nonparametric statistics of one-sample Chi-square, Spearman's (rho) correlation coefficient, Friedman's $\chi 2$ two-way analysis of variance (ANOVA), and principal component analysis were employed.

The findings contribute to the literature on natural hazards, DRR, and climate change adaptation. This research is especially unique because it has brought new methodological and theoretical insights into the research, combining qualitative and quantitative methods to facilitate an in-depth investigation of spring flooding by employing a mixed case study approach. The first contribution is the documentation of community-specific traditional knowledge concerning spring flooding characteristics and river morphology to identify the major drivers of increased flooding risk and recurring evacuations. These findings complement the existing spring flooding data collated by natural scientists and contribute to the literature on the spring breakup ice jamming phenomenon to better understand ecological and human-induced changes to mitigate flooding risk. The contribution is involving traditional and scientific knowledge systems about warming temperatures, and the spring breakup ice jamming contributes to bridging the gap between the two diverse knowledge systems. Second, this research has explored the experiences of the short-term evacuations of residents that happened 14 times since 2004. The findings are unique because there is a lack of research about how people and a community are affected by recurring evacuations. This research also revealed the consequential negative effects due to repeated evacuations on the community's sociocultural, emotional, and spiritual well-being. The finding of enhanced resilience and coping capacity is a significant contribution to the literature.

Third, this research contributes to the literature on adaptive capacity by focusing on the perceived capacity of the First Nation. The adaptive capacity literature mainly focuses on objective capacity. This research shows that perceived capacity is as important as the objective capacity to determine total adaptive capacity. The fourth contribution is the use of survey research and the integrated socio-ecological system approach to assessing perceived capacity involving a First Nation. This is the first application of the method and the approach in northern Canada to assess perceived adaptive capacity. The use of structured interviews contributes to the literature by showing that survey research involving northern Indigenous communities can be culturally appropriate.

Preface

I. This thesis is my original work. The research project received research ethics approval from the University of Alberta Research Ethics Board, Project titled "Flooding Hazard and Remote First Nation Communities: The Case of Kashechewan, Northern Ontario", Study ID: Pro00065168, 14th July 2016. I developed the research design of this mixed methods research and methods of data collection under the supervision of Dr. Tara McGee, as my supervisor, and Dr. Brenda Parlee and Dr. Damian Collins as members of my Ph.D. Supervisory Committee.

II. Chapter 2 of this thesis has been published as Khalafzai, M-A.K., McGee, T.K, and Parlee, B. (2019), Flooding in the James Bay region of Northern Ontario, Canada: Learning from Traditional Knowledge of Kashechewan First Nation, *International Journal of Disaster Risk Reduction,* 36: 101100. https://doi.org/10.1016/j.ijdrr.2019.101100. I was responsible for the data collection and analysis as well as the manuscript composition. Dr. Tara McGee supervised this research project and contributed to editing the manuscript. Dr. Brenda Parlee contributed to editing the manuscript as a supervisory committee member.

III. Chapter 3 of this thesis has been submitted to the *International Journal of Disaster Risk Reduction* and is under review. The title of the manuscript is "Spring Flooding and Recurring Evacuations of Kashechewan First Nation, Canada". The co-authors are Dr. Tara McGee and Dr. Brenda Parlee. I was responsible for the data collection and analysis as well as the manuscript composition. Dr. Tara McGee supervised this research project and contributed to editing the manuscript. Dr. Brenda Parlee contributed to editing the manuscript as a supervisory committee member.

IV. Chapter 4 of this thesis has been submitted to the ARCTIC Journal, Canada and is under review. The title of the manuscript is "Frequent Flooding and Perceived Adaptive Capacity of Subarctic Kashechewan First Nation, Canada". The co-authors are Dr. Tara McGee and Dr. Brenda Parlee. I was responsible for the data collection and analysis as well as the manuscript composition. Dr. Tara McGee supervised this research project and contributed to editing the manuscript. Dr. Brenda Parlee contributed to editing the manuscript as a supervisory committee member.

Dedication

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

In the name of Allah, Most Gracious, Most Merciful.

"وقل ربي زدني علما"

“O Allah (my Lord) increase me in knowledge.”
(Al-Quran; Surah Ta-ha, 20, 114)

To my Beloved Parents:

محمد ظریف خان خلف زئی ۔ معراج النساء خلف زئی ۔

AND Beloved Siblings:

محمد عارف ضیا خلف زئی ۔ محمد حنیف خان خلف زئی ۔ افتخار احمد خان خلف زئی ۔ امتیاز احمد خان خلف زئی ۔ جمیلہ طاھرہ خلف زئی ۔ نبیلہ سارہ خلف زئی ۔ محمد آصف کامران خلف زئی۔ محمد عاصم فسعح خلف زئی ۔ سجیلا امبرین خلف زئی ۔ عبدالباسط خلف زئی۔ عائشہ خان خلف زئی ۔

Names are given in Urdu language.

Acknowledgements

I would like to thank Dr. Tara McGee, my supervisor, who provided much guidance, constant support, and mentorship and continued encouragement since Fall 2014. The achievement made in completing this research would have not been possible without her continued guidance and support. I would also like to thank my supervisory committee members, Dr. Brenda Parlee and Dr. Damian Collins. In particular, my supervisory committee member, Dr. Brenda Parlee provided much guidance and support as well as her innovative ideas and insightful advice during all these years. I thank Dr. Joshua Evans for sharing ideas during our frank conversations.

Many individuals, including my colleagues and friends, provided their support and shared useful ideas at every stage during all these years. Particularly, Dr. Henok W. Asfaw, with whom I shared the office space, was very helpful, while frequently exchanging information, knowledge, and views on many issues concerning our research. I would also like to thank my friends Dr. Altaf Hussain and Dr. Alam Zeb who provided much-needed support and help in times of need, while they were also busy in their research projects and writing theses. I also like to thank statistician Muhammad Zahid Jamal for his support, particularly for his guidance during statistical analysis. I would also like to thank my friends Muhammad Asad Raza, Dr. Sheikh Javed, Dr. Humayun Chaudhry, and their wives for their support, help, and kindness during my transit in Milton, Mississauga, Toronto, and Calgary, while traveling several times between Edmonton, AB, and Kashechewan, ON. I also thank my friends Omar Elhore, Rizwan Khalid, Muhammad Imtiaz Anjum, Waseem Qasuria, Qamar Abbas Zaidi, Aziz Ullah, and Adil Qayyum for their support.

My special thanks to Kashechewan Chief Leo Friday, Grand Chief Jonathan Solomon, Elder William Sutherland, Oliver Wesley, Phillip Goodwin, Byron Koosses (Late), all community members, and to those who participated in my research project. I also like to thank Project Manager of Belanger Construction company and Holly Woodhouse (cook) who took care of me when I was staying with them during my fieldwork. I especially like to thank all those who have provided the financial support for my research project, including the Northern Scientific Training Program (NSTP) and U Alberta North (Patricia Fontaine), the University of Alberta, and Human Geography Program, Department of Earth and Atmospheric Sciences, the University of Alberta.

List of Tables

List of Figures and Photographs

Figures:

Photographs:

List of Appendix Items

List of Acronyms and Abbreviations

CAC – Community Advisory Committee

CAD – Canadian Dollar

CAF – Cancun Adaptation Framework

CIHR – Canadian Institute of Health Research

CAS – Children's Aid Society

DRR – Disaster Risk Reduction

GIS – Geographic Information System

GPS – Global Positioning System

HBC – Hudson Bay Company

HEA – Hishkoonikun Education Authority

INAC – Ministry of Indian and Northern Affairs Canada

IPCC – Intergovernmental Panel on Climate Change

ISC – Indigenous Services Canada

MMR – Mixed Methods Research

MOU – Memorandum of Understanding

NRC – Natural Resource Canada

REB – Research Ethics Board

SIDE – Small Islands Developing States

TCPS-2 – Tri-Council Policy Statement 2

UNFCCC – United Nation's Framework Convention on Climate Change

UNISDR – United Nations International Strategy for Disaster Reduction

Table of Contents

CHAPTER 1: INTRODUCTION

1.1. Flooding and Indigenous Peoples of Canada

Spring flooding is one of the major natural hazards that affects northern Indigenous Peoples[1] in Canada (Newton, Paci, & Ogden, 2005). According to the Ministry of Indigenous Services Canada (ISC), there are numerous First Nation[2] communities at-risk of spring flooding[3] across Canada due to their proximity to rivers. From 2006 to 2016, sixty-seven First Nations experienced about 100 floods in Canada, while 13 First Nations of Ontario experienced 20% recorded floods (McNeill, Binns, & Singh, 2017). In particular, the northern Ontario climate is conducive to ice jams in the southwestern James Bay region (Gerard & Davar, 1995). The Cree[4] First Nations, such as Attawapiskat, Fort Albany, and Kashechewan, located along the southwestern James Bay coast are frequently affected by ice jam spring flooding risk (Nafziger, She, & Hicks, 2016; Abdlnour, 2013; Ho, Tsuji, & Gough, 2011). Kashechewan First Nation community is regularly affected by elevated flooding risk and evacuations every spring between 2004 and 2008 and from 2012 to 2019. This research aims to examine how Kashechewan First Nation is affected by and responds to floods and provide recommendations as a way forward. The specific objectives are to:

- Explore Kashechewan First Nation's traditional and local spatial knowledge concerning the elevated spring flooding risk.
- Examine Kashechewan residents' experiences of actual flooding or frequent flooding risk impacts and recurring evacuations.
- Analyse residents and the community's perceived adaptive capacity to the increased flooding risk.

[1] Indigenous Peoples is a collective name for the original peoples of North America and their descendants. Often, 'Aboriginal Peoples' is also used. The Canadian Constitution recognizes three groups of Aboriginal Peoples: First Nations (also called Indians), Inuit, and Metis. These are three distinct peoples with unique histories, languages, cultural practices, and spiritual beliefs (Government of Canada). https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303.

[2] First Nations identify themselves by the nation to which they belong, e.g., Cree. There are over 630 First Nations in Canada, which represent more than 50 Nations and 50 Indigenous languages (Government of Canada). https://www.rcaanc-cirnac.gc.ca/eng/1100100013785/1529102490303.

[3] Spring flooding is caused by rapid snowmelt runoff due to ice breakup and jams in the spring season.

[4] The Cree First Nations are the most populous and widely distributed Indigenous Peoples in Canada. Cree First Nations occupy territory in the Subarctic region from Alberta to Québec, and parts of the Plains region in Alberta and Saskatchewan. The 2016 census data shows that 356,655 people have Cree ancestry, and 96,575 people speak the Cree language (Canadian Encyclopaedia, 2019). https://www.thecanadianencyclopedia.ca/en/article/cree

1.2. Kashechewan First Nation

Kashechewan is a fly-in remote First Nation settled on Fort Albany Reserve 67 in the southwestern James Bay region (Figure 1.2). According to Chief Leo Friday, Kashechewan ("Kakiigachiwan" in Cree) means "water flows forever: as long as the sunshine, as long as grass grows, and as long as the river flows". Fort Albany Reserve 67 is unique because two First Nations, Kashechewan and Fort Albany, are located on the reserve. The existing Kashechewan community was established in 1957 on the northern bank of the North Channel of the Albany River. Kashechewan is situated 81 degrees west longitude and 52 degrees north latitude. Kashechewan is about 12 kilometres (straight line distance) upstream from the James Bay coast and about 13 kilometres (estimated driving distance via winter ice road) from the nearest First Nation community of Fort Albany. Fort Albany First Nation is settled on the southern bank of the River's South Channel. While the two First Nations share the 225 square kilometres territory of Reserve 67, Kashechewan is in the Kenora district and Fort Albany in the district of Cochrane. Over 95% of the reserve territory falls in the Kenora district and the remaining in Cochrane. The next nearest fly-in First Nation is the community of Attawapiskat about 88 kilometres (straight line distance) north of Kashechewan. The nearest major town of Moosonee is about 150 kilometres away, an estimated winter ice road driving distance. Moosonee is accessible to the residents of the three First Nations of Kashechewan, Fort Albany, and Attawapiskat via the 312 kilometres winter ice road but for only about 10 weeks. The three communities also are accessible via boat and barge during other seasons since there is no all-season road that connects them to the rest of the country. Essential supplies, such as groceries, other staple goods, and gasoline, are transported via the ice road in winter and by barge and by air during other seasons.

The Cree First Nations have lived in the Hudson Bay and James Bay Lowlands for centuries and have been using natural resources, including the lands, the waters (Wee-nee-peg-kook) of surrounding rivers and lakes, and wildlife. The First Nations, including the Kashechewan community, of the southwestern James Bay region also are called the Swampy[5] Cree First Nations (Molohon, n.d). The land and water are considered an integral part of their traditional way of life

[5] "An Algonquian People comprising the Maskegon and the Monsoni formerly inhabiting Swampy regions of Manitoba and Ontario from Lake Winnipeg and Lake of the Woods to the Moose River and Hudson Bay and sometimes classed with the Cree People and sometimes with the Chippewa." https://www.merriam-webster.com/dictionary/Swampy%20Cree

and essential for their spiritual, cultural, and economic well-being (Government of Ontario, 2017). The Cree hunters would visit the Old Post (She-Ban-Nuck), which was established before 1755 at Albany Island for fur trade in the summer season. Old Post was established at the mouth of Albany River (6-8 km from the coast); the third fur trading post established by the Hudson Bay Company (HBC) in Canada (Molohon, n.d). Old Post, Albany Island was about only 6 feet higher than sea level. Before the establishment of Kashechewan in 1957, initially, the federal government proposed Fishing Creek Island (88.5 km south of Kashechewan) as a possible area for relocation of the community. The First Nation members were not persuaded to take this option due to problems related to a third party located on the island and the government's inability to acquire the whole of the island to add to Reserve 67.

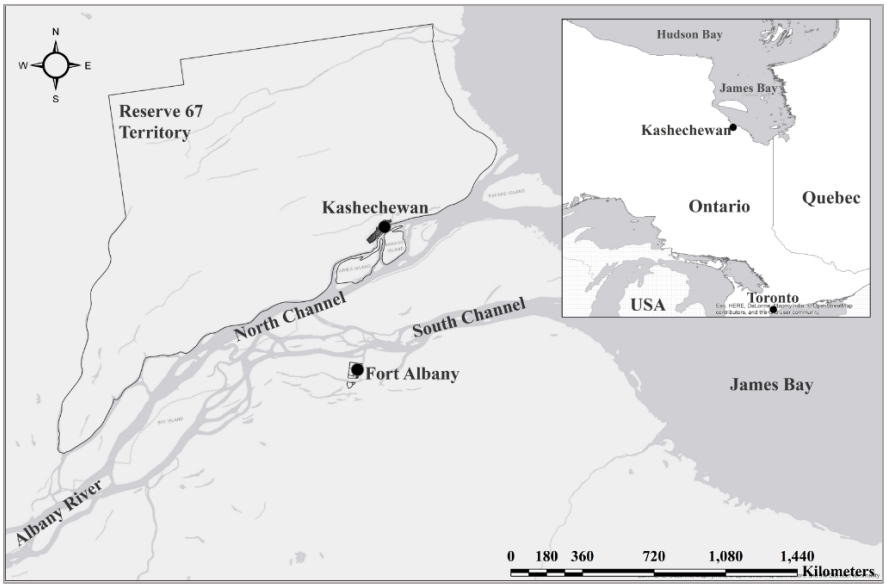


Figure 1.2. Kashechewan First Nation Location Map.

In the summer of 1905, Treaty 9 was agreed and signed at Old Post, Albany Island.[6] As a result, the Fort Albany Reserve (67 of Treaty 9) was created. During the 1950s, the original Fort Albany band[7] was divided along denominational (religious) lines and left the Old Post, Albany Island settlement (Long, 2010). According to Long (2010), the Roman Catholic went to the present-day Fort Albany, also called the Oblate site at Lac Ste Anne and, the Anglican were

[6] Kashechewan First Nation is one of the eight members of the Mushkegowuk Tribal Council, including Attawapiskat (Reserve 91/91A), Chapleau Cree (75), Fort Albany (67), Moose Cree (68), Taykwa Tagamou (69/69A), and Weenusk now called Peawanuk (90), and Missanabie Cree (recently granted reserve status).

[7] In Canada, a "band" is a self-governing unit of Indigenous Peoples.

resettled at the present-day Kashechewan. However, Reserve 67 is officially shared even today by the two First Nations. The Fort Albany Chief and Council administered Fort Albany First Nation and Kashechewan First Nation until 1974. Since then, the Kashechewan First Nation community has had an independent chief and council. Before resettlement at its existing location in 1957, Kashechewan First Nation desired to set up its community at a higher and safer ground on the reserve territory.[8] Instead, the federal government relocated and resettled the community at its existing location.

Before the 1920s, the Cree First Nations of the James Bay Lowland did not have permanent settlements and coped with floods during spring by moving several dozen kilometres inland and spending most of the year away from the flood-prone, low-lying areas (McCarthy, Crandall, Whitelaw, General, & Tsuji, 2011; Newton, 1995). After the establishment of the HBC trading posts along the southwestern James Bay coast, change in the First Nations communities' way of life from nomadic to permanent settlements drastically increased their exposure to spring floods (McCarthy et al., 2011).

1.3. Flooding Risk at Kashechewan First Nation

Kashechewan First Nation is frequently affected by spring flooding or flooding risk and recurring evacuations, more than any other First Nation in the region. The region is considered the hotspot of spring floods in northeast Ontario because of the area's flat, low-lying topography, which is susceptible to flooding. During spring, the river flows often rise 1-2 meters top of the riverbank. The southwestern James Bay Lowland is the largest Canadian wetland region that extends inland 160-322 kilometres (NAV-Canada, 2002; Ohmagari & Berkes, 1997). Overall, the region is muskeg, marsh swamp, and peatland. Most of the sea coastline (3-5 km inland) is tidal, mudflat, and below the sea level. The elevation of Kashechewan is only a few feet higher than the Albany River and just 27 feet above the sea level. Most of the reserve territory falls under the government declared flood-zone, and the Kashechewan location is a very high risk.

[8] Standing Committee on Aboriginal Affairs and Northern Development (2005, p. 2). (http://cmte.parl.gc.ca/Content/HOC/Committee/381/AANO/Evidence/EV2067775/AANOEV48-E.PDF)

The Albany River is 982 kilometres long, named after the King James II of England, Duke of York and Albany. The river is in the James Bay drainage basin.[9] Its Cree name is "Chichewan". It has different names for different people with different but related meanings. According to the Canadian Encyclopaedia (2015), the river "Chichewan" means "several rivers form one that flows towards the ocean". The Albany River has the three sub-rivers of the Ogoki, Kengogami, and Mammamattawa. The Ogoki River is 480 kilometres long and flows from Lake Nipigon in the northwest (through Wabakimi National Park) to Ogoki in the northeast and merges with the Albany River. The Kenogami River (meaning "long water" in Cree) is 320 kilometres long, which flows north from Long Lake, Longlac into the James Bay. The confluence point of Kenogami and Kabinakgami rivers is called Mammamattawa, which is an unorganized northern part of the Cochrane District.

During the early 20th century, spring floods of 1914, 1922, and 1928 severely affected the original community that was initially established as early as 1743 at Old Post, Albany Island, and had been relocated to the new location of Fort Albany (Molohon, n.d). Fort Albany is about 15 kilometres upstream and consists of three areas, including the mainland, Anderson Island, and Sinclair Island. In the recent past, the most significant spring floods occurred in the Albany River in 1966, 1972, 1976, 1985, 2006, and 2008 since the establishment of Kashechewan in 1957 (Abdelnour, 2013; McCarthy et al., 2011). During spring, Albany's high floodwaters and breakup ice jams amid warming spring temperatures seriously threaten Kashechewan and its critical infrastructure. Beginning March, residents start getting worried due to fear of being flooded; it has become a part of new life.

To deal with the increased spring flooding risk, Natural Resource Canada (NRC) helps the First Nation by providing the river flow discharge at the Hat Island gauging station. The discharge threshold at the Hat Island gauging station (150 km upriver) is 5,000 m^3/s.[10] This threshold must be met for the band to declare an emergency in Kashechewan. The past 52-year discharge data recorded at the gauging station indicate that there is no significant change in the annual average flows. Figure 1.3 shows the timing of maximum discharge events 5,000 m^3/s or more and the major

[9] The basin is the ancestral lands of Cree First Nations who have been hunting and fishing here for centuries (Canadian Encyclopaedia, 2015).

[10] River discharge is a discharge of one cubic meter per second. In other words, at a single point on the riverbank, 1,000 litres of water flow every second.

floods that occurred from 1965 to 2018. The recorded annual average discharge for the period 1965-2018 is 4,655 m^3/s. The 1985 and 2006 floods were caused by a rapid increase in temperature and precipitation or, in the case of the 1976 flood, substantial rainfall (McNeill et al., 2017; Abdelnour, 2013; Grover, Vrkljan, Beltaos, & Andres, 1999). The maximum flow that occurred during April in 1976, 1985, 2006, and 2008, and during May in 1992, 1996, and 1997 represents the premature and over-mature[11] ice breakups, respectively. Notably, the timing of annual maximum spring discharge of the Albany River indicates that premature breakups caused the major floods of 1976, 1985, 2006, and 2008 with flows of over 6,000 m^3/s. Conversely, the higher flows of 8,000 m^3/s or more in 1992, 1996, and 1997 were over-mature breakups and did not result in floods. This indicates that the floods occurred because of ice jams and not peak river flows. Table 1.3 summarizes the estimated discharge at the Hat Island and in South Channel at Fort Albany for different return periods and indicates the elevated risk of spring flooding, particularly at the river's mouth.

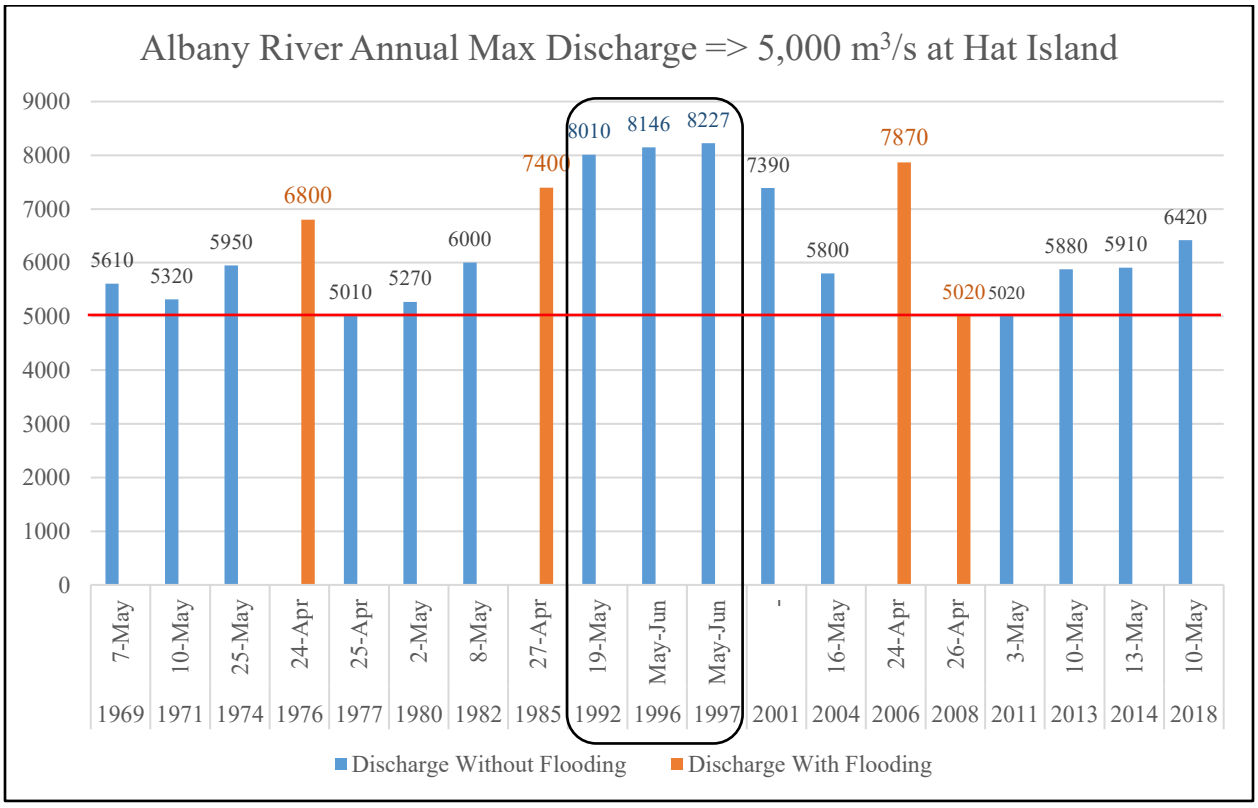


Figure 1.3. Albany River Annual Maximum Discharge 5,000 m^3/s or More at Hat Island.

[11] The over-mature ice (often in May) breakup is caused by mild weather with little or no runoff (Beltaos, 2007).

Return Period (year)	Hat Island	Fort Albany*
2	4,390	4,840
5	5,670	6,250
10	6,580	7,260
20	7,500	8,270
50	8,760	9,660
100	9,770	10,800

Source: Grover et al. (1999).
*Note: The Kashechewan (North Channel flows) data is not available.
Table 1.3. Albany River Flows Return Period at Hat Island and Fort Albany.

1.4. Federal Government's 2006 Relocation Proposal

On 6th June 2006, the Government of Canada appointed Alan Pope as Special Representative of the then Minister of Indian and Northern Affairs Canada (INAC) to investigate the flooding problem in Kashechewan and deficiencies in community services and recommend solutions. In October 2006, Pope completed his study and reported that despite the construction of a (5.3 km long by 3.5 m high ring-shaped) dike system in 1997 surrounding Kashechewan, the community has been facing the risk of flooding and evacuation every year. He also reported serious infrastructure issues, particularly design and construction deficiencies in the dike, and a lack of repair and maintenance, and inappropriately designed houses for the large family sizes. Additional infrastructure issues were inadequacies and operational deficiencies of the water treatment plant and water supply services, backup of the sewerage system, and inconsistent primary healthcare and educational services. In addition, he indicated the socioeconomic challenges such as lack of employment, limited economic opportunities, isolation, and poverty. In summary, Pope (2006) recommended relocation of the community from the existing site to the outskirts of Timmins (about 425 km southwest of Kashechewan). On 8th September 2006, he presented the proposal to the Kashechewan Chief at a community public forum. As part of potential solutions, Pope (2006) conducted a survey and offered band members the following three on- and two off-reserve options to choose from for possible relocation. Appendix A provides details of the five options and their respective advantages and disadvantages.

1. Staying at the existing site and raising the settlement (aggregate fill in the community) 30 feet higher, including the airport.
2. Relocate to Fort Albany and have new housing and infrastructure on an elevated ground, while merging with the Fort Albany First Nation and have one band.
3. Relocate 30 kilometres (straight line distance) upriver on the reserve territory known as Site 5, which is relatively a higher and safer ground.
4. Relocate to Smooth Rock Falls, 380 kilometres southwest of Kashechewan with possible availability and buying of empty houses.
5. Relocate to Bigwater Lake near Timmins, about 425 kilometres southwest of Kashechewan, being near the urban centre.

In response, most of the community, however, rejected the four options because they wanted to relocate to Site 5 (3rd option). According to Chief Leo Friday and the October 2016 referendum commissioned by the First Nation, a significant majority (89%) of band members voted in favour of Site 5. In brief, the community wanted to relocate to Site 5 because they essentially do not want to lose their traditional ancestral lands and the wealth of natural, mineral, and other resources. Nonetheless, the five options appeared complex, which added to the problem coupled with the expected high costs and politics. The cost of relocation was initially estimated between CAD (Canadian dollar) 350 million and CAD 400 million and was increased to CAD 750 million in the year 2008-2009 (Harries, 2008).[12] The relocation proposal did not materialize because the federal government did not allocate the required funding, and the community continues to be exposed to the increased flooding risk.

1.5. Theoretical Framework

This Ph.D. research is guided by concepts drawn from multidisciplinary social sciences. The concepts of vulnerability, adaptation, and resilience were employed. Specific theoretical frameworks that guided the three main research objectives are discussed in Chapters 2, 3, and 4. The first is the 2010 UNFCCC (United Nation's Framework Convention on Climate Change) framework, which highlights the contributions of traditional knowledge to a broader understanding of climate change–including climate-change observations, impacts, and opportunities for

[12] http://www.cbc.ca/news/canada/sudbury/kashechewan-prepares-for-another-flood-evacuation-worries-about-dike-1.3041852

adaptation and DRR and is discussed in Chapter 2. The second is the vulnerability and resilience framework developed by Maru, Smith, Sparrow, Pinho, and Dube (2014), which is discussed in Chapter 3. The Maru et al. (2014) framework allows a conjoined treatment of vulnerability and resilience to take advantage of the contributions that both traditions can make for complementarity and synergy. The third and last specific framework is the integrated socio-ecological system approach developed by Whitney and colleagues (2017) discussed in Chapter 4. The approach focuses on a systems-based, integrated, social-ecological understanding of adaptive capacity, which includes the analysis of both social and ecological drivers of change and their interdependencies.

Disasters are conceptualized in three different ways. First, the classical approach conceptualizes disasters simply by focusing on the negative impacts of disasters (Perry, 2007). Second, the hazard-disaster perspective characterizes disasters when vulnerable people and hazards risks interact with each other (Susman, O'keefe, & Wisner, 1983). Notably, this perspective focuses on hazards risks that shape the nature of impacts. The research rooted in the hazard-disaster view also has shifted from disasters to vulnerability and resilience (rather than vulnerability or resilience) of communities (Maru et al., 2014; Gaillard, 2007; Cutter, 2006; Cutter, Boruff, & Shirley, 2003; Blaikie, Cannon, Davis, & Wisner, 1994). Finally, the third perspective explicitly focuses on the socio-ecological phenomenon (e.g., socio-ecological vulnerability)[13] as a defining characteristic of hazards risks (De-Lange, Sala, Vighi, & Faber, 2010; Perry, 2007). I employed the last two approaches with a focus on the vulnerability to hazards and the resilience (or adaptive capacity) of the community. I applied the vulnerability concept in the context of people's exposure to the hazard risks, sensitivity to impacts, and adaptive capacity to spring floods.

1.5.1. Vulnerability

In my research, the concept of vulnerability was central to the broad theoretical framework because people's disaster response is shaped by their vulnerability conditions as well as the influence of perception (Tobin et al., 2011; Cutter, 2006; Cutter et al., 2003; Cutter, 1996). Today,

[13] "Social vulnerability is partially the product of social inequalities–those social factors that influence or shape the susceptibility of various groups to harm and that govern their ability to respond" (Cutter et al., 2006, p. 115). Social vulnerability is often described using individual characteristics such as health, income, and type of dwelling. Ecological vulnerability is "the potential of an ecosystem to modulate its response to stressors over time and space, where that potential is determined by characteristics of an ecosystem that include many levels of an organization. It is an estimate of the inability of an ecosystem to tolerate stressors over time and space" (De-Lange et al., 2010, p. 3872).

The vulnerability of people to natural hazards is an extensively used conceptual and theoretical explanation for disasters (Cannon, 2014; Wolf, 2011; Lindell, Tierney, & Perry, 2001; Blaikie et al., 1994) because the condition of vulnerability plays a critical role in determining climatic and natural hazards risks. Wisner (2016) and Wisner and colleagues (2004) emphasize that individual or group characteristics and their conditions affect (or limit) their capacity to anticipate, cope with, and recover from the impact of natural hazards.[14] This emphasis involves a combination of factors that determine the degree to which people's lives, livelihoods, and properties are exposed to the hazards risks. In this connection, the hazard-disaster approach also guided my research because people's exposure to hazards often interacts with their sensitivity to the impacts, and this complex combination and relationship allow hazards to become disasters.[15] Vulnerability of socio-ecological systems can be created by political, socioeconomic, ideological, and cultural processes as well as institutional structures that expose individuals and communities to natural hazards risks (Cannon, 2014; Wolf, 2011; Lindell et al., 2001; Adger & Kelly, 2000). People's vulnerability to natural hazards increases or decreases according to sociocultural processes and politico-economic institutional structures. Because of the varying degree of vulnerability, some individuals or groups are more susceptible to disaster losses than others. Their vulnerability can be determined by different factors, such as class, occupation, ethnicity, gender, health status, and age, in addition to the nature and extent of social networks. People's vulnerability can also be determined while evaluating their hazards knowledge and disaster experiences. In my research, vulnerability was used concerning people's exposure to the hazards, their sensitivity to the impacts, and adaptive capacity to mitigate disaster damage and losses and quickly recover from the impacts. The Kashechewan First Nation's socioeconomic condition, their exposure to spring flooding hazard, and sensitivity to the flooding impact as well as the region's flood-prone, low-lying topography increase their social, emotional, environmental, and physical vulnerability. However, the condition of vulnerability was the direct result of colonization, the imposition of the federal reserve system, and the forced relocation of people who had lived and managed themselves on the land for thousands of years. Indigenous Peoples' social capital, particularly strong social networks and communal bonding, is created, maintained, and flourished through a substantial investment of

[14] Vulnerability is defined as "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Blaikie et al., 1994, p. 11).

[15] A hazard event refers to the occurrence of a hazardous event, the effects of which change demographic, socioeconomic, cultural, and/or environmental conditions. On the other hand, a disastrous event refers to a major hazardous event that causes widespread disruption (damage) to a community or region that the affected community is unable to deal with adequately without outside help.

unacknowledged time, co-operation, and efforts and contributes to avoiding their social vulnerability (Natcher, 2015).

1.5.2. Adaptation

This research also was drawn from the concept of adaptation. Adaptation refers to the decision-making process(es) and action(s) undertaken to maintain the capacity of a community in dealing with existing or future anticipated change(s) without experiencing substantial functional or structural changes while sustaining growth (Nelson, Adgar, & Brown, 2007). Adaptation strategies can be spontaneous or planned (Smit, Burton, Klein, & Wandel, 2000). Individuals and households often adopt spontaneous strategies, such as changing the pattern(s) of livelihoods, including diverse sources of income.[16] In contrast, planned adaptations are government policies implemented to protect communities, in the context of flooding hazard risks, include building dikes or relocation of the community (Birkmann, 2011; Nelson et al., 2007). Every community has certain adaptation boundaries or limits and coping ranges. They can be tangible (e.g., material or physical resources) and/or intangible, such as adaptation knowledge and perception of capacities, as well as financial, social, institutional, and political (Birkmann, 2011). Nonetheless, the community's value and belief systems and their adaptation choices should also be considered while dealing with such limitations. Furthermore, the community's social networks, organizations, and traditional and local spatial knowledge can play an important role in developing community-specific adaptation strategies. For example, the community location-specific flood-related traditional knowledge can guide flood adaptation. Traditional knowledge is passed on through generations over a long time, and local spatial knowledge is associated with specific locations of something concerning a spatial reference. I used the two terms in my thesis to collect and analyse data, such as flood mapping and qualitative interview data. The community elders' traditional knowledge helped in exploring the elevated risk of spring flooding. Local spatial knowledge of participants enabled this research to answer the research question: What are community members' flood-related observations on changes in the Albany River, in their landscape, and the local environment?

[16] People adopt spontaneous strategies keeping in view the changing climate and/or environmental conditions. For example, farmers in water-stressed regions, particularly in rural areas, change their livelihoods patterns from a single source of income to diverse sources of income because they start cultivating wide range crops (suitable to the local changing conditions) due to the changing weather conditions. In other words, they change the crop cultivation patterns from monocrop to multi-crop.

Adaptation helps in mitigating the impacts of natural hazards. Adaptation also refers to building people's adaptive capacity, which enables them to adjust to climate change and variability and environmental change. According to Nelson et al. (2007), adaptive capacity includes people's resources, and their ability to utilize them. While adaptation is essentially context-specific, adaptive capacity is location-specific and path-dependent (Yohe & Tol, 2002). The adaptive capacity of a community contributes to reducing its vulnerability to hazards risks (Nelson et al., 2007; Newton et al., 2005). In this context, because many Indigenous Peoples still live close to the land and natural environment, they possess valuable traditional and local spatial knowledge that can contribute to their adaptive capacity and resilience (Berkes, Colding, & Folke, 2000; Newton, 1995). Similar to traditional knowledge, Indigenous Peoples' resources, social institutions networks, cultural values, and attitudes (or perceptions of available resources and their value) can enhance their adaptive capacity in building resilience (UNU, 2013; Berkes & Ross, 2012). Since adaptive capacity helps to build people's resilience, both qualities are positively correlated, while having an inverse relationship with vulnerability. Therefore, adaptation, as a process, and adaptive capacity,[17] as an attribute of community resilience, placed the adaptation concept as an important part of the broader theoretical framework.

1.5.3. Resilience

Resilience is a community's ability to respond to and recover from disasters—the ability to survive and deal with events by reducing impacts and sustaining minimum loss or damage (Cutter et al., 2008; Berke & Campanella, 2006). This definition focuses on resilience (the ability to recover quickly as well as avail the opportunities created due to the change) as an attribute of the community with optimal (ideal) adaptability at its core, whereas adaptation must result in a positive outcome with enhanced resilience after experiencing a disaster. In other words, resilience means living with change by developing the capacity not just to deal with it effectively but also to avail the opportunity. Furthermore, resilience is important for vulnerability as well as relevant to the broader framework because it helps to determine hazards risks holistically, emphasizes people's adaptive capacity, and is essentially forward-looking (Berkes, 2007). Vulnerability also resides in the resilience of the socio-ecological systems that experience hazards risks. Vulnerability

[17] Adaptive capacity is people's ability to adapt to changes, and adaptation refers to making adjustments, for example, in the human or socio-ecological system in response to actual or expected climate change and environmental hazards and their effects.

and resilience depend on demographic, socioeconomic, cultural, and political factors (Gaillard, 2007). Therefore, I focused on community resilience, which included, among other aspects, the flood-related traditional and local spatial knowledge that can contribute to a flood resilient community.

Community resilience-building focuses on the adaptive capacity of individuals, households, and communities, and includes people's resources and their collective strategic action, social networks, and knowledge, skills, and learning (Berkes & Ross, 2012; Cutter et al., 2008). Community resilience is interwoven with and connected to individual resilience at the local level. However, to estimate community resilience, attributes of a group(s) are needed rather than those of individuals (Boon, 2014). Resilience is, therefore, central to the discussion of vulnerability because it helps to determine hazards risks holistically in the context of human-environment systems (Maru et al., 2014; Davies, Newsham, Wood, & Bene, 2012; Gaillard, 2007). Furthermore, the community's resilience is enhanced through improvement in its adaptive capacity. Thus, the broad theoretical framework focused on the individual household and community levels and their respective perceived adaptive capacity.

In this research project, I examined and applied vulnerability, adaptation, and resilience concepts because they are interrelated and crucial in determining hazards risks. Specifically, I focused on the intersecting areas of people's perceived adaptive capacity concerning their access and perceived ability to utilize available material/physical resources required to cope with and respond to existing and future hazards risks. I used the vulnerability concept concerning the degree to which the Kashechewan First Nation is exposed to the hazard risks and its sensitivity to the impacts of the hazard and the level of perceived adaptive capacity. In addition, resilience overlaps with adaptive capacity. As resilience refers to the degree to which individuals and groups are capable of self-organization, they can build and/or enhance their capacity for learning and adapting to existing and future changes (Endfield, 2012). The resilience of a community can also be determined by the condition of vulnerability as well as perceived and objective capacities, which contribute to total adaptive capacity.[18]

[18] People's resilience can be assessed by their condition of vulnerability as well as adaptive capacity (including their perception of ability to access and utilize the available material resources to effectively deal with disaster risks).

1.6. Approach and Methods

The post-positivist approach guided my research because it challenges the traditional concepts of universal truth or presumptions about what constitutes a fact. Post-positivists believe that knowledge is context-specific, which should have an empirical basis (Nuttall, 2010). Mostly, post-positivists are constructionists—they believe that people construct their worldviews based on their perspectives, opinions, and perceptions. Because of specific sociocultural and historical context (Lincoln & Guba, 1985), Kashechewan people also have multiple meanings for and experiences of frequent spring flooding risk and repeated evacuations. Therefore, the post-positivist paradigm enabled me to explore the variance in the meaning and experiences of Kashechewan community members towards the elevated flooding risk and recurring evacuations.

I employed mixed methods research (MMR) that is a combination of both qualitative and quantitative approaches. Combining the two approaches, and a range of data collection methods and multiple sources of information allow a comprehensive understanding of a phenomenon and reveal various features of empirical reality (Creswell & Plano-Clark, 2011; Brannen, 2007). The mixed methods strategy was very useful because it allowed me to use the required data collection methods that were appropriate to investigate the problem of the elevated spring flooding risk and frequent evacuations. So, I used multiple participatory techniques of flood mapping workshops, on-site walks, photography, and semi-structured qualitative interviews. I also used the quantitative method of survey. These multiple methods also enabled this research to include a large number of community members to participate (Aliaga & Gunderson, 2002). The strategy promotes the use of multiple worldviews, perspectives, or paradigms because methodological pluralism (or eclecticism)[19] is a key feature of MMR (May, Hunter, & Jason, 2017, 2012; Creswell, 2007). The complexity of the research problem also required the use of both qualitative and quantitative datasets (Creswell, 2007). This research carried out the two components concurrently, and analysed the qualitative and quantitative datasets separately and merged their findings for interpretation. Another reason to use MMR was to achieve the goal of triangulation (Creswell & Plano-Clark, 2011; Mason, 2006; Johnson & Onwuegbuzie, 2004). I used the case study approach

[19] Eclecticism is a conceptual approach that does not hold rigidity to a single (qualitative or quantitative) paradigm or set of assumptions but rather draws upon multiple theories, styles, or ideas to gain complementary insights, and applies different theories in cases.

for an in-depth understanding of the frequent flooding risk and evacuation problems. A case study can be qualitative, quantitative, or a combination of both (Bryman & Bell, 2016).

1.6.1. Qualitative and Quantitative Approaches

Qualitative research is well-suited to explore individual and group experiences and the meaning ascribed to their experience (Creswell, 2012). Among the qualitative approaches, the case study approach well-suited this research because it involves the study of a case(s) for an in-depth understanding of the complex problem and encompasses its contextual condition (Hay, 2010; Yin, 2009). The approach also best suited my research because it is typically bounded by time and activity and gathers detailed information on the problem through a range of data collection methods and sources of information (Creswell, 2007; Stake, 1995).

Semi-structured interviews helped in discovering what was relevant to research participants (Hay, 2010). The interviews enabled me to gain insights into the participants' views, opinions, and perspectives of flooding risk and evacuations based on their individual and family accounts. I used this method for its flexibility in addressing the complex problem involving information-rich participants (Hay, 2010). During the interviews, I used the interview guide (Appendix B) comprising a list of questions that helped me to focus the exchange during the interviews. Only a few qualitative interview participants participated in the survey; therefore, a large number of residents (n = 155) were included in the two components of this research. Sixty-five (65) participants participated in the qualitative participatory techniques, making 5.42% of the targeted population (N = 1200). The participatory flood mapping workshops provided research participants the opportunity to share their useful traditional and local spatial knowledge, which helped in exploring and identifying the drivers of the increased spring flooding risk. Participants mapped the hazard risks indicating their perceptions of the past, present, and future of their local environment and surroundings, and the changes on the land and in the Albany River (Appendix C-1 & C-2). For example, mapping participants shared the breakup ice jam-related flooding features, such as onset, direction, speed, height, scale and extent, locations, duration, and water-recession. Flood mapping was essentially based on the proximity of the community to the waterbody. The participatory flood mapping method greatly helped in eliciting the community's traditional and

local spatial knowledge by mapping their direct experiences, particularly their historical inundation memories.

I used the survey method in the quantitative component. The survey research is most commonly used for quantitative data collection in social sciences (Bryman & Bell, 2016; Bryman, Bell, & Teevan, 2012; Bryman, 2006). The survey method is now increasingly used when researching with First Nations communities.[20] I used close-ended questions (Appendix D) and collected quantitative data, for example, gathered information on demographics, and how individual households and the community were affected by the frequent events of flooding risk and evacuation. Furthermore, data on flooding risk impact reduction, adaptation, and application and usefulness of flood-related traditional and local spatial knowledge were also gathered. The survey form was used for uniformity in asking questions and recording data for increased accuracy, minimum errors, and maximum ease in processing respondents' responses. I completed the 90 face-to-face surveys with the assistance of a community research assistant (e.g., enabling translation) at locations convenient for respondents, making 7.5% of the targeted population. I completed the qualitative interviews and quantitative surveys separately, at different times involving different (over 95%) participants for each. The following table illustrates the data collection methods and sampling techniques used to collect data vis-à-vis the three research objectives. The order of using the data collection methods is based on the input received from the community advisory committee (CAC) before the data collection started.

#	Research Methods	Approach	Method	Sampling
1	Explore Kashechewan First Nation's traditional and local spatial knowledge concerning the elevated spring flooding risk.	Qualitative	Flood Mapping, Onsite Walk, Photography, Semi-structured Interview	Purposeful, Snowball
2	Examine Kashechewan residents' experiences of frequent flood risk impacts and recurring evacuations.	Qualitative	Semi-structured Interview	Purposeful, Snowball
3	Analyse the community's perceived adaptive capacity to flooding risk.	Quantitative	Semi-structured Interview	Convenience

Table 1.6. Research Objectives, Data Collection Methods, and Sampling Techniques.

[20] For example, Mehrabadi et al. (2008), Schuster et al. (2011), and Jackson et al. (2012) have used surveys when researching First Nations.

1.6.2. Sampling Techniques

In this research, I employed nonprobability sampling. I used purposive, convenience, and snowball sampling techniques to select participants both for the qualitative and quantitative components (Valerio et al., 2016; Taherodoost, 2016; Suri, 2011).[21] The purposive and snowball sampling strategies were used for qualitative research (objectives 1 and 2), and convenience sampling was employed for quantitative research (objective 3). Purposive sampling is the most suitable to understand complex research problems while focusing on the target population (Onwuegbuzie & Collins, 2007; Newman, I., Ridenour, Newman, C., & DeMarco, 2003). Purposive sampling was useful in identifying and selecting information-rich participants keeping in mind the problem investigated and participants' knowledge or real-life experiences (Ritchie & Lewis, 2003). The targeted population was based on individuals who have had better knowledge, understanding, and experiences of the increased flooding risk and frequent evacuations. Individuals selected for qualitative interviews did not participate in the quantitative survey and vice versa except for a few individuals who were considered most suitable and were keen to be included in both components. I primarily focused on individuals who were information-rich and had experienced the frequent flooding risk and reoccurring evacuations multiple times, with the maximum variation of perspectives and experiences and possessed critical information. I interviewed participants who held and provided significant insights into the increased flooding risk and recurring evacuation problems keeping in view the community-context. I also employed snowball sampling. All of the interviewees were asked if they wanted to recommend anyone else to whom I should speak concerning flooding impacts and evacuation experiences, including those who might have had different perspectives and experiences. During the fieldwork, some participants also approached me to participate in my research. In brief, I ensured that the selection criteria reflected the target population without omitting any useful socioeconomic, sociocultural, and demographic subgroups. The criteria to identify and select participants for the qualitative component are as under:

- Individuals who were 18 and above and willing to participate.

[21] The nature of the problem and purpose of this research called for employing purposive, convenience, and snowball (nonprobability) sampling instead of probability because of the technique used, which facilitated to include information-rich participants with extensive flood-related knowledge and experience. Other reasons to use the sampling strategies included the limitation of resources, the sample selection criteria, the target population, and the community context and its size.

- Residents who were impacted/experienced actual flooding or flooding risk events.
- Those who experienced multiple evacuations were preferred.
- Experienced hunters/fishers/elders who had been observing changes on the land, in the Albany River/local environment, and the region's topography, weather, and climate, etc.

For the quantitative component, I employed convenience sampling. All community members above 18 years of age were potential respondents. I included easily accessible individuals who were willing to participate and readily available in proximity during the structured interviews (Etikan, Musa, & Alkassim, 2016). I completed almost 70% of the surveys in front of a coffee shop. After getting permission from the management of the main grocery store (called Northern Store) in Kashechewan, I set up a table for interviews in front of the coffee shop within the premises of the Store. The coffee shop opened about a year before my fieldwork have had become a centre for socializing. Almost every community member, regardless of their demographics, socioeconomic, and professional backgrounds, would frequently visit the coffee shop or the grocery store. Therefore, the venue selected was the most suitable for structured interviews. I also completed the remaining 30% surveys at other prominent places in the community, such as the band and social welfare offices. These additional venues were selected for the interviews because a large number of community members would visit them. Involving community members from diverse backgrounds in the targeted population helped me to avoid under-coverage and minimize selection bias.

1.7. Ethical Considerations

Collaborative research projects essentially promote partnerships between the researcher and Indigenous communities based on mutual trust and cooperation (CIHR, 2008). This research involved early input of the First Nation leaders and CAC members on the appropriate research objectives, respect for the traditional way of life, and recognition of traditional knowledge system, and to seek triangulation of information. My role and responsibility, as a researcher, and rights of the community, as participants, were discussed, agreed upon, and followed in letter and spirit (Ball & Janyst, 2008). This initial community engagement (Appendix G) helped in building rapport and trust with the First Nation leadership and understanding their priorities, which facilitated the fieldwork. The more than four-year interaction with the CAC members, community research

assistant, Chief Leo Friday, and community elders helped in completing the pre- and post-fieldwork activities. The activities included confirmation of the accuracy of data, verification of results with participants and CAC members, and dissemination of knowledge in mutually beneficial and culturally appropriate ways (Castleden, Morgan, & Lamb, 2012). The CAC members provided much guidance and feedback, particularly on the data collection instruments, including the qualitative interview guides, base maps for mapping workshops, and the survey form. I spent over five weeks in Kashechewan to collect data from the end of October to early December 2016, which further facilitated the building of rapport with the larger community.

Before commencing fieldwork, I obtained official approval (Appendix E) for my research project from Research Ethics Board (REB) at the University of Alberta and adhered to its ethical guidelines, including the guidelines outlined in the Tri-Council Policy Statement-2 (TCPS-2) document, particularly referring to ethical conduct for research involving First Nations in addition to the principles of respect, relevance, reciprocity, and responsibility (TCPS-2, 2014). The research process was well appreciated by the community leaders because the First Nation's interests, needs, and concerns were well taken into account right from the start and at every stage (Kovach, 2010; Bishop, 2005). In short, the research was completed with the community as a collaborative project, which was based on mutual respect, trust, and good relationship rather than research done to or in Indigenous communities.

In line with the REB approval, the free, prior, and ongoing informed consent of each participant was obtained before conducting interviews and mapping workshops. I read the introduction letter in a manner that each participant fully understood. Then, each participant was asked to sign the consent form (Appendix F) before commencing the data collection process. Participants were also informed that withdrawing from this research during the interview was completely voluntary. Each participant was asked if they grant permission for their name to be identified with the information that they provided. Participants were also asked for permission if they allow using the digital recorder to record interviews. They were also provided information concerning their withdrawal from or stopping the interview as and when a participant feels uncomfortable. I offered participants the following two statements to choose from concerning the identification of their names:

- I Do Not Grant permission for my name to be identified with the information I am providing.

- I Do Grant permission for my name to be identified with the information I am providing.

I visited Kashechewan in November 2018 for community reporting and presented the research findings to the larger community during an open house event. The event was organized with the help of Elder William Sutherland, the principal, and research assistant in the main hall of the high school. Kashechewan Chief and Council, community elders, the CAC members and community research assistant, research participants, school students, and teachers were invited. I presented ten large laminated posters (Appendix I) containing quotes of elders and the First Nation leaders. The posters that were displayed in the main hall of the school included flood- and climate change-related additional information provided in plain language along with photographs as a gesture of reciprocity while documenting the community's traditional and local spatial knowledge. The purpose of exhibiting the posters in the school hall was to disseminate the documented knowledge so that the present and future generations could benefit from the valuable yet eroding knowledge.

1.8. Reliability and Validity

According to Bryman and Bell (2016), the three most prominent criteria to evaluate research are reliability, replicability, and validity. A measure or variable, which changes over time, is reliable, replicable, and valid (both internally and externally) if it gives the same results repeatedly whenever a researcher tests the same research participants in any research project. The use of the research design criteria of reliability, replicability, and validity depends on a researcher if s/he considers these criteria suitable for her/his research. Given that reliability, measurement or construct validity, and external validity are more relevant to quantitative research, internal validity has greater relevance to both approaches, and trustworthiness is considered an appropriate criterion to evaluate qualitative study (Bryman & Bell, 2016). For trustworthiness, the four criteria of credibility (parallels internal validity), transferability (parallels external validity), dependability (parallels reliability), and confirmability (parallels replicability) recommended by Baxter and Eyles (1997) helped to establish rigor in the qualitative component of my research. First, credibility determined how much the risk of intersubjectivity was minimized in the findings. In other words, whether my findings truly represent the views, perspectives, and perceptions of participants. Second, transferability ascertained the applicability of my research findings to other cases (or contexts) facing a similar problem. Third, dependability determined whether the research findings

are likely to be consistent over time. Finally, confirmability indicated would conclusions of other researchers be the same.

1.8.1. Blended Sampling Strategy

The purposeful and snowball sampling strategies employed are aligned and can be used in conjunction with one another to recruit participants for an in-depth understanding of the phenomenon under investigation (Valerio et al., 2016; Suri, 2011). The blend of the strategies used significantly contributed to improved credibility because they likely yield the desired samples of the community (Valerio et al., 2016). In addition, all subgroups of the targeted population based on the community's diverse demographics, such as socioeconomic, professional, and sociocultural, were included both in the qualitative and quantitative samples. Participants were selected keeping in mind the advice of the CAC members and research assistant, community elders and leaders, including Kashechewan Chief and Council. Upon request, many potential participants were recommended by interviewees, flood mapping participants, and survey respondents.

1.8.2. Triangulation

One of the main purposes of using the mixed methods strategy was triangulation to compare different forms of data to search for congruent findings (Johnson & Onwuegbuzie, 2004; Creswell, 2003). Rossman and Wilson (1985) note that multiple paradigms and methodological triangulation acknowledge the convergence of qualitative and quantitative data during the research process (Creswell, 2007; Moor, 1991). Furthermore, combining the two approaches and integrating multiple data and sources of information for interpretation of results contributed to the credibility of my research findings (Bryman and Bell, 2016; Creswell, 2007; Brannen, 2007). In brief, the integration of various methods and frames of reference helped to bridge the gap among various sources of knowledge and the ways of examining to triangulate and illuminate unexplored experiences of research participants (Harrison, 1994). The purpose of triangulation was not merely deriving consistency across various data and sources of information because the inconsistency should not be understood as fading the evidence but rather as a prospect to uncover deeper meaning in different datasets (Patton, 2002).

1.8.3. Corroboration and Complementarity

In this MMR research project, I used the results of one or more methods to support the results of the other method(s) (Halcomb & Hickman, 2015). For example, I used the semi-structured interviews and participatory flood mapping findings to confirm survey findings that the First Nation's perception of risk is high. Similarly, statistical analysis of survey data suggested that the community's emergency preparedness and coping capacity have increased because of frequent emergencies that were supported by the semi-structured interviews providing the same results. Furthermore, the finding of a significant change in the adaptive behaviour of residents was verified by the qualitative as well as quantitative data.

Complementarity seeks to elaborate, illustrate, enhance, and clarify the results obtained from one method with the results reached from the other (May et al., 2017; Creswell & Plano-Clark, 2011). For example, the finding that flood-related traditional and local spatial knowledge is useful was reached using the survey was illustrated by qualitative interviews in which participants provided detailed accounts of what the knowledge was and how it was used. The finding from the quantitative data in numbers that residents frequently use the social media platform to get information on flooding and evacuation was elaborated in narrative form during the qualitative interviews. Similarly, the finding of the perception of protection from the dike failure from survey data was enhanced by qualitative interview participants while clarifying why the community believed that the dike would breach if there will be severe flooding in the future.

1.8.4. Data Analysis

The semi-structured interviews, flood mapping workshops, and survey data were analyzed using different methods, computer software, and statistical tools. The qualitative data, including semi-structured interviews and flood mapping, were analyzed using NVivo, ArcMap, Geographic Information System (GIS), and Google Earth. I analyzed survey data in SPSS (Statistical Package for the Social Sciences). Analyses of the three types of dataset are illustrated as follows.

The audio recordings of the semi-structured interviews were transcribed by a professional transcriber. Then, I coded and analysed the transcribed data in the NVivo software while using a mix of descriptive and analytical coding schemes (Gibbs, 2007). During descriptive coding, I made

categories using the terms and words, such as living in a bowl (ring-shaped 5.3 km long by 3.5 m high dike), muskeg, and precautionary evacuation, which were locally and commonly used by research participants. I also derived analytical codes from the relevant literature, previous research, and my understanding of the rich, in-depth qualitative data collected. The data gathered using participatory techniques of flood mapping and on-site walk were analysed in the ArcMap, GIS, and Google Earth software to produce scaled maps to achieve accuracy and precision. I reproduced the participants' hand-drawn maps in ArcMap, GIS maps using numerous shapefiles available online and shapefiles that I created which were not readily available. The data gathered through the techniques of on-site walk and photography significantly contributed to the reproduction process by triangulating and supplementing the information obtained from different sources.

I used SPSS descriptive and inferential statistics to analyse the survey data. For example, risk perception and adaptive behaviour data were analysed using descriptive statistics. I used the nonparametric statistics because of the skewness of the survey data. For inferential statistical analyses, I used a one-sample Chi-square statistic to determine whether the sample data of each indicator was consistent with its hypothesized distribution. The Chi-square test also determined which indicators, as one-sample, have had a greater contribution to the perceived adaptive capacity. I employed Spearman's (rho) to calculate the correlation coefficients to determine the nature and strength of the relationship between variables/determinants. The effect size of the correlation between the determinants was also estimated by squaring the values of rho; the larger the effect size, the larger will be the impact, assuming other things remain the same. Friedman's Chi-square was used to calculate two-way ANOVA (analysis of variance) of related samples because the data are related rather than independent samples. In addition, I conducted Kendall's W (coefficient of concordance) test to calculate the effect size estimates. Finally, the principal component analysis (PCA) was also conducted to estimate how the determinants are associated with one another, the direction of their relationship, and the relative importance of these directions. The analysis was conducted to determine which determinants contributed more to adaptive capacity than others.

For interpretation of the two datasets, I compared and analyzed the qualitative and quantitative data sources. Both datasets were integrated into two separate (qualitative and

quantitative) sets of coherent wholes. In summary, the two sets of inferences were combined into a coherent whole, which is called meta-inference.[22]

1.9. Limitations

Every research design has certain limitations. The case study research design has many limitations, particularly if the researcher employs purposive, convenience, or snowball sampling strategies. For example, the results of a case study cannot be generalized beyond the cases or people investigated (Bryman & Bell, 2016). I used multiple approaches, methods, and sources of information to address the limitations. The use of multiple approaches, methods, and sources of information contributed to the process of triangulation. Triangulation or greater validity is critical for an in-depth, complete understanding of complex phenomena (Bloomberg & Volpe, 2012). Although the research design has limitations, the qualitative approach also offered many benefits, such as a comprehensive understanding of the complex research questions (Hay, 2010; Yin, 2003). Achieving a power balance between the researcher and the researched is challenging, especially when using semi-structured interviews and researching an Indigenous community. It is difficult because the researcher, as an interviewer, controls the conversation in addition to factors, such as explicit and implicit power relationships. The guidance provided by the community leaders, the CAC members, and the assistance of the research assistant during interviews contributed to overcoming the challenge of power dynamics. In addition, the community's cultural values, customs, and traditional way of life were respected throughout the research process, particularly during fieldwork. While hearing similar stories from my father about his experiences of colonialism, I was fully aware of the power dynamics; therefore, being always vigilant in this regard helped me to deal with the power dynamics throughout different research stages. For example, before commencing every interview, I explicitly stated, "I am here in Kashechewan to learn from you," and started with a general and simple conversation by asking about life in Kashechewan. The humility was demonstrated during formal (interviews) and informal (communication) interactions with all community members.

[22] Tashakkori and Teddlie (2008: p 101) describe a meta inference as "an overall conclusion, explanation or understanding developed through and integration of the inferences obtained from the qualitative and quantitative strands of a mixed method study".

An additional limitation was that a few over 70 years of age participants were fluent in Cree but had difficulty speaking English. To overcome this problem, the research assistant assisted me in language translation (from English to Cree and vice versa) when required. For example, it was challenging for me to interview two participants, 72 years male and 65 years old female, who were unable to communicate fully in English. Such interviews were much more difficult than all other interviews because of the time spent to translate a few complex Cree words into English and vice versa. It is worth mentioning that the research assistant, being a younger generation, did not understand some Cree words spoken by elder/older participants. Indeed, I wanted to interview an over 90 years of age elder but was unsuccessful because he had a severe hearing problem. Surely, the over 90 years elder would very likely have had a unique perspective, traditional and local spatial knowledge, and varying experiences in comparison to 60-70 years old participants. I was unable to interview the then Director of Health whose responses might have had provided useful insight into the impacts of mental and emotional health due to stress, fear, and anxiety caused by frequent emergencies and recurring evacuations.

Finally, the Kashechewan flooding case study essentially has a limitation of being bounded temporally and spatially. The views, perspectives, and perceptions of participants collected through interviews during the fieldwork in 2016 might have had evolved, for example, since the establishment of Kashechewan in 1957. This research is temporally bound because the local spatial knowledge of participants is restricted to the past 62 years. It is spatially bound because elders over 65 years of age have had been dealing with the spring flooding before the establishment of Kashechewan. Additionally, I was only able to interview three long-term evacuees during my study because the others were living in Kapuskasing, Ontario at the time of my fieldwork in Kashechewan.

The quantitative case study component also has certain limitations, for example, concerning the sampling techniques used to select survey respondents, and the statistics employed because of the unsuitability or skewness of the data. Nonetheless, I used the relatively large sample size ($n = 90$, 7.5% of the population $N = 1,200$) by including individuals from all age groups above 18, with an equal participation of males and females, and inclusion of respondents from diverse socioeconomic, sociocultural, and professional backgrounds. Thus, the sampling frame used helped to mitigate under-coverage, minimized the selection bias. Furthermore, the goodness-of-fit

statistical test established that the sample data represented the data that were expected to be found in the actual population. The results of this study are not generalizable to all First Nations.

1.10. Positionality Statement

I am a 51 years old male, a Pakistani Canadian, and am a Pashtun (or Pathan) by ethnicity, which originates from Afghanistan. I believe ethnicity is important and essential for individuals' identities. I recognized, acknowledged, and respected the diversity of ethnicity during my research in a manner that all community members were treated on an equal basis. My educational background, particularly my MA degree in Disaster Management and MS degree in Development Studies helped me in understanding and respecting multiple perspectives and diverse and unique worldviews. In addition, before my fieldwork, the coursework that I completed, such as Perspectives on Traditional Knowledge, enabled me to recognize, acknowledge, and benefit from the value and usefulness of traditional knowledge and indigenous observations of community elders to investigate the increased spring flooding risk.

Documenting the First Nation's flood-related traditional knowledge using culturally appropriate techniques in a collaborative research project, and presenting it to the First Nation as reciprocity helped in dispelling the feeling that the researcher is an outsider and can be biased. My background, identity, personal and professional experiences, and values of justice, equality, respect, and professionalism helped me to be aware of personal values and biases during the research process. I oppose colonialism based on racism and discrimination experienced by my father and ancestors during British colonial rule in South Asia. However, I value reconciliation, diversity, respect for different ways of life, and norms, customs, and distinct cultures and languages. Before commencing my fieldwork, I assumed that the elevated spring flood risk in Kashechewan is because of the increase in annual average river discharge. However, my first experience of investigating the spring flooding (breakup ice jams) phenomenon helped in dispelling the assumption. In brief, my role, as a researcher, was to learn from the community by facilitating, such as the flood mapping workshops, and promoting the two-way rich interaction. My gender did not affect the research process because I considered all participants equal regardless of their gender orientations. For example, the participation of females and males in survey research was almost equal; females 49% (44) and males 51% (46).

1.11. Organization of the Thesis

The thesis has a total of five chapters, including three papers presented in Chapters 2, 3, and 4. Chapter 2 presents the first paper, which focuses on the spring flooding hazard characteristics by providing insights into traditional and local spatial knowledge concerning the increased flooding risk in Kashechewan. It discusses the causes of the increased flooding risk, drivers of the major spring flooding events that occurred since 1957, and flooding risk impacts exacerbated by the landscape and resource development. Chapter 3 discusses the effects of frequent flood emergencies on the community's vulnerability and resilience. Chapter 4 discusses the risk perception and perceived adaptive capacity of residents to the spring flooding risk. Finally, Chapter 5 provides a conclusion by consolidating and interpreting the results of Chapters 2, 3, and 4. It also provides recommendations, as a way forward, for the First Nation, the Mushkegowuk Tribal Council, and provincial and federal emergency management agencies, including the federal government.

CHAPTER 2

Flooding in the James Bay Region of Northern Ontario, Canada: Learning from Traditional Knowledge of Kashechewan First Nation

2.1. Introduction

The risks of spring flooding in Canada's northern Indigenous communities have been a focus of both media and public attention over the last two decades. Although annual actual flooding or flooding risk and associated evacuations in the James Bay Lowlands have been publicized, there is relatively little research on the spring flooding hazard risks. A critical gap within this literature is research that supports the oral histories and traditional knowledge of local First Nations communities. This study, based on collaborative research with the Kashechewan First Nation, aims to address this gap by exploring participants' (historical and contemporary) knowledge about spring flooding in their community. The research questions that guide this study are as follows:

- What factors have elevated the spring flooding risk faced by the First Nation?
- What are community members' flood-related observations on changes in the Albany River, in their landscape, and the local environment?
- How have Kashechewan First Nation coped with flooding hazard in the past and what is community members' perception of reducing the increased risk of flooding?

This article presents the results of research that used participatory methods of flood mapping, on-site walk, photography, and in-depth interview to investigate the regular spring flooding problem in Kashechewan. The study focuses on the elevated flooding risk faced by residents since the establishment of Kashechewan in 1957. The most significant spring flooding occurred in the Albany River in 1966, 1972, 1976, 1985, and 2006 (Abdelnour, 2013; McCarthy et al., 2011). Notably, Kashechewan residents have been evacuated 14 times because of actual flooding or flooding risks due to potential dike failure or due to the E. coli problem since 2004.

Although Indigenous Peoples have been adapting to gradual change for centuries, new global pressures are increasing their risks from environmental hazards while significantly changing their socioeconomic, political, and environmental context in particular (Mercer, Kelman, Taranis, & Suchet-Pearson, 2010; Dekens, 2007). The study was completed in collaboration with the First Nation leaders and documented traditional knowledge in November and December 2016 using culturally appropriate participatory techniques. In this study, I employed participatory methods which are a useful way for Indigenous communities to draw on their own conclusions for their problems in a strategy that works best for them (Mercer et al., 2010; Louis, 2007).

Traditional knowledge is increasingly being recognized by academics, policymakers, and managers, both in Canada and globally (Gervais, 2004, 2001; PRB, 2001; Mauro & Hardison, 2000; WIPO, 1998; Anaya, 1996). Traditional knowledge is contextualized as a body of cumulative knowledge, evolving by the adaptive process, passed on through generations, and associated with a specific place for a long time period (Rosenberg, Hall, & Dei, 2000; Berkes et al., 2000; Berkes, 1999). Traditional knowledge has cultural and local meaning, such as the Inuit way of doing things, based on past, present, and future knowledge and experiences of the Inuit People or the collective wisdom of Cree First Nations in Canada (Rosenberg et al., 2000).

Traditional knowledge's contributions to understanding weather patterns, biophysical vulnerability, social-ecological resilience, and adaptation are well documented in many fields, including natural resource management, environmental impact assessment, climate change adaptation, and natural hazards and DRR (Nakashima, Galloway, Thulstrup, Castillo, & Rubis, 2012). For example, traditional knowledge of the Cree First Nations of Hudson Bay and James Bay contributed to the study that Ho et al. (2005) conducted to determine river-ice breakup dates for the Albany, Moose, and Attawapiskat rivers. The study used the traditional knowledge of Cree First Nations of the James Bay region because scientific data about the spring river-ice breakup had not been collected in recent years. Traditional knowledge can help researchers better understand Indigenous Peoples' climate change observations, impacts, and opportunities for adaptation as well as vulnerabilities for DRR. The Intergovernmental Panel on Climate Change's (IPCC) 32nd Session also recognized traditional knowledge as an important guiding principle for the Cancun Adaptation Framework (CAF), which was adopted by its members at the 2010 UNFCCC Conference in Cancun (UNFCCC, 2010; IPCC, 2001a). This framework highlights the

contributions of traditional knowledge to broader understandings of global climate change—including climate-change observations, impacts, and opportunities for adaptation and DRR. Furthermore, the UN agencies such as UNISDR (United Nations International Strategy for Disaster Reduction) have emphasized the need for mainstreaming and linking both DRR and climate change adaptation for future vulnerability reduction, particularly of communities at-risk of environmental hazards and climate change (Thomalla, Downing, Spanger-Siegfried, Han, & Rockstrom, 2006). Additionally, climate change adaptation and DRR should be considered equally important because there exist more similarities than differences between the two (Mercer, 2010).

Traditional knowledge offers valuable insights particularly into the areas of climate history, community adaptation, local scale expertise, and environmental monitoring in addition to a useful source of diachronic information on extreme events, subjective perspectives, and qualitative data (Moller, Berkes, Lyver, & Kislalioglu, 2004; Riedlinger & Berkes, 2001). Diachronic information is based on observations of Indigenous Peoples on changes occurring in their environment over a period of time. Indigenous observations are based on smaller areas over a longer time period, which provides more opportunity to collect diachronic information; minimizing the chances of any change being overlooked. In essence, traditional knowledge comprises the process of observing, discussing, and making sense of new information—in other words, Indigenous ways of knowing (Berkes, 2009). Traditional knowledge deals with a qualitative understanding of the whole system. Therefore, the diachronic information offered by traditional knowledge can be a valuable resource, particularly when scientists are facing reduced funding for research. Collaboration with traditional knowledge holders can help scientists recognize that Indigenous Peoples' observations and assessments offer valuable insights to, and provide local verification of, e.g., global scientific models—; moreover, taking indigenous observations and assessments seriously can help experts ensure that adaptation measures align with local needs and priorities (UNU, 2009). Such collaboration can also promote innovative and effective adaptation action, and relevant traditional knowledge can inform cost-effective and sustainable DRR.

Traditional knowledge is an underutilized resource by the scientific community (Twarog & Kapoor, 2004; Agrawal, 2002). While traditional knowledge is transmitted orally and lacks formal documentation, it is being eroded with the passage of time (Dube & Munsaka, 2018; Rahman, 2004) because, for example, Kashechewan elders (highly respected historians and

knowledge keepers) are passing away (CBLUP, 2017; L. Friday, personal communication, 16 November 2016). Since traditional knowledge system lacks formal documentation, DRR practitioners seem to be skeptical of the usefulness and potential contribution that traditional knowledge can make in reducing hazards risks when dealing with disasters (Dube & Munsaka, 2018). However, the benefits and contribution of traditional knowledge within the DRR activities as well as harnessing its potential for implementation of sustainable development projects at the local level are now increasingly acknowledged and identified (Mercer, Dominey-Howes, Kelman, Lloyd, 2007; Dekens, 2007; Twarog, 2004). Exploring and documenting traditional knowledge can also be a means to the participation and inclusion of people for integration of DRR into development for sustainability at the local level (Dekens, 2007; Rahman, 2004). Through this research, learning from and documentation of Kashechewan First Nation's traditional and local spatial knowledge can contribute to the future DRR activities in the flood-prone southwestern James Bay region. Notably, one of the guiding planning principles of the Kashechewan First Nation and Ontario Provincial Government's Community-based Land Use Plan 2017 is that "planning decisions will be based on the best available data and information drawn from both Indigenous traditional knowledge and western science" (CBLUP, 2017, p. 4).

Several studies have been conducted in flood-prone Canadian Indigenous communities from various perspectives including risk perception, preparedness, coping strategies, hydro-damming projects, livelihood sustainability, social learning, and climate change-related vulnerabilities and impacts. For example, Thompson, Ballard, and Martin (2014) examined the artificially flooded and permanently displaced (development-induced displacement) Lake St. Martin First Nation in Manitoba because the provincial government decided to divert floodwater to the reserve to protect urban and agricultural properties. Their research methods included workshops on strategic analysis and community planning and participatory video component using the sustainable livelihood framework. Newton (1995) examined flood risk perception and the community-level preparedness and coping strategies of northern Indigenous Peoples, including Attawapiskat First Nation in the southwestern James Bay. He used the methods of mailed questionnaires, field observations, and qualitative interviews to collect data. My study is different from others because it focuses on spring flood-related traditional knowledge of the Kashechewan First Nation and their observations on the breakup ice jamming phenomenon in the midst of climate change and global warming.

Researchers are also increasingly using participatory techniques, for example, hazard mapping at the community level for DRR while researching with Indigenous Peoples (Bensen, Twigg, & Rossetto, 2007; Twigg, 2004; Smith, 2003). This study employed multiple participatory techniques to collect data, which are culturally appropriate keeping in view the study objective and the theoretical framework. Participatory mapping and photography were used by Gill, Lantz, and GSCI (2014) involving Teetł'it Gwich'in land users and youth from Fort McPherson, Northwest Territories, Canada to record information about local environmental conditions and changes. Their study used GPS (Global Positioning System) devices to record changes in the local environment. Mercer (2010) used participatory techniques for mapping flood (open-water flooding), an active volcano, and landslides as well as the impacts of land-use practices and changes observed in their environments, including land, rivers, and forests, to identify the environmental impacts on the small Indigenous communities of Kumalu and Singas in Morobe and Madang Provinces of the small island developing states (SIDS). However, there are no traditional knowledge studies on spring flooding in the James Bay region and a very few studies involving Kashechewan First Nation. Of the many traditional knowledge studies elsewhere, this study is similar to others in terms of using the flood mapping method, which is considered a standard method for hazard mapping. However, this study is unique because it specifically focuses on the spring (i.e., breakup ice jams) flooding hazard, which is a different ecological phenomenon as compared to other types of floods (e.g., open-water or flash flooding). Spring floods have the greater potential for damage and are more dangerous than open-water floods. Other main differences include the use of multiple participatory techniques, including an on-site walk and photography as well as flood mapping. This study's methodological approach was the first application of participatory techniques in the region and may be considered a useful method for flood monitoring and risk reduction by other First Nations communities at the risk of spring flooding in northern Canada. Notably, previous research has largely focused on the physical factors initiating the process of breakup ice jams that cause spring flooding. The focus of this study is on exploring and documenting the Cree traditional and local spatial knowledge and observations using multiple participatory techniques.

2.2. Setting

2.2.1. Socio-Cultural Context

The Kashechewan First Nation is located on the North Channel of the Albany River in the southwestern James Bay region of Ontario (Figure 2.2.1). The topography of the area is mainly low-lying, with an insignificant variation in elevation (Ohmagari & Berkes, 1997). The lowlands are the largest wetland region of Canada that extend inland 160–322 kilometers (NAV-Canada, 2002; Ohmagari & Berkes, 1997). The Albany is the second largest river (982 km long) in Ontario. It consists of the three sub-rivers, the Mammamattawa, Ogoki, and Kengogami. Its Cree name is "Chichewan" meaning "several rivers form one that flows towards the ocean" (Canadian Encyclopaedia, 2015). The Albany flows from northwest to northeast Ontario, emptying into James Bay. Kashechewan is in Treaty 9, signed in 1905, and is one of the eight Cree First Nations of the Mushkegowuk Tribal Council. According to Chief Leo Friday, there are 2,000 band members (L. Friday, personal communication, 14 November 2016). An isolated and remote community, Kashechewan is about 12 kilometers upstream from James Bay and 13 kilometers (estimated winter ice road driving distance) from the nearest community, Fort Albany, which is on the southern bank of the River's South Channel. Fort Albany is accessible to Kashechewan residents during winter via ice road and during other seasons via boat. The nearest major town, Moosonee, is about 150 kilometers away.

Figure 2.2.1. Study Site Map.

The Fort Albany Reserve 67 was created in 1910 with 225 square kilometers of territory. The Reserve is shared by the Kashechewan and Fort Albany First Nations, which are Anglican and Catholic, respectively. In the 1950s, the two communities were divided along religious lines. The Fort Albany Chief and Council governed the two First Nations until 1974. Since 1974, the Kashechewan First Nation has had a separate chief and council. At its establishment in 1957, the Kashechewan First Nation wanted to set up its community at a higher ground on the reserve territory.[23] Instead, the federal government established Kashechewan at its existing location. The Kashechewan First Nation, however, claims that the federal government said it would not provide housing and infrastructure unless the First Nation set up the community on the appointed reserve territory (O. Wesley, personal communication, 16 November 2016; Pope, 2006).

Kashechewan is a linear settlement located in the flood-prone southwestern James Bay area and is susceptible to spring flooding. In 1995-97, to protect the community, a ring-shaped (5.3 km long by 3.5 m high) dike was built at cost of CAD 16.1 million using gravel and sand (Shimo, 2017; Bhagwandass, 2016; Pope, 2006). The dike that surrounds the Kashechewan town is located along the riverside in the east and along the Red Willow Creek in the north and west, and at the crossing of the airport road in the south as highlighted in Figure 2.2.2. In 2006, flood waters rose and leaked through the dike.[24] Studies showed that the construction was not "in accordance with the drawings and specifications," and as a result the dike does not meet the required safety standards (Donnelly, Stephen, Jamieson, Perkins, & Hinchberger, 2015, p. 8). In 2007, the federal government agreed to spend CAD 200 million over five to seven years for community infrastructure, including dike improvements (Barei, 2011; Murdocca, 2010). From 2006 to 2009 and in 2010, CAD 3.5 million and CAD 5.6 million were spent by the federal government to improve the dike with concrete blocks to prevent it from eroding; erosion had been occurring at the rate of one foot per year because of heavy ice pushed towards the dike (Barei, 2011). The concrete blocks started displacing (Photo 2.4.2.1) after the 2010 spring season, and the 2014 heavy ice jams severely damaged the dike (Bhagwandass, 2016). In 2005, the engineers commissioned by the First Nation reported that the dike is deteriorating and inadequate to protect the community (Barei, 2011).

[23] Standing Committee on Aboriginal Affairs and Northern Development (2005, p. 2). (http://cmte.parl.gc.ca/Content/HOC/Committee/381/AANO/Evidence/EV2067775/AANOEV48-E.PDF).

[24] The dike deficiencies could result in failure during flood/ice jam events.

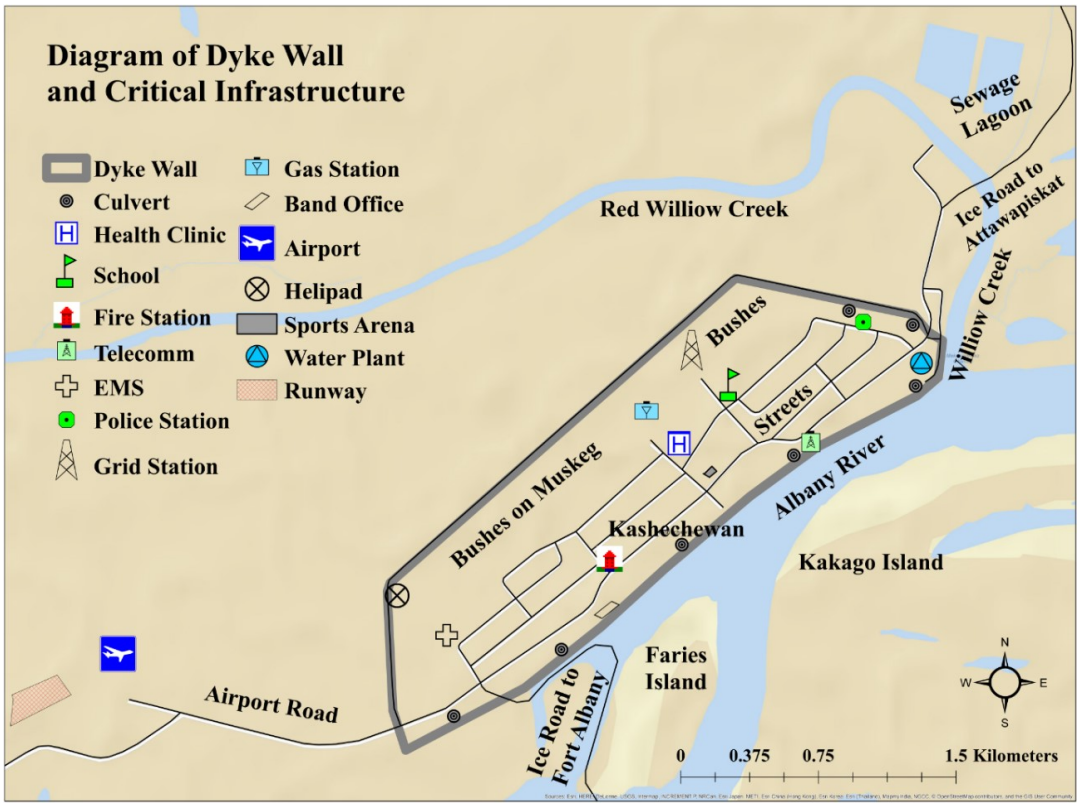


Figure 2.2.2. Diagram of Ring-Shaped Dike and Critical Community Infrastructure.

Since the establishment of Kashechewan in 1957, the most significant spring flooding occurred in 1966, 1972, 1976, 1985, 2006, and 2008 (Abdelnour, 2013; McCarthy et al., 2011). Kashechewan residents have been evacuated 14 times to 22 different host communities because of actual flooding or flooding risks or due to the E. coli problem since 2004 (Table 2.2.1). The federal government commissioned a study in the summer of 2006 to investigate the problem. The study recommended relocating the community to Timmins, about 425 kilometers (straight line distance) to the southwest (Pope, 2006). The community refused the federal government proposal because it wanted to relocate 30 kilometers (straight line distance) upriver on the reserve territory. In 2007, the federal government decided not to relocate the community because of the cost (Murdocca, 2010; Gosine & Teelucksingh, 2009), which was estimated at CAD 500 million (excluding non-financial, social, and cultural costs) and increased to CAD 750 million[25] (Bhagwandass, 2016; Harries, 2008). As the relocation did not occur, the community continues to face elevated spring flooding risks. After 2005, residents were evacuated because of actual flooding or flooding risks in 2006, 2007, 2008 and, then, every year between 2012 and 2019, all at significant costs. For

[25] http://www.cbc.ca/news/canada/sudbury/kashechewan-prepares-foranother-flood-evacuation-worries-about-dike-1.3041852.

example, during the 2014 flooding, CAD 21 million was reportedly spent to evacuate the community.[26] In a referendum commissioned by the band in October 2016, over 89% of band members voted in favor of relocating 30 kilometers upriver (L. Friday, personal communication, 14 November 2016).

Event Type	Event Date	Community Affected	People Evacuated	CD$ Million	Host City/Community
Flood risk	12th April 2019	Kashechewan	2,500	---	Timmins, Kapuskasing, Thunder Bay, Hearts and Cochrane.
Flood risk	26th April 2018	Kashechewan	1,690	---	Timmins, Kapuskasing, Cochrane, Smooth Rock Falls (SRF), and Thunder Bay.
Flood risk	16th April 2017	Kashechewan	600	---	Kapuskasing, SRF, and Hearst.
Flood risk	27th April 2016	Kashechewan	1,207	---	Kapuskasing and Thunder Bay.
Flood risk	17th April 2015	Kashechewan & Fort Albany	1,333	**9.4**	Kapuskasing, SRF, Wawa, and Cornwell.
Flood risk	April 2014	Kashechewan	1,600	**21.0**	Kapuskasing, Thunder Bay, Greenstone, and Cornwell.
Flood risk & sewer back-up	30th April 2013	Kashechewan	1,500	---	Kapuskasing, Kirk Lake, Englehart, Cochrane, Iroquois, North Bay, and Cornwell.
Flood risk	24th March 2012	Kashechewan & Fort Albany	269	**6.7**	Kapuskasing, Thunder Bay, and Wawa.
Flood risk	April 2007	Kashechewan	---	---	Stratford and Sudbury.
Flood risk	23rd April 2005	Kashechewan	200	---	Moosonee and Cochrane.
Flood risk	April 2004	Kashechewan	---	---	---
Flood risk	1st January 1989	Kashechewan, Fort Albany & Attawapiskat	1,000	---	---
Actual flooding	25th April 2008	Kashechewan & Fort Albany	1,900	---	Cochrane, Geraldton, and Sudbury.
Actual flooding	23rd April 2006	Kashechewan	1,100	**20.2**	Peterborough, S.S.Marie, Thunder Bay, Geraldton, and Cochrane.
Actual flooding	April 1985	Kashechewan	---	---	Moosonee.
Actual flooding	April 1976	Kashechewan	300	---	Fort Albany, and Moosonee.
E. Coli found in tap water	26th October 2005	Kashechewan	1,100	**16.00** 1.0 (plant)	Attawapiskat, Cochrane, Ottawa, Moosonee, Sudbury, & Timmins.

(Sources: W. Sutherland, personal communication, May 9, 2018; Public Safety Canada, 2017; Environment Canada, 2017, 2008; Barei, 2011; McCarthy et al., 2011; Digital Journal, 2007; Beltaos, 1995). The sign "---" indicates that information is not available from a reliable source.

Table 2.2.1. Past Events of Flooding Risk or Actual Flooding, E. Coli, and Evacuations.

[26] http://news.nationalpost.com/news/canada/we-cannot-continue-to-livethis-way-flood-risk-forces-kashechewan-evacuation-for-fourth-year-in-a-row.

2.2.2. Climate, River Morphology, and Human Ecology

The southwestern James Bay region is part of the Hudson Bay Lowland, one of the seven physiographic regions[27] of Canada (Canadian Encyclopaedia, 2015). The lowlands also are the largest wetland region of Canada, which remained covered by glaciers until about 10,000 years ago (Ohmagari & Berkes, 1997). The James Bay waters significantly influence the region's weather, which comprises relatively cold and warm temperatures in summer and winter, respectively (NAC-Canada, 2002). James Bay largely remains free of ice from mid-July to mid-October with little or no open water after mid-December (NAC-Canada, 2002). The Kashechewan mean daily minimum temperatures in December, January, February, March, and April are −7, −23, −23, −15, and −6, and mean daily maximum during the same months are −9, −13, −11, −5, and 3 °C, respectively, with 200–240 cm mean annual snowfall (Ohmagari & Berkes, 1997). The hot days in June, July, and August are recorded 31, 32, and 31 °C, respectively. The average precipitation over 50 mm is between May and October, and 38 mm during April, which is the crucial month triggering spring flooding.[28]

The Albany River consists of multiple channels near its mouth at the bay. The North and South Channels split into two or more subchannels, which are narrower than their respective parent channels with almost the same slope; however, the river's slope flattens when it approaches the bay (Grover et al., 1999). Numerous smaller connecting channels run in the north and south directions between the two parent channels (Grover et al., 1999). While the flow distribution between both varies and is dependent upon the river's total discharge, the North Channel carries more flow than the South Channel (Grover et al., 1999). There are several islands and rapids[29] in the two parent channels, which contribute to ice jams and trigger flooding. The Albany Island is the largest among all islands and divides the North and South Channels at the river's mouth. The downriver islands of Fafarid, Linklater, Kakago, and Faries in the North Channel, and Willow and Anderson in the South Channel can cause ice jams and therefore are considered dangerous. For

[27] The term physiographic means physical geography. The other six physiographic regions are Arctic Lands, Cordillera, Interior Plains, Canadian Shield Forest Lands, St Lawrence Lowlands, and Appalachia. The divisions are based on each area's relatively similar physical geography and landforms (https://www.thecanadianencyclopedia.ca/article/physiographic-regions).

[28] https://www.meteoblue.com/en/weather/forecast/modelclimate/kashechewan_canada_5989520.

[29] Rapids are parts of a river where its bed has a relatively steep gradient or slope. They are hydrological features between a smooth flow and a cascade. Rapids can cause an increase in water velocity and turbulence.

example, Fafarid Island caused major ice jams, which triggered the flooding events of 1976 and 1985 (Abdelnour, 2011).

Natural resources, including wildlife and fish, are crucial for Cree land-based sustenance economy. Spending time on the land and camping grounds and engaging in traditional hunting called "Bush Life" is considered essential by the community leaders for sustainable livelihood security and Cree social and cultural health (Ohmagari & Berkes, 1997). Traditional hunting, trapping, and fishing, and harvesting[30] the hunted meat, such as smoking geese, contribute to the First Nation's food and nutrition requirements and are based on the region's wildlife. The community has abundant wildlife, including geese, ducks, moose, beavers, bears, wolves, rabbits, and otters. The abundant marine food sources are whitefish, trout, northern pike, pickerel, and sturgeon. The region's vegetation includes black spruce, sphagnum moss, and ground lichen in the bogs, and sedge, birch, and tamarack in the fens in addition to white spruce, balsam fir, trembling aspen, balsam poplar, and white birch, which occur in the better-drained areas (Ohmagari & Berkes, 1997). The changing climate and unpredictable weather are affecting the pattern of migratory birds in the region, and the increased risk of flooding is negatively impacting spring hunting of the First Nation.

2.2.3. Spring Flooding Hazard

Many Canadian watersheds, including the Red River and the Albany River basins, are exposed to spring flooding—one of the foremost natural hazards among remote and isolated northern communities (Boluwade & Rasmussen, 2015; Abdelnour, 2013; Cunderlik & Ouarda, 2009; Beltaos, 2007; Newton et al., 2005). From 2006 to 2016, sixty-seven First Nations experienced 100 recorded floods in Canada (McNeill et al., 2017). During the same period, 13 First Nations experienced 20% of the recorded floods alone in Ontario (McNeill et al., 2017). As the frequency and intensity of spring floods are expected to increase over time because of global warming, Indigenous Peoples are likely to be heavily affected (Green & Raygorodetsky, 2010; Hicks & Beltaos, 2008; Newton et al., 2005).

[30] Harvest refers to the hunting, fishing, trapping, and gathering activities (Berkes et al., 1994).

Spring flooding occurs because of the temporary blockage of river flow and the build-up of broken-up ice blocks within a river channel. Jams cause the river water to rise instantly upstream, which may cause the river to overflow its banks, depending on the height of the blockage relative to the depth of the river (Brooks, Evans, & Clague, 2001). The high flow, lower freeze-up conditions, and thin ice cover increase the probability of flooding (Beltaos & Carter, 2009; Beltaos & Burrell, 2003; Beltaos, 1997). Weather conditions, such as temperature, wind speed, and precipitation, also contribute to flooding because they affect the flow, and the ice-cover thickness and strength (Beltaos & Burrell, 2003; Beltaos & Prowse, 2001). The flooding features, such as onset, speed, and magnitude, are governed by the region's topography, land-use pattern, vegetation, and soil, and changes in the river in question (Few, 2003). Spring flooding has a greater potential for damage than open-water floods (Hicks & Beltaos, 2008).

Ice breakup is "the period from when water levels begin to rapidly rise beneath ice cover, in response to the spring freshet, until ice is fully cleared from the river channel, typically just after peak water level" (Emmerton, Lesack, & Marsh, 2007, p. 12). The onset of breakup depends on water levels, freeze-up conditions, ice thickness, and air temperature (Beltaos & Prowse, 2001). The two phases of ice breakup are premature and over-mature. The premature breakup involves rapid and extensive snowmelt, often augmented by rainfall, and is associated with rapid runoff (Beltaos, 2007). The over-mature breakup is caused by mild weather with little or no runoff (Beltaos, 2007). Premature breakup causes more severe flooding and damage than over-mature breakup (Beltaos & Prowse, 2001). The river slope, width, depth, and elevation also influence the breakup and flow pattern (Beltaos & Carter, 2009; Beltaos & Prowse, 2001). Climate-induced factors, such as the winter ice-cover thickness and river flow, affect the breakup and jam processes (Beltaos & Burrell, 2003; Beltaos & Prowse, 2001). Ice breakup is more predictable than jams; the forecasting is essentially empirical as the site-specific local conditions are not spatially transferable (Hicks & Beltaos, 2008; Gerard & Davar, 1995; Prowse, 1995).

Ice jams are a vital feature of spring flooding faced by riverside communities, particularly in northern Canada (Woo, Rouse, Stewart, & Stone, 2008; Emmerton et al., 2007; Gerard & Davar, 1995). A jam is defined as "a stationary accumulation of fragmented ice or frazil that restricts flow" (Beltaos, 1995, p. 71). Jams are caused by surface ice blockage at floating obstacles, ice congestion at natural constrictions and reduced speed areas, and at typical jam geomorphic-related

or manmade sites (Beltaos, 1995). A sudden jam release threatens downriver communities because it releases large waves and ice-run (Nafziger et al., 2016; Beltaos & Carter, 2009; Beltaos, 2007). Jams can occur within a few minutes, allowing very little time to evacuate (Beltaos, 2007). They can be several meters thick and can increase the water level thrice as compared to the open-water flooding (Beltaos, 2007; Beltaos & Prowse, 2001). Jams are locally produced depending on site-specific geomorphologic conditions and are difficult to predict (Hicks & Beltaos, 2008; Beltaos & Burrell, 2003; Beltaos & Prowse, 2001). Ice jams are also influenced by factors such as hydraulic resistance, reduced flow velocity, curvature of islands, manmade obstructions, river confluence, and channel constrictions (Beltaos & Carter, 2009; Beltaos & Prowse, 2001; Ettema, Muste, & Kruger, 1999; Beltaos, 1995).

2.3. Approach and Methods

A post-positivist approach guided this research because that approach challenges the traditional concepts of universal truth or presumptions about what constitutes a fact. When studying human perception, behaviour, and action, post-positivism recognizes that researchers cannot be infallible about their claims of knowledge (Creswell, 2003; Phillips & Burbules, 2000). Post-positivists confront the positivist's notion of universal objectivity by challenging the dominant Eurocentric conceptions of social life to give voice to the marginalized (e.g., traditional knowledge holders) who do not fit into the westernized mainstream social reality (Hay, 2010). Hence, post-positivists proposed primarily a different conceptualization of truth (Clark, 1998). Botha (2011) argues that Indigenous research methodologies should go beyond conventional qualitative approach suggesting the MMR using creative, participatory, and reflexive techniques. He asserts combining existing qualitative methods with "the specific aspirations" of Indigenous Peoples in a "mixed method strategy framed within the cultural-historic activity theory (CHAT)[31] principles of expansive learning" to reflect the distinctive epistemological aspects of the Indigenous ways of knowing (Botha, 2011, p. 313). They are 'Traditional Knowledge' (handed down from previous generations), 'Empirical Knowledge' (gained through careful observations), and 'Revealed Knowledge' (spiritual in origin). This research employed MMR because combining

[31] "CHAT enables researchers to analyse complex and evolving professional practices and practitioners to engage in reflective research" (Foot, 2014, p. 330).

qualitative and quantitative approaches, multiple methods, and sources of information offer a more in-depth understanding of a phenomenon and uncover different aspects of empirical reality (Creswell & Plano-Clark, 2011; Brannen, 2007; Denzin, 1978). The multi-method strategy attempts to serve the "particular theoretical, methodological and practical purposes" (Brannen, 2007, p. 182). MMR is more practical than a single method as it enabled using all required methods and multiple techniques to address the regular flooding problem in Kashechewan and allowed 12.9% (5.4% + 7.5%) of the community members to participate in the research. The focus of this study is only on the qualitative research data and multiple methods used, including in-depth interviews and flood mapping workshops. The results of this study were developed using participatory techniques discussed later in this section. The quantitative results from the associated survey research for assessing the perceived adaptive capacity of the First Nation are presented in Chapter 4.

The research project began with recognizing the important value of traditional knowledge to understanding the ecological phenomenon of spring flooding and respect for the expertise of elders within Kashechewan. The participatory techniques, including flood mapping workshops and qualitative interviews, were developed to ensure that both narrative and spatial information could be documented. This study was collaborative in nature. It involved early input of the First Nation on the research proposal, respect for Cree traditions and differing perspectives, appropriate research objectives, recognition of various forms of knowledge systems, and seeking triangulation of information. I visited Kashechewan three times (2015, 2016, and 2018) in a 4-year period (2014-2018) and verified results with community leaders and elders. I had the initial engagement with the community in November 2015 and spent a week in Kashechewan while presenting the research proposal to the Chief and Council and revised after receiving their input. This initial community engagement helped me in building rapport and trust with the First Nation leadership and understanding their priorities. After this initial visit, I spent five weeks in Kashechewan to collect data in 2016, which further enabled building of rapport with other community members. Given that postsecondary enrolment of Indigenous Peoples in Canada is low, a young community research assistant was hired and trained in the research methods to assist the fieldwork. Given that there has been little research carried out in Kashechewan on spring flooding hazard, by working with a member of the community throughout the fieldwork, my research project aimed to build capacity for the community to do its own research in the future.

During the third and visit for community reporting in November 2018, I presented ten large laminated posters (Appendix I) containing quotes of elders and the First Nation leaders, related additional information provided in plain language, and photographs as a gesture of reciprocity while documenting Cree traditional and local spatial knowledge. The posters were presented to the community during an event held in the high school and displayed in the main hall of the school.

2.3.1. Participatory Flood Mapping

Participatory mapping is a process of map-making in which local people are asked to visualize their association with the land and environment by using language that is locally understood and accepted (IFAD, 2009). The purpose of mapping was to elicit traditional and local spatial knowledge by facilitating discussion among the participants and availing the opportunity to build local capacity, give voice to traditional knowledge holders, and facilitate two-way communication (Chapin, Lamb, & Threlkeld, 2005). Participatory mapping also has been used to "investigate problem-oriented research questions" (Smith, 2003, p. 233). In participatory mapping, the drawing sketch map technique is commonly used for DRR because it enables communities to delineate areas that they perceive to be prone and vulnerable to environmental hazards (Cadag & Gaillard, 2012). Cadag and Gaillard (2012) call drawing sketch maps as the middle ground while comparing it with other mapping techniques, such as on-ground mapping and the technology-based GPS mapping. During the participatory mapping, participants drew sketches on unscaled and non-georeferenced google base maps provided by the band. In a group setting, participants identified the past flooded and high to low-risk areas, jam sites, and higher ground on the reserve territory.

The mapping technique was useful for the identification of factors contributing to the hazard vulnerability of the community and allowed participants to share their knowledge of past and present flooding events and localized flood characteristics while focusing on physical rather than socioeconomic aspects. The technique used was easily accessible to participants in the group setting. Experienced hunters, fishers, and trappers participated in the flood mapping workshops. It helped me to investigate the problem in a two-way rich social interaction by involving residents as capable and active partners rather than passive recipients.

Five elders participated in an hour and a half-long mapping workshops to draw sketches using the simple base map to indicate spring flooding characteristics as shown in Figure 2.3.1. The

hand-drawn sketches were converted into GIS using ArcMap software for accuracy. The sketch maps drawn on simple papers are rarely reproduced as standardized maps (Smith, 2003). A participant who works as a Land-use Planner for the band provided suggestions to make the maps more precise using ArcMap, GIS. The results, including maps, were shared with and verified by the research participants for their input during the follow-up visit for community reporting in November 2018 and improved accordingly. The reproduced map (Figure 2.4.6) shows accurate distances between different locations, the elevation of the reserve territory, and the location of different sites, focusing on breakup ice jam sites and the winter ice road.

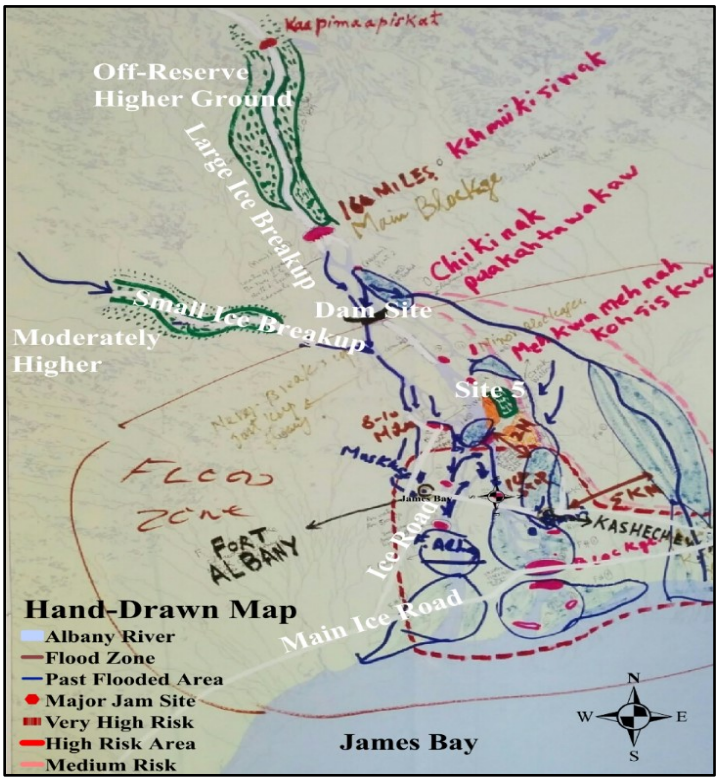


Figure 2.3.1. Participants Hand-Drawn Flooding Risk Map.

2.3.2. On Site Walk and Photography

The onsite walk technique is interactive, simple, and makes it inexpensive to gather information (NOAA, 2015). Photography also contributes to the process because it helps in documenting local spatial features and is now increasingly used while researching with Indigenous

Peoples (Gill et al., 2014; Samaddar, Chatterjee, Misra, & Tatano, 2011). For example, photography of the floodwater height and dike's vulnerable spots helped to document the fieldwork. Two knowledgeable elders accompanied me on four separate walks (each about an hour long) to the dike, and the areas around the airport, and the Albany River. The on-site walks helped provide detailed information about past flooded areas and details, such as flood height, water inflow and outflow, and the raised platform of the helipad. The walks also helped me to understand the community's spatial context and to learn the river's morphologic features, such as sharp bends and slopes. The walks contributed to the process of assessment of the community's physical vulnerability to spring floods. During the walks, critical sites were also photographed, including the low-lying areas, the dike's vulnerable spots, and the floodwater height during past events in and around the community. Photography supplemented the on-site walks and flood mapping workshops data and contributed to understanding the problem and documenting the local spatial knowledge. It also enabled this study to visually present the changes occurring in the local environment identified by participants.

Photo 2.3.2. Floodwater Level 2006
The top photographs indicate the five-foot floodwater at the airport road indicated by Elder William Sutherland. The bottom photos show Elders (mapping participants) engaged in drawing sketches in the group setting.

2.3.3. Qualitative Interviews

After the mapping workshops and on-site walks, I completed 17 semi-structured, in-depth interviews with elders and community leaders who have extensive hunting, fishing, and trapping experiences. These interviews provided participants an opportunity to share their stories and

experiences on changes observed in the river, on the land, and in their local environment. Qualitative interviewing is culturally appropriate when researching with Indigenous Peoples and respecting their traditions, customs, and way of life (Kariippanon & Senior, 2017). The qualitative interviews allowed participants to share their narratives and experiences and present a more holistic picture of their understanding of the problem (Brannen, 2007). An interview guide (Appendix C-1 & C-2) of topics and questions, such as changes observed in the river's morphology, geographical, and topographical changes since the establishment of Kashechewan in 1957, changes in the climate and its likely impacts on the breakup ice jamming phenomena, the winter ice road, and the muskeg wetland, was used to guide the interviews.

Before commencing interviews, I tested the guide by interviewing the community research assistant and revised it based on his feedback. The 17 interview participants were selected using the purposeful sampling technique. The criteria to select participants included community leaders and experienced hunters, trappers, and fishers who had been observing changes in their local environment as stated above. The average interview duration was a little over an hour. The qualitative interview method supplemented the participatory flood mapping techniques by enabling me to collect additional information in one-on-one conversations from all five mapping method participants in addition to 12 information-rich additional participants, including women and community leaders such as Chief and Grand Chief who only participated in in-depth interviews. Collecting information using multiple methods and techniques from different participants helped me to understand the problem holistically.

The interviews recordings were transcribed by a professional transcriber. The transcribed data were coded and analysed in the NVivo software while using a mix of descriptive (participants words) and analytical (literature reviewed) coding schemes (Gibbs, 2007). During descriptive coding, I made categories using the local terms and words commonly used by the interview participants such as muskeg and wetland. I also derived (analytical) codes from the research literature, previous studies, and based on my understanding of the data. The data collected using other participatory techniques, such as flood mapping workshops, were analysed in the ArcMap, GIS and Google Earth software to produce scaled maps. For accuracy and precision, numerous shapefiles were used, which were available online. Several shapefiles not readily available online

were also created by me to produce the maps. Photographs were analysed by triangulating the information obtained from various methods and sources.

2.4. Results

2.4.1. Low-Lying Wetland

The region's topography is muskeg, marsh swamp, and wetland. Mostly, the reserve is low-lying and prone to spring flooding. The land is soft with a small variation in elevation. Mostly, the sea coastline (3-5 km inland) is tidal, mudflat, and below sea-level. Kashechewan is only a few feet higher than the river and 27 feet above sea level. The reserve territory's elevation decreases as it gets closer to James Bay and the land is less muskeg while moving away from the bay.

> *"For the longest time, this place hasn't been the best due to the lack of functional waterways. So, this place has been wet for way too long, and I don't like that."*
> (Kenneth Hughie)

According to mapping and interview participants, Kashechewan falls under the federal government declared flood zone. They also indicated that the relatively higher and safer ground (Site 5, which has about 24 meters elevation) on the territory is 30 kilometres (straight line distance) upriver. Figure 2.4.1 produced in ArcMap, GIS highlights the elevation of the study area, focusing on the reserve territory. While most of the reserve is at risk of flooding, Kashechewan is at very high risk.

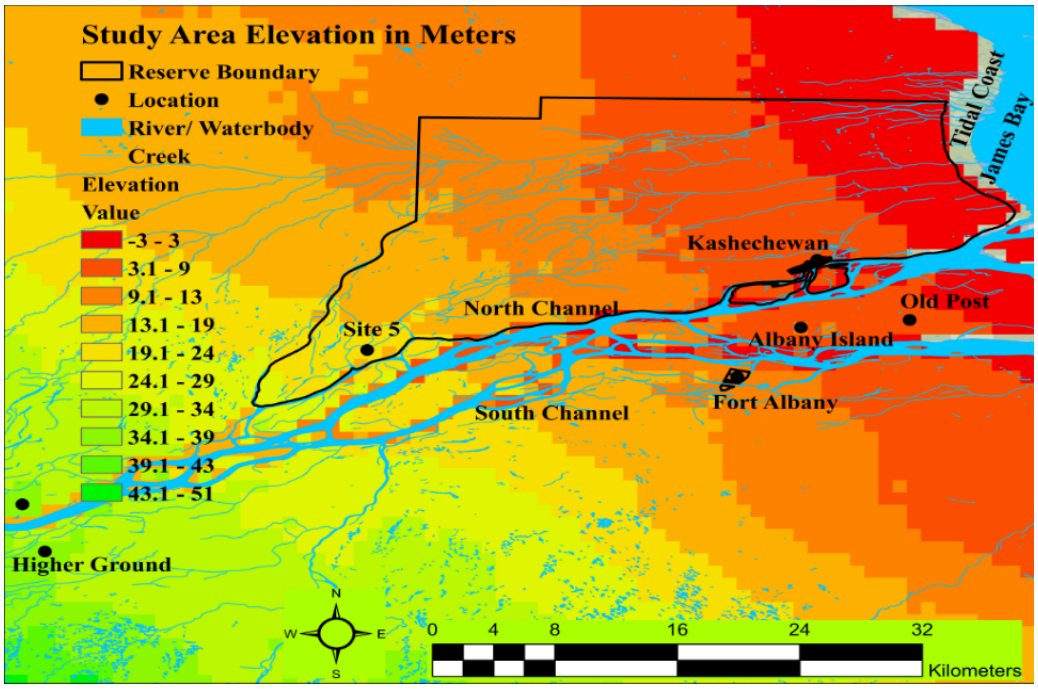


Figure 2.4.1. Study Area Elevation Map.

2.4.2. Community Infrastructure

2.4.2.1. Ring-Shaped Dike

Interview participants claimed that the federal government agreed to fulfill its treaty promises of providing additional housing, community infrastructure, and civic services only if the First Nation agreed to construct the dike in the 1990s to protect the assets. As explained by one interview participant, the ring-shaped dike was built in 1995-97. The dike has several culverts, including five along the river with gates to control the floodwater outflow/inflow. According to this participant, engineers estimated the initial cost of a good quality dike at CAD 40 million, but a less expensive dike was built for CAD 16.1 million. Between 2006 and 2010 the federal government spent more than CAD 9 million to improve the dike after the relocation attempt failed.

> *"The government policy is a form of threat. Like you have no choice but to accept."*
> (Oliver Wesley)

Interview participants have many concerns about the dike related to aesthetics, emotions, spiritual and physical needs, sociocultural issues, health, weather, safety, and trust. The 3.5-meter-high dike is bowl-shaped and surrounds the community from all sides while blocking views of the river and trees. As Tamara Koosees, an interview participant, said, *"It's ugly. It takes the beauty away from Kashechewan. The beauty is that river, and you can't see it unless you go up on the dike. I don't like living in a bowl."*

> *"It's a very nice place to live with the river, the view. The one thing I don't like about since the change the dike all around the community. It's because you can't see the trees the scenery has changed since that dike; it's blocking the view. Before that, it was really nice."* (Valentino Kamalatisit)

One interview participant explained that the dike obstructs her emotional and spiritual connection with the land and the river because it makes her feel disconnected from the natural environment.

> *"I don't like living inside the dike. But other than that, I like [Kashechewan]. I love it. It feels like you're cut off from the land. It was way better when we were living without the dike. Yeah, there's no sense, when [in the past] you look at the river, out in the bay, you sense this, just kind of peace, when you're looking out."* (Wilma Williams)

A participant who had been away from Kashechewan for several years said he used to see many canoes and people in the river and on the riverbank before the dike was constructed. He blames the dike for keeping people away from the outdoors in this way. Another participant explained that the bowl-shaped dike contains dust from unpaved dirt roads in the community, particularly during summer, which causes respiratory problems, especially among children because they spend a lot of time playing in the streets.

> *"The dike causes a negative effect more because of the [dirt road] dust in the summertime. You drive around, you can't go nowhere. [Dust] goes within the dike itself and cause[s] a lot of asthma [and] health issues."* (Edward Sutherland)

Two interview participants said that the community experiences higher temperatures and fewer fresh breezes in the summer because of the dike. These environmental conditions stand in contrast to what occurs in the open environment outside the dike. One participant also shared his memories before the dike and its deteriorating condition.

> *"It seems like we're in a bowl here. You know, in the summertime, it's hot. I go over [walk on] the dike. It's less hot on the dike; the wind is not as lively [inside] as it is over the dike. Growing up, my house was right by the river. I used to wake up in the morning and see a beautiful river. Now I don't see the river. I have to go on top of the dike. But something that I observed is that it seems like the first year, the dike was high, but it has settled; [it is] a little bit lower."*
> (Grand Chief Jonathan Solomon)

Although many participatory mapping and interview participants agree that the dike protected the community, particularly from the 2006 flooding, they do not trust that the dike, with its deficiencies, deterioration, and settlement, can save them from future flooding. Georgina Wynne said that the dike has "*actually helped a lot of times,"* but that she fully expects, someday, *"it will just collapse on us 'cause it's been, like, over 10 years with that dike. They [residents] say that it was higher, and it's going down, down, down, yeah."* Tamara Koosees agrees with Wynne and said that "*I don't feel safe because that bowl is not gonna last forever, and that's what it feels like. It's deteriorating, year by year, and it's not always gonna be there to protect us and it's gonna do damage."*

Another concern is that a large amount of snow inside the dike can trigger non-riverine flooding during the spring breakup. The flooding can be triggered because of warmer weather, rapid snowmelt, the closure of culvert gates, and high flow in the river. The culvert gates are closed during the high spring river flow to prevent the floodwater coming through the culverts into the community. When the gates are closed the rapidly flowing snowmelt water is trapped inside the community, threatening Kashechewan with flooding. In spring 2014, the heavy river flow pushed the floodwater to leak through the culvert gates into the community, although the gates are meant to drain the snowmelt water from the community away, and into the river (Bhagwandass, 2016). Participants explained that a breach of the dike can inundate Kashechewan quickly, which will not give residents enough time to evacuate.

"It affects more after the dike; people don't trust the dike no more, even though it's there, saved the community twice, they [residents] still don't trust the dike. If it breaks, it might flood the community in a couple of minutes […] plus [there is] no place to run, it's [area] all flat." (Elder William Sutherland)

"Well, definitely it would breach the dike for sure, and also those culverts that shut. They're not that strong, yeah." (Edward Sutherland)

During the freeze-up in winter and early spring, the dike is strengthened as the ground and gravel freezes. The mild weather, however, thaws frost and can result in a breach. The dike deficiencies and the 2006 floodwater leak add to the residents' uncertainty and fear. Grand Chief Jonathan Solomon quoted the late Cree Elder Francine J. Wesley, who used to say, *"we don't need to worry about the dike because the dike is frozen."* Solomon wonders if the engineers considered the freeze-thaw cycle during the dike testing. The Cree Elders knowledge of the dike freeze-thaw cycle could have contributed to the findings of the study of engineers. The residents are more afraid of floating breakup ice than they are of floodwater, because if there is a sudden onset of flooding, they have little chance to evacuate using canoes. As Oliver Wesley said, "*even if you are in a canoe, ice will carry or destroy it. The flow of ice will carry the canoe away."*

The residents' fear of a dike breach increased after the federal government said that shoring up the dike for CAD 40 million is still no guarantee that the community will be protected. Moreover, bad weather can potentially delay evacuation by air. The following pictures highlight the deficiencies and culverts and gates that can cause floodwater leakage into the community.

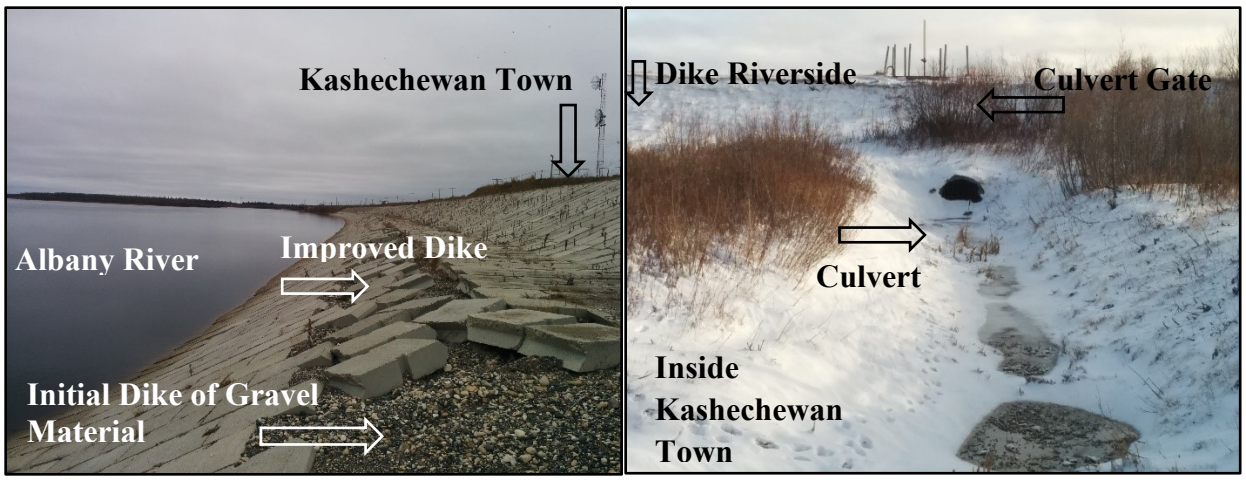


Photo 2.4.2.1. The Deteriorating Dike and a Culvert and its Gate.

> *"It's on record by engineers saying that the dike is high risk. […] You know, it's in a state of negligence. You know what is it gonna take to be heard [by the government]? A Disaster? I hope not."* (Grand Chief Jonathan Solomon)

2.4.2.2. Water Treatment Plant

Jams also affect the intake pipe of the conventional water treatment plant (Photo 2.4.2.2). The plant is situated northeast of the town near the Red Willow Creek and flows west to east into the river. The plant intake draws surface water from the creek. However, breakup ice affects the river water quality and blocks or damages the intake pipe and disrupts the drawing capacity for treatment and supply.

In 2005, the breakup ice jammed the water intake pipe which forced the community to evacuate because E. coli was found in the treated water. The contamination occurred because of a drainage ditch upstream of the plant, and because the upstream sewage lagoon (waste stabilization or tundra pond) was clogged by a beaver dam. Meanwhile, excessive rain led to downstream water contamination. Mapping participants said that the sewage lagoon and drainage ditch located upstream of the plant are the potential sources of downstream contamination. In 2005, the plant operator also lacked adequate training (Jacobs, 2010). That year, 1,100 residents were evacuated for about two months. In March 2016, 16 children were airlifted from Kashechewan after developing rashes and infections and the community reportedly blamed the plant for contamination

(HuffPost, 2016). Since the 2005 water contamination, many residents do not trust the tap water for drinking supplied by the plant. They buy bottled water from the Northern Store or the filtration plant operated by a local resident.

> *"Most people don't trust the water here 'cause that happened back then [2005]. […] So, they couldn't get water 'cause of the ice [that] was jammed in that intake, so our reservoirs [storage] kept getting lower, and [at] that point they had no choice [but] to shut down the pumps that runs the water to the community."* (Justin Wesley, Plant Operator)

Photo 2.4.2.2. Water Treatment Plant: Storage Tanks and Machinery/Equipment.

2.4.3. Climate Change

> *"The winters are getting milder; the winters are getting shorter. Climate change is not something that's gonna happen. It's happening it's been happening for a while now. Mother Nature is changing. They [Elders] observe[d] the winter. And they also observe[d] the temperature during the wintertime, and how much snow. The less snow, the less blanket, so the frost goes deeper. The more snow, the frost is not as thick. So, they observe[d] these things, and they also looked at the muskeg how much water is out in the muskeg."* (Grand Chief Jonathan Solomon)

> *"The weather is getting warmer, the winter's getting shorter. Because, when I'm growing up, this time of year should be skidoo down the river, go to my camp. The river would be frozen by now [mid-November]."* (Participant 10)

Participants say that winter used to be colder and longer and has now been reduced by up to two weeks, starting later in the third or fourth week of November, because of warming and late freeze-up. Participants explained that 15 to 20 years ago, snowfall would occur by mid- or sometimes early October and would be up to the knees by mid-November. That no longer happens. 15-20 years ago, by the end of October or early November, people would skate on the frozen river and go out to camps for hunting and to harvest traditional food. For the past few decades, participants have been experiencing early spring and snowmelt. They explained that spring is two to three weeks shorter. Hunters used to go out hunting and would stay on their camping grounds until early June. Now, they are airlifted by the band using helicopters and return earlier in April because of the early breakup and flood risk. The hunting pattern has had to change because of warmer weather, which triggers an earlier spring breakup and has elevated the flooding risk. Hunters cannot stay longer on the land and return in mid-April because of the mandatory precautionary evacuation every spring. As Oliver Wesley said, *"there's hardly anybody that stay[s] in the bush for two months, they only stay, like a week or two."* Edward Sutherland said that several years ago, he used hunt until late April. *"Way back, we used to hunt late April. Now, the geese start arriving late March. It affects the hunting because of early spring, early warmth".*

In recent years, increased temperatures accompanied by excessive rainfall in the spring have caused a quick snowmelt. As a result, a large amount of water flows downriver. *"The increased flow has to do with snow lots of snow and warm weather and when it rains,"* said Oliver Wesley. *"That's what triggers lots of water."* For example, excessive snowfall and a warm spell that remained for several days caused a major flood in 1976 in Kashechewan. The interview participants consider warming weather as the main cause of flooding. Heavy precipitation that continues for days also increases the probability of flooding. The participants' observations are consistent with the findings of Barnett, Adam, and Lettenmaier (2005), who reported that increasing temperatures cause earlier snowmelt in spring and affect the timing and volume of streamflow on the Canadian prairies. They argue that the accumulated snow and the spring melt phenomenon are more sensitive than precipitation to temperature.

One participant explained that elders observe changes in the hydro-meteorological factors, including accumulated snow (in the command and catchment area), ice thickness, and freeze-up conditions during winter, and river flow, temperature, and precipitation in spring. Their observations and forecasting the hydro-meteorological factors help them to determine the probability of a flood. Mapping participants also explained that the discharge threshold at the Hat Island gauging station (150 km upriver) is 5,000 m^3/s; that is the threshold that must be met in order for the band to declare an emergency in Kashechewan. One participant who has been Flood Watch Coordinator explained that the band started aerial monitoring of the river breakup ice jams after the 2006 flooding and has not observed any significant change in the river flow during this period.

Unlike in the past, it is getting harder for participants to predict the weather. The unpredictability, for example, the sudden increase in temperature or heavy precipitation, or a combination of both during the spring results in ice breakup and increases the flood risk, thereby forcing hunters to return to the community from their camps and hunting grounds.

> *"[The increased flow has] something to do with the water the breakup why lots of water all of sudden when they [community] don't expect the high waters in the springtime. In the past, we never used to experience or heard of the flood before [1976] in this community. They [community] think it's something to do with climate change. […] You tend to see something is coming, and all of a sudden, it's not, and sometimes you don't see something that's coming, and all of a sudden it is. That's how sneaky the weather is right now."* (Chief Leo Friday)

One interview participant stated that the community is losing flood-related traditional knowledge. He explained that traditional flood preparedness practices, such as preparing canoes with supplies and preparing a camp at a safer place for temporary relocation, are disappearing because of reliance on the dike.

> *"Sometimes I think we seem to put the traditional knowledge aside, but it is very important. Like, the observation that my grandfather used: traditional knowledge is something that's very valuable, even with climate change and how do you adapt to that? What we used to do prior to 1976 we used to get ready. I remember my*

grandfather, he would go up the airport road, and he used to build a pad over there [with] branches, trees up to five/six feet, and he would put a tent on top of that. So, when the spring came, that's where he would go and live on top of that pad instead of staying here. You were more prepared. But I think, you know, okay, we got a dike around us, we don't have to worry." (Grand Chief Jonathan Solomon)

2.4.4. Breakup Ice Jams

"They [elders] observe the winter—how it was at this time of the year. If it's freezing over—did we have high water or was it low? And they also observe the temperature during the wintertime, and how much snow. The less snow, the less blanket, so the frost goes deeper. The more snow, the frost doesn't—the ice is not as thick with—with less blanket of snow. So, they observe these things, you know, and they also looked at the muskeg—how much water is out in the muskeg."
(Grand Chief Jonathan Solomon)

After the 2006 flooding and engineers' report about dike deficiencies, as stated above, the band started monitoring the river breakup and jams using a helicopter. During the interviews, participants said that they had not observed any significant changes in the ice breakup phenomenon. However, the breakup events that occur at different locations in the Albany River system far upriver increase the risk of jams both up- and downriver. Participants say that the breakup process used to take longer because of colder weather and that in the past the water and ice flow continued without frequent jams.

"The spring breakups are almost the same every year but, sometimes [happen] more sooner now. [With] the slow breakup, we don't expect any flooding, because [ice] just moves, kilometre-by-kilometre. But the blockage is different where the ice jams up. Yeah, the regular breakup doesn't create any blockage. […] You [interviewer] have to be an "Indian" to understand [spring flooding]."
(Elder William Sutherland)

"When there's breakup in those three [sub]rivers [Mammamattawa, Ogoki, and Kenogami] at the same time, that's a high risk of flooding. [If] it's only one

breakup, and then another breakup comes, it's not noticeable, the ice is thinner. It's one at a time that's normal." (Oliver Wesley)

Participants explained that the warmer weather is causing more frequent jams, and the wet snow on ice contributes to jams.

"If [ice] breakup with snow in it, there will be ice jams because ice forms a wet snow they stick [together] because of wet snow." (Participant 10)

"See that curve there [four to five kilometres downriver]? That's where it jammed downstream when the 1976 flooding occurred. That's where it jammed, the ice, and that water built up it accumulated the water level, and that's how we got flooded because of the ice jam." (Oliver Wesley)

The research participants explained that predicting jams is difficult because a jam can occur anywhere in a river. There are, however, a few typical jam sites in the study area, particularly near the islands and the confluence point where the river divides into two channels. The jams include Kaapimaapiskat and the Fafarid Island located upriver near the confluence and downriver at the river's mouth, respectively.

"Nobody knows where ice jams where it's gonna happen, but we know a few places that always happens, but no one is sure where [jams] gonna happen exactly." (Elder William Sutherland)

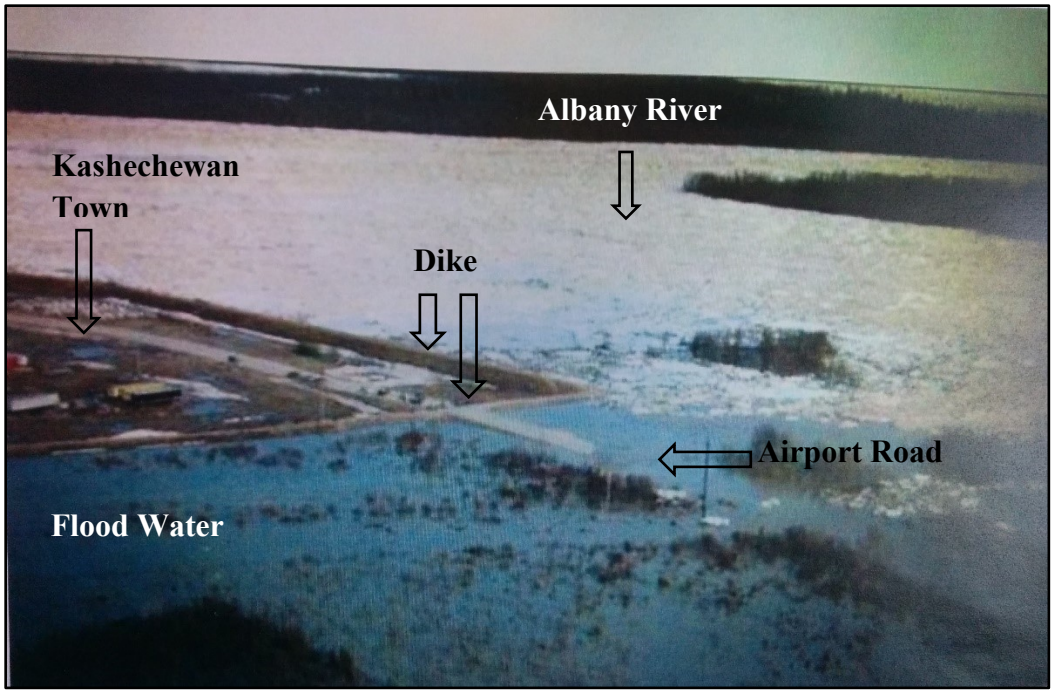


Photo 2.4.4.1. Spring 2006 Flooding. (Source: Kashechewan Band Office).

Photo 2.4.4.2. Albany River Spring Breakup 2017. (Photo: Holly Woodhouse).

Photo 2.4.4.3. Albany River Spring Breakup 2018. (Photo: Elder William Sutherland).

The recent significant changes participants have observed include the more frequent occurrence of jams and increased number of jamming sites because of warmer weather. Warmer spring has also added to the jamming unpredictability.

2.4.5. Winter Ice Road

Interview participants explained that warming has reduced the span and safety of the 312-kilometer-long winter ice road. The span of ice road was about three months during winter from January to March because the winter season used to be longer in the past. As a result, the ice road would open a few weeks earlier and would last longer. A participant who is an experienced ice road construction and maintenance worker said, *"the first time [16 March 2013] I experience[d] when the road was all gone, it was all melted"*. He concluded that as a result of global warming access to the neighbouring First Nations communities in the area is becoming restricted with the reduced safety level of the ice road.

Photo 2.4.5.1. 312 KM Winter Ice Road Connecting First Nations of James Bay. (Source: http://www.winterroadcompany.ca)

Mapping and interview participants revealed that the ice bridges and ice ramps built for crossing the Albany River and creeks also cause jams.

> *"They [Winter Road Company] build ice bridges, ice crossing, and as they build [ice bridge], it causes a dam effect, [because] it dries up downstream, and floods upstream […] about 48 inches each year."* (Edward Sutherland)

> *"When they [Company] built the ice bridge our river overflows because of the ice bridge. The river and creeks in our camping area overflows. […] One time we were almost flooded, near our campsite, where the chopper land, 100-150 yards away. The flood came this way. It never happened in the past."* (Participant 9)

The downriver ice bridge caused a jam and triggered the 2006 flood, incurring a cost of CAD 20.2 million. Every spring, numerous holes are drilled in the six-to-seven-foot thick ice bridge to avoid jams. However, the freeze-up conditions block the holes and results in jams. *"The drilled holes don't help,"* said Elder William Sutherland, *"and since then, we have problems with the flooding. That's where the ice stops downriver from Kashechewan and that's where it creates flooding."*

2.4.6. Kashechewan-Specific Spring Flooding Characteristics

Figure 2.4.6 produced in ArcMap, GIS, highlights the localized flooding features identified by participants based on their local spatial knowledge. The map focuses on breakup ice jams and higher ground on- and off-reserve territories. There are six major typical ice jams sites, shown as JM-1 to JM-6. The three downriver jams, JM-1 to JM-3, are critical and can cause the sudden onset of rapid flooding reaching several meters high and leaving little or no time to evacuate. The jams JM-1 and JM-2, located four to five kilometres downriver in the North Channel, seriously threaten Kashechewan. The jam JM-1, near Fafarid Island, caused the 1976 and 1985 floods. The ice jam JM-2 is at the river crossing and caused the 2006 flooding because the holes drilled in the six to seven feet thick ice bridge froze and blocked the flow. The increased flow caused by JM-2 in 2006 pushed the ice (two feet higher) on top of the dike. Within a few hours, the airport runway (outside of the dike) and its parallel road were inundated with two and five feet of floodwater, respectively. The entire community was evacuated by helicopters. The ice jam JM-3 in the South Channel causes flooding in Fort Albany and can also threaten Kashechewan by blocking and reversing the flow and then diverting it into the North Channel. The downriver jams are far more dangerous than the upriver jams; when the upriver jams occur, residents have several days to evacuate. The minor jams up- and downriver do not cause flooding. But they contribute to the major jam's flooding. Several islands and rapids in the two channels can cause jams and contribute to flooding. The downriver islands of Fafarid, Linklater, Kakago, and Faries in the North Channel, and Willow and Anderson in the South Channel contribute to the jams JM-1 and JM-2, and JM-3, respectively. The Albany Island causes the jam JM-3. The upriver islands near the confluence called "Kahmiikisiwak" cause the jam JM-6. Transportation and deposit of sand and sediments from up- to downriver around the islands and rapids also contribute to the jamming process. The off-reserve higher ground ("Kahmiikisiwak") has an elevation of 115-140 feet, which is over 100 feet higher

than Kashechewan located about 55 kilometres (straight line distance) upriver. Another off-reserve relatively higher ground located about 40 kilometres (straight line distance) in the southwest of Kashechewan has an elevation of around 100 feet. Mapping participants explained that constructing a dam and moving the winter ice road upriver can prevent or mitigate jams.

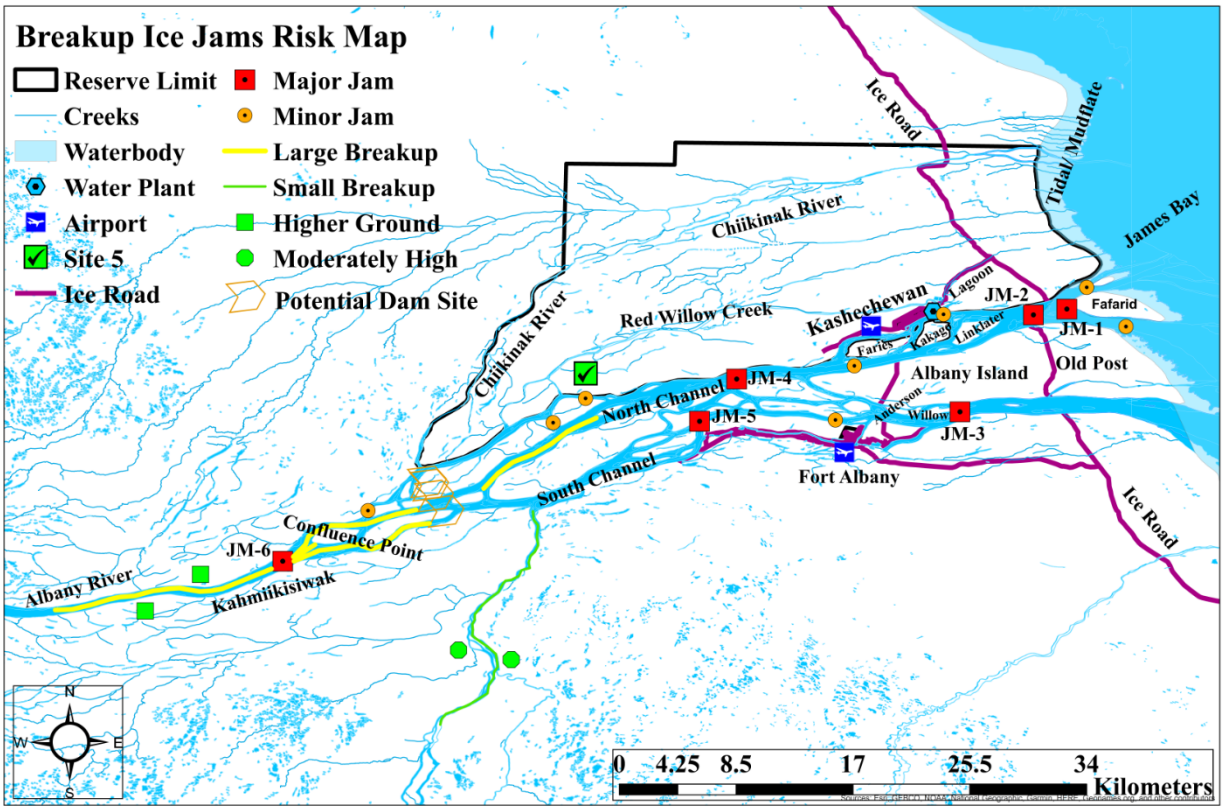


Figure 2.4.6. Kashechewan-Specific ArcMap (GIS) Spring Flooding Risk Map.

2.4.7. Socio-Economic Implications

> *"We have to train our young people, but we don't have that anymore. Like, the harmony of the land, the importance of the land, the spiritual connection of the land, and those things that we have to teach our people, and especially preparing our meat. How to make it last long for the summer. That's we can't do that anymore. That's how much interference we have from the flood and the river system that we have, it's [getting] really hard."* (Chief Leo Friday)

Before the early 1920s, the Cree of the Hudson Bay and James Bay Lowland did not have permanent settlements and coped with floods by moving to higher ground in spring (McCarthy et al., 2011; Newton, 1995). The permanent settlements increased their exposure to the spring flooding risk. Interview participants claimed that their leaders agreed to relocate from Old Post, Albany Island to Kashechewan in 1957 to gain the treaty benefits that the federal government had promised along with the on-reserve resettlement. During interviews, the participants insisted that they must relocate, but the government seems reluctant because of the high cost.

> *"But the reality is, someday it's gonna be flooding, that's why they [community] have to relocate, regardless. We need to convince the government that we need to relocate. It's just not pleasant to be in [Kashechewan] because you're displaced. You're just stressed out, and you can't enjoy life that's what it is. It [flooding] happened already a few times, and they [government] weren't convinced. I think they want us to die. You know what, that's in back of our mind, that's I think they're trying to, like, get rid of Indian problem. That stays in our mind that mentality still exists today."* (Oliver Wesley)

> *"The community is growing, and the government doesn't want to build more houses, and the people that are in the houses are overcrowded and I think it would be wiser to start thinking about the development of the new community and start implementing it."* (Chief Leo Friday)

> *"I'm hoping the government will give us new roads, a new water sewer system and new housing, new school, new hospital for our people. I know they spend millions and millions of dollars on evacuations, and if you add that up for a long time, it's cheaper for us to move upriver."* (Elder William Sutherland)

> *"I think relocation is not gonna happen tomorrow. It's gonna be years. It's gonna be a long process. The studies that need to be done, tendering, engineering, and everything. They're not gonna finish the whole process within three years. Let's not worry about the infrastructure, the housing they can be replaced but a loss of life cannot be replaced."* (Grand Chief Jonathan Solomon)

In the October 2016 referendum commissioned by the First Nation, according to Chief Leo Friday, 89% band members voted in favor of relocation from Kashechewan to Site 5 because they do not want to lose their ancestral traditional lands and natural resources.

2.5. Discussion

This study examined community members' flood-related traditional and local spatial knowledge using participatory techniques to investigate the elevated spring flooding problem in Kashechewan. The study also explored how are spring flooding risk and its impacts on the local environment changing as a result of global warming and human-induced development in the region since the establishment of Kashechewan. Traditional knowledge and observations of research participants on changes in their environment helped in the in-depth understanding of the elevated risk of spring flooding. The timing and extent of spring flooding have changed in recent years with warming temperatures in the region and have caused earlier spring, snowmelt, and rapid runoff. The elevated risk of flooding has also exacerbated its impacts on Kashechewan residents especially because of inadequate community infrastructure, the substandard dike, and the downriver ice bridge of the winter ice road, which, in turn, has increased the frequency and scale of spring breakup ice jams in the Albany River, without significant change in the annual average flow.

One of the findings is the increased ice jamming events and the increasing number of jamming sites with the warming temperatures in the region. Similar to participants' observations, the hunters and fishers of northern Canada have also observed one to two weeks late freeze-up in fall and one to two weeks early spring (McBeath & Sherpro, 2007; Ho et al., 2005). While the prediction of an ice jam is difficult, the Kashechewan elders' ability to predict breakup ice jams due to increased warming temperature appears to have reduced. Participants' observations are also similar to those of Ho et al. (2005) who noted potentially rapid changes in ice breakup in James Bay and predicted the earlier breakups and increased average temperatures in the region. McCarthy, Canziani, Leary, Dokken, and White (2001) also predicted climate changes due to increasing temperature in the Hudson and James Bay Lowlands. The Albany River is also experiencing earlier breakup dates (Ho et al., 2005; Gagnon & Gough, 2005). During three visits of Kashechewan in the month of November of 2015, 2016, and 2018, I also observed late freeze-up and experienced the first snowfall that occurred as late as mid-November, which would occur

during October in the past as indicated by Kashechewan elders. I also witnessed different species, such as migratory birds and worms, in mid-November, which would disappear as late as the end of October in the past, as observed by the community elders. It was also noted that the migration pattern of migratory birds is also being negatively affected. The change in the migration pattern of birds is impacting local hunting and traditional harvesting of meat. The earlier spring and elevated flooding risk have also negatively impacted the sociocultural activities of the community, such as camping by hunters along with family, including children on their traditional hunting and camping grounds. The reduced traditional spring hunting and camping in the bush is one of the main reasons for the erosion of traditional knowledge. With the significant reduction in spring hunting, the community elders have now little opportunity to train their younger generation.

Human-induced development activities also appear to have aggravated the risk of spring flooding. It was noted that substandard dike built improperly with gravel and sand material on peatland is the main cause of precautionary evacuation every spring, particularly after the 2006 flooding when floodwaters leaked through the dike. The weak dike foundation, which is only a meter deep without digging a core trench (Hatch, 2015; Kauppi, Pallard, & Faries, 2015), does not allow raising or reinforcing the wall because it can not bear the additional load. The depression in the crest of the dike, its erosion with the passage of time, and deficiencies reported by engineers (Bhagwandass, 2016; Kauppi et al., 2015) have resulted in the lack of trust of residents, which significantly adds to their psychological stress and anxiety as the spring season approaches. Raising the ground level within the dike with a substantial cost can mitigate the urban (snowmelt within bowl-shaped dike) flooding risk. However, this will not reduce the spring riverine flooding risk and other related problems of the First Nation because of the following reasons. First, Kashechewan is at very high risk because of its flood-prone location and elevation, which is perhaps the lowest in the region. Based on their traditional and local spatial knowledge, the community elders opposed the federal government's decision to establish Kashechewan in 1957 at its existing site. Second, the community has grown significantly from 300 band members in 1976 to over 2,000; therefore, it requires additional space for new housing and community infrastructure, while the existing area protected by the dike is insufficient for the growing future needs. Third, the emotional and psychological health of residents might remain in stressful condition because of experiences of the past flooding events, frequent evacuations, and the increased flooding risk, particularly after the 2006 flooding, which was a close call. Finally, based

on their traditional knowledge, Kashechewan elders and community leaders have concerns about climate change and its expected impacts on the First Nation and the neighboring communities of Fort Albany and Attawapiskat.

Another human-induced resource development activity relates to the ice bridge of the winter ice road causing ice jams. For example, the ice bridge jamming caused the 2006 flooding. This result indicates that human disturbance of the local landscape as a result of infrastructural development can increase the risk of flooding. In fact, an ice bridge as a cause of ice jam flooding has not been indicated by previous research. The other related finding is the reduced time span and safety level of the winter ice road, which connects the four First Nations communities of Moosonee, Fort Albany, Kashechewan, and Attawapiskat in the region. The ice road connects these communities during winter; therefore, it has socioeconomic, communication, and transportation significance. The reduced span (about two weeks) and safety of the winter ice road because of earlier spring have significant implications for the Kashechewan First Nation. Particularly, the cost of essential food items and other goods is increased because they are transported by air during the off-season of the ice road. The air travel in the Canadian north, including the James Bay region, is expensive. The participants' observations about the impact of warming temperatures on winter ice road are consistent with those found in the literature. For example, the span of ice road shortened in northern Ontario during 1997-98 because of warmer weather, which has also delayed the road construction, particularly in muskeg areas (Hori, Gough, Butler, & Tsuji, 2017; Hori, 2016; Ford & Smit, 2004). In the past, the span was three months (January-March) because of long winter and would open a few weeks earlier and last longer (Hori et al., 2017). To mitigate the spring flooding risk, building ice road upriver near the river confluence can prevent the ice bridge jamming. However, this may not be viable financially, technically, or because of increasing spring temperature. The higher spring flow due to breakup ice jams caused damage to the water treatment plant, coupled with the incidence of E. coli in the tap water, resulting in the evacuation of residents at a significant cost. Hicks and Beltaos (2008) also note that the excessive produced frazil ice can obstruct water intakes. The First Nation leaders consider the water treatment plant as an additional risk factor for their community. While visiting the plant, I observed that the plant appeared old, outdated, and is composed of obsolete technology.

Through structural and non-structural measures and technological mitigation strategies, spring ice jams risks can be reduced. Burrell (1995) argues that the structural measures for jams prevention are reliable. However, they are too costly to be implemented and sustained because of capital and maintenance costs, particularly for a remote, isolated, and small community. For example, construction of a dam 35-40 kilometers (straight line distance) upriver can prevent ice jams. The non-structural measures, such as ice booms, ice blasting, or cutting, are cost-effective but are not reliable to protect lives and property. Other technological solutions, such as piers and gates and ice control weir deployment upriver, can mitigate ice jams but are not reliable. Based on their traditional and local spatial knowledge, the community elders and First Nation leaders, however, consider such technological mitigation measures neither reliable nor sustainable to protect Kashechewan from the elevated risk of spring flooding in times of climate change and warming spring.

2.6. Conclusion

This paper focused on illuminating the observations and experiences of spring flooding based on the traditional and local spatial knowledge of residents of Kashechewan First Nation. The existing literature related to flood hazards in this region is relatively limited; previous research has highlighted aspects, such as risk perception, emergency preparedness, health and livelihood, housing, social learning, and socioeconomic implications (McNeill et al., 2017; Bhagwandass, 2016; McCarthy et al, 2011; Barei, 2011; Newton, 1995).

Participants identified a number of factors they feel have been exacerbated by climate change. These include the increased spring flows of the river, the increased temperatures, unpredictability of the weather, increased breakup ice jams events, and the reduced time span and the safety level of the winter ice road. Participants also identified the factors of low-lying and muskeg topography of the lowlands, and substandard community infrastructure; the deteriorating dike and obsolete water treatment plant.

The results of this study highlight traditional and local spatial knowledge and indigenous observations of climate change impacts, including the typical breakup ice jams sites, which are lacking in the existing spring flooding literature. This research contributes to the existing literature in three areas. First, the study documented the community's traditional and local spatial knowledge

and their observations on changes in the spring flooding hazard. In particular, the timing and extent of spring flooding, which have changed in recent years with warming temperatures in the region. Second, the study also explored the impacts caused by exacerbating factors of landscape and human-induced development, which are equally contributing to the elevated risk of spring ice jams and resultant flooding. Third, as stated earlier, the methodological approach employed in this study was the first application of participatory flood mapping techniques involving First Nation in the region and in Canada. Through the use of multiple culturally appropriate participatory techniques, the study brought new insight into how flood-related traditional and local spatial knowledge of the First Nation can be used to better understand localized flood risks and hazard-specific characteristics. In particular, I noted that the application of participatory flood mapping technique may be considered a useful method for ongoing flood monitoring and DRR for the study community and other Indigenous communities experiencing similar problems. The community's traditional and local spatial knowledge enabled this study to identify the main drivers of increased flooding risk and recurring evacuation every spring. Nevertheless, the findings of this research are not generalizable because they are Kashechewan context-based and spatially and temporally bound.

2.7. Chapter Summary

Chapter 2 described the importance of traditional and local spatial knowledge and its contribution to climate change adaptation and DRR. It provided the community context, discussed the phenomenon of spring flooding, and the participatory techniques used to collect and analyze data. The results presented show that the timing and extent of flooding have changed with warming temperatures along with earlier spring, snowmelt, and rapid runoff. Flooding impacts are exacerbated by landscape and resource development, which have increased the frequency and scale of spring breakup ice jams. The chapter concluded that ecological changes and warming springs have contributed to the elevated flooding risk.

CHAPTER 3

Spring Flooding and Recurring Evacuations of Kashechewan First Nation

3.1. Introduction

Vulnerability is an extensively used theoretical explanation for disasters (Lindell et al., 2001; Blaikie et al., 1994). Blaikie et al. (1994) have found that the way someone deals with and recovers from the impact of natural disasters is directly related to that person's characteristics and conditions (e.g., living, socioeconomic). This applies both to individuals and groups. This emphasis involves a combination of factors that determine the degree to which populations are exposed to a hazard risk. People's vulnerability can be affected by political, economic, ideological, and cultural processes as well as institutional structures that expose them to hazard risk (Lindell et al., 2001; Adger & Kelly, 2000). Due to the varying degree of vulnerability, some individuals or groups are more susceptible to disaster losses than others. Their vulnerability can be determined by factors such as class, occupation, ethnicity, gender, age, and the nature and extent of their social networks. Vulnerability can also be determined by the hazard knowledge to which people are exposed, as well as their experience to deal with disasters. Existing research on vulnerability to natural hazards indicates that Indigenous communities are among those that suffer the most from socioeconomic and environmental stresses (Newton et al., 2005; Adger & Kelly, 2000; Adger, 1999). Their vulnerability to natural hazards can be further aggravated by remoteness, isolation, and marginalization (Newton et al., 2005; Adger & Kelly, 2000). The root cause of this vulnerability is settler-colonialism, which marginalized Indigenous Peoples in a number of ways: including socioeconomically, culturally, and politically (Coulthard, 2014; Wolfe, 2006). This study considers the marginalized (through colonization process) context of remote and isolated socio-ecological systems because that context plays a crucial role in vulnerability (Maru et al., 2014). Vulnerable people who frequently experience a hazard are often less resilient. Both

vulnerability and the level of adaptive capacity determine community resilience. Community resilience is also seen as proactive and positive characteristics when dealing with natural hazards.

Floods can affect people, property, and socioeconomic activities. They can disrupt community infrastructure and essential lifeline services, such as healthcare, education, drinking water, power supply, sanitation, transportation, and waste disposal, including breaching dikes and blocking ill-planned water drainage system (Deshmukh, Oh, & Hastak, 2011; Brattberg & Sundelius, 2011; Du, FitzGerald, Clark, & Hou, 2009). In the Subarctic region, flooding also affects cultural and traditional activities and the local economy, thereby negatively impacting people's well-being. In particular, health risks significantly increase because of the disruption to healthcare services and because flooding leads to a non-functional health infrastructure (Mudavanhu, 2014; Du et al., 2009; Peek, 2009; Warren, Burner, & Curtis, 2005). One of the implications of floods is an evacuation.

Evacuations due to floods can seriously affect individual and community well-being (Tally, Levack, Sarkin, Gilmer, & Groessl, 2013; Tobin et al., 2011; Cohn et al., 2006). Evacuation is a complex phenomenon (Aguirre, 1983). Evacuation experiences are determined by family dynamics, childcare, mechanisms for coping with the emergency and emotional stress, and by cultural and ancestral belief (Chester & Duncan, 2009; Whiteford & Tobin, 2004; Fothergill, 2004; Ronan, Paton, Johnston, & Houghton, 2000; Chester, 1993). Evacuees often experience emotional stress because they fear that the belongings that they leave in their homes will be stolen. They also have to leave jobs, which means a loss of income, and must find new services in evacuation centres, where they often face racism (Asfaw, SLFN, McGee, & Christianson, 2019b; Tobin & Whiteford, 2002; Cola, 1996; Lindell & Perry, 1992). In other words, evacuations can have far-reaching social, psychological, economic, and other impacts on evacuees (Tally et al., 2012; Sorensen & Sorensen, 2007; Cohn et al., 2006). For Indigenous Peoples, evacuations cause numerous negative impacts such as a disruption in their traditional way of life and cultural activities, a loss of the place attachments, and an erosion of community and social relationships (Asfaw et al., 2019a, 2019b; Asfaw, McGee, & Christianson, 2019; Waldram & Scharbach, 2013; Newton, 1995).

Cutter et al. (2008) define resilience as a community's ability to respond to and recover from disasters. Their definition focuses on people's inherent ability to absorb shocks and deal with

disaster impacts (Cutter et al., 2008). The ability also helps people to re-organize, build and/or enhance the community's capacity to learn and to adapt to natural hazards (Cutter et al., 2008). During a hazard event, disaster resilience also refers to the community's ability to survive and deal with events by reducing impacts and sustaining minimum damage (Berke & Campanella, 2006). Resilience also helps people to assess hazards holistically in the context of social systems and environmental hazards (Berkes, 2007; Gaillard, 2007). It emphasizes people's adaptive capacity and is future-oriented (Maru et al., 2014; Davies et al., 2012; Berkes, 2007; Gaillard, 2007). The resilience of a community can also be determined by the level of adaptive capacity; adaptation and resilience are interrelated and have an application to human-environment systems (Smith & Wadel, 2006). Community resilience-building focuses on the adaptive capacity of individuals, households, and communities. This capacity involves people's resources and collective strategic action; social networks/capital; and knowledge, skills, and learning (Berkes & Ross, 2013; Cutter et al., 2008). The more adaptive people are, the more resilient they are to natural hazards (Nelson et al., 2007; Newton et al., 2005). Furthermore, adaptation and resilience overlap with adaptive capacity because both help to build people's resilience. Against this backdrop, remoteness, isolation, and marginalization can have positive as well as negative effects on the adaptive capacity of Indigenous Peoples, subsequently influencing their resilience (Maru et al., 2014). The frequent flooding risk and recurring emergency evacuation experiences can enhance or weaken community resilience.

Using regional case studies, a small group of researchers has examined the vulnerability and resilience of communities while focusing on spring flooding that affects remote northern Canadian Indigenous communities. Ford and Smith (2004) looked at the implications of flooding risk for Inuit communities and developed a conceptual model of vulnerability and presented an analytical approach for assessing adaptive capacities. Newton et al. (2005) explored the linkages between natural hazards and climate change, while focusing on spring flooding and the role of Indigenous communities and their traditional knowledge. They studied ways in which the Canadian territorial governments responded to spring flooding involving Indigenous communities in northern Canada. Newton (1995) examined flooding vulnerabilities and the resilience of the Indigenous communities of Aklavik and Liard, Northwest Territories, and Attawapiskat, Ontario. He looked at distinctions between perceptions, attitudes, and activities at three (individual, communal, government) operational levels and how they interrelate while responding to flooding.

Thompson et al. (2014) focused on the Lake St. Martin First Nation in Manitoba, which was artificially flooded and permanently displaced during 2011. Ballard and Thompson (2013) studied the impacts of artificial flooding on sustainable livelihoods, homes, health, and the sociocultural integrity of the Lake St. Martin First Nation. The relevant literature reviewed suggests that spring flooding and the resultant recurring evacuation experiences of northern Canadian Indigenous communities are not well documented. Nonetheless, there have been a few studies about the permanent evacuation experiences that resulted from flooding and wildfires in remote and isolated Indigenous communities. For example, Thompson et al. (2014) studied the permanent evacuation experiences of the Lake St. Martin First Nation, whose participants told him, "We're life refugees" (p. 79). After four to five years of displacement, the Lake St. Martin First Nation was resettled at a site selected by the federal government. Scharbach and Waldrem (2016) explored the wildfire evacuation experiences of residents of the Hatchet Lake Denesuline First Nation in northern Saskatchewan. The main evacuation impacts on the Hatchet Lake Denesuline First Nation include the fragmentation of community social organization and stability, separation of extended family members, and negative effects on health, particularly for disabled residents. Asfaw et al. (2019a; 2019b) examined wildfire evacuation preparedness and evacuation challenges while researching the Sandy Lake First Nation in north-western Ontario. The negative impacts of that evacuation included inadequate accommodation, financial difficulties, racism, and evacuees' concerns about the condition of their homes, property, and pets. The positive experiences included material and emotional support provided by host communities, an opportunity to socialize with fellow evacuees, and the leadership provided by the Chief.

Asfaw et al. (2019) studied the role of family, social supports, and place attachment among wildfire evacuees. They found that evacuees were negatively impacted by being dispersed to multiple host communities. The negative impacts included difficulty with communication and information-sharing, disruption of community cohesion and support services, and lack of a sense of place. Christianson, McGee, and the Whitefish Lake First Nation (2019) explored the factors that complicated the evacuation process and caused additional stress for the evacuees of the 2011 wildfire event that occurred in the Whitefish Lake First Nation. Among the factors that affected that evacuation experience were transportation issues compounded by cultural land-use activities, fear of home loss, lack of information and media attention, health issues, and large multi-generational families. Although a wildfire hazard is different from spring flooding, the experiences

of First Nations communities during their stay in host communities can be similar regardless of the reason for the evacuation. However, little is known about the impacts of frequent flooding risk and recurring evacuation experiences of northern Canadian Indigenous communities.

The Kashechewan First Nation in northern Ontario is regularly affected by the risk of spring flooding and has been evacuated every year from 2004-2008 and 2012-2019. While flooding risk and the resultant evacuations in the James Bay region of northern Ontario have been much publicized, little is known about the impacts of spring flooding and recurring evacuations (Khalafzai et al., 2019). According to Khalafzai and colleagues (2019), spring flooding has occurred seasonally in the region and has not increased significantly over time. But the timing and extent of flooding have changed in recent years with warming temperatures in the region. Impacts are exacerbated due to changes in the landscape and resource developments, including inadequate community infrastructure and a downriver winter ice road, which have increased the frequency and scale of breakup ice jams. Khalafzai and colleagues (2019) conclude that these ecological changes have resulted in an increased risk of flooding for the First Nation. The aim of this study is to examine how the First Nation is affected by and responds to the regular spring flooding risk. Two research questions guided this study:

- How has the increased spring flooding risk in Kashechewan affected the First Nation?
- How have regular flooding risk and recurring evacuation experiences of the Kashechewan First Nation affected the community's vulnerability and resilience?

This study employed the vulnerability and resilience framework developed and tested by Maru et al. (2014). The framework recognizes that Indigenous communities demonstrate significant resilience to climate change and variability and, therefore, may be among those best equipped to adapt; and that such communities are marginalized through colonization process and, therefore, are the most vulnerable to the impacts of climate change. This framework is different from the conventional treatment of concepts of vulnerability and resilience where one or the other is often solicited (Maru et al., 2014). The framework allows a conjoined treatment of vulnerability and resilience to take advantage of the contributions that the two traditions can make for synergy and complementarity (Maru et al., 2014; Miller et al., 2010a).

3.2. Approach and Method

3.2.1. The Community

Kashechewan First Nation, one of the eight Cree First Nations of the Mushkegowuk Tribal Council, is part of Treaty 9, signed in 1905. Kashechewan is 12 kilometres (straight line distance) upriver from James Bay and about 13 kilometres (estimated driving distance via winter ice road) from Fort Albany, the nearest community located on the southern bank of the River's South Channel. Kashechewan is only accessible by air except for about 10 weeks during winter when the community has an ice road connecting it with the neighbouring Attawapiskat and Fort Albany and the nearest major town of Moosonee, about 150 kilometres to the south. Essential supplies such as groceries and other staple goods are transported in the winter season via the winter ice road.

The First Nation is located on the North Channel of the Albany River in southwestern James Bay, northeast Ontario (Figure 3.2.1). The Albany River, composed of three sub-rivers (Ogoki, Kengogami, and Mammamattawa) is 982 kilometres long and the second largest river in Ontario. Its Cree name is "Chichewan," meaning "several rivers form one that flows towards the ocean" (Canadian Encyclopaedia, 2015). The river flows from northwest Ontario to northeast, emptying into southwestern James Bay. The topography of the area is flat and low-lying (Ohmagari & Berkes, 1997). The region is the largest lowland in Canada, which extends inland between 160 and 322 kilometres (NAV-Canada, 2002; Ohmagari & Berkes, 1997). Southwestern James Bay is flood-prone and susceptible to spring flooding.

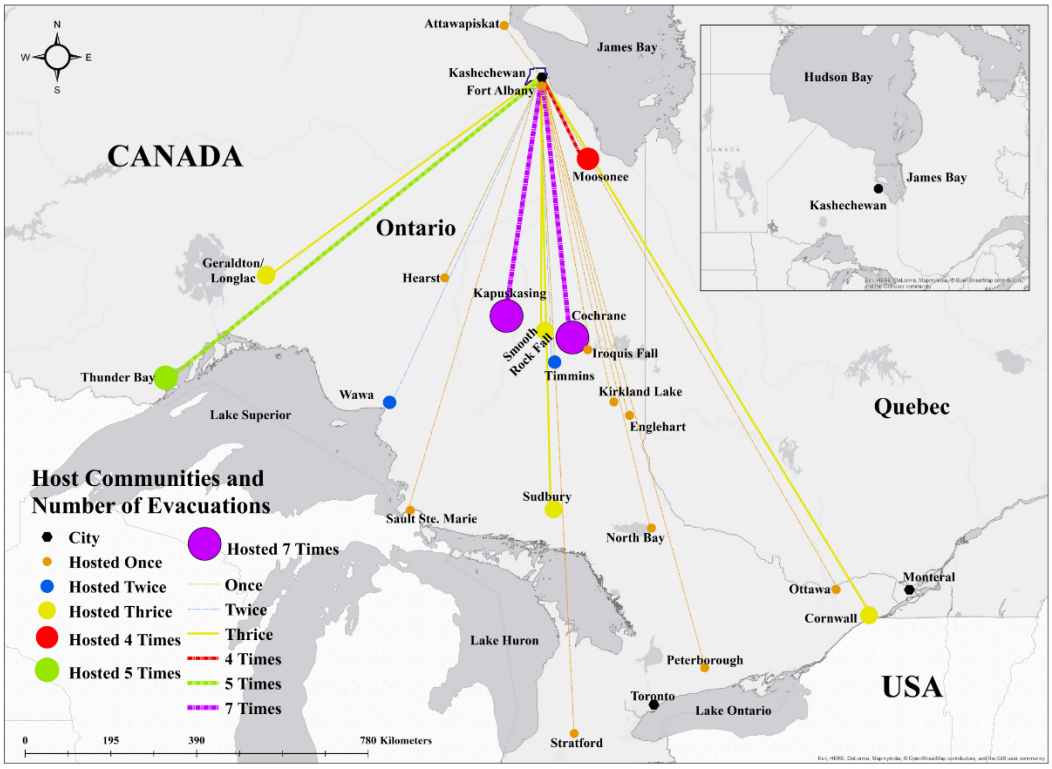


Figure 3.2.1. Evacuation and Host Communities Map.

Kashechewan was established in 1957. Since that time, major flooding events have occurred in 1966, 1972, 1976, 1985, and 2006 (Abdelnour, 2013; McCarthy et al., 2011). Between 2004 and 2019, Kashechewan residents have been evacuated 14 times to at least 22 different host communities because of flooding risks or actual flooding or due to the E. coli problem (Table 3.2.1). The minimum average, maximum average, and total average straight line distances from Kashechewan to the host communities are 302, 654, and 478 kilometres, respectively. To protect Kashechewan, a ring-shaped dike (5.3 km long by 3.5 m high) of gravel and sand was built between 1995-1997 at a cost of CAD 16.1 million (Shimo, 2017; Bhagwandass, 2016; Pope, 2006). During the 2006 flooding event, flood waters rapidly rose and leaked through the dike. Engineers reported in 2005 that the deficiencies in the dike could cause failure during floods caused by spring breakup ice jams. Studies since 2005 showed that the construction had not been completed according to specifications, and as a result, the dike does not meet Canadian safety standards (Donnelly et al., 2015). The same engineers commissioned by the band in 2005 reported that the dike is deteriorating and inadequate to protect Kashechewan (Barei, 2011).

Event Type	Event Date	People Evacuated	Host City/Community
Flood risk	12 April 2019	**2,500**	Timmins, Kapuskasing, Thunder Bay, Hearts and Cochrane.
Flood risk	26th April 2018	**1,690**	Timmins, Kapuskasing, Cochrane, Smooth Rock Falls (SRF), and Thunder Bay.
Flood risk	16th April 2017	**600**	Kapuskasing, SRF, and Hearst.
Flood risk	27th April 2016	**1,207**	Kapuskasing and Thunder Bay.
Flood risk	17th April 2015	**1,333**[32]	Kapuskasing, SRF, Wawa, and Cornwell.
Flood risk	April 2014	**1,600**	Kapuskasing, Thunder Bay, Geraldton/Greenstone, and Cornwell.
Flood risk & sewer back-up	30th April 2013	**1,500**	Kapuskasing, Kirkland Lake, Englehart, Cochrane, Iroquois, North Bay, and Cornwell.
Flood risk	24th March 2012	**269**[33]	Kapuskasing, Thunder Bay, and Wawa.
Flood risk	April 2007	---	Stratford and Sudbury.
Flood risk	23rd April 2005	**200**	Moosonee and Cochrane.
Flood risk	April 2004	---	---
Flood risk	1st January 1989	**1,000**[34]	---
Actual flooding	25th April 2008	**1,900**	Cochrane, Geraldton/Greenstone, and Sudbury.
Actual flooding	23rd April 2006	**1,100**	Peterborough, Sault Ste. Marie, Thunder Bay, Geraldton, and Cochrane.
Actual flooding	April 1985	---	Moosonee.
Actual flooding	April 1976	**300**	Fort Albany and Moosonee.
E. Coli found in tap water	26th October 2005	**1,100**	Attawapiskat, Cochrane, Ottawa, Moosonee, Sudbury and Timmins.
Demolished 38 Houses Uninhabited	April 2014 (to 2017)	**300-350**	Kapuskasing (the long-term evacuees in Kapuskasing for almost three years)

(Sources: O. Wesley, personal communication, 15 May 2019; W. Sutherland, personal communication, 9 May 2018; Public Safety Canada, 2019; Environment Canada, 2017, 2008; Barei, 2011; McCarthy et al., 2011; Digital Journal, 2007; Beltaos, 1995). The sign "---" indicates that information is not available from a reliable source.

Table 3.2.1. Evacuations by Kashechewan Residents 1976-2019.

According to Chief Leo Friday, about 75% of band members speak Cree and a few can read or write Syllabics. Around 50% speak, read, or write English (L. Friday, personal communication, 11 April 2019). Survey data indicates that about 1,250 band members are under 25, and half are in high school or elementary school. The community has been facing many challenges such as poverty; the high cost of food; a lack of safe drinking water; and congested, deteriorating, and inadequate housing and community infrastructure, particularly the dike and the water treatment plant (McNeill et al., 2017; Bhagwandas, 2016; Pope, 2006). Kashechewan has

[32] 1,333 evacuees include Fort Albany and Kashechewan residents.

[33] 269 evacuees include Fort Albany and Kashechewan residents.

[34] 1,000 evacuees were affected by flooding in the Albany and Attawapiskat Rivers.

high unemployment (80%) compared to the province of Ontario (5.7%) and Canada (5.8%) (L. Friday, personal communication, 17 July 2019; Statistics Canada, 2019). Similar to numerous Canadian Indigenous communities, Kashechewan also has to deal with boil water advisories because of the operational deficiencies and inadequacies of the sole and obsolete water treatment plant (Pope, 2006). For example, the First Nation had been on a boil water advisory for two years before the 2005 E. coli contamination (Gray, 2005). Most of the houses are sub-standard and too small to accommodate large families (comprising 9-10 adults) and do not adhere to building or fire codes (Barei, 2011; Pope, 2006). Between 300 and 350 residents stayed for almost three years (from 2014-2017) in the town of Kapuskasing (300 km southwest of Kashechewan) because 38 houses located in the low-lying northeast part of the community had become uninhabitable, as they were contaminated by mold (Khalafzai et al., 2019). The mold seriously threatens the health of residents. It was triggered by sewage backup because of high spring floodwaters, which also affected the health clinic and school buildings, causing frequent evacuations. Kashechewan does not have a hospital. Instead, it has a clinic that offers limited health services to residents. I witnessed rainwater seepage through the roof of the high school during my fieldwork in November 2016. I also noted that the high school and elementary school buildings needed repair.

3.2.2. Fieldwork

The research engagement with the Kashechewan First Nation was initiated in November 2015 when I visited the community to meet with the Chief and Council about a proposal for this research project, including the purpose, proposed research design, procedures for data collection, and the desire to incorporate community feedback into the research design. The proposal was revised based on the input received during this meeting. On the recommendation of Chief Leo Friday, the CAC consisting of three elders was formed to provide guidance throughout the fieldwork. The members provided guidance in a number of areas: they provided feedback on the interview guide (Appendix B) and helped with the hiring of a community research assistant, recruitment of research participants, completion of data collection, and community reporting of the research findings. After recruitment, I also provided training to the research assistant about his role in the project, particularly about adhering to ethical principles such as privacy and confidentiality of participants. The research assistant helped to identify potential research

participants and assisted in language translation (from English to Cree and vice versa) when required.

Before commencing the fieldwork, I obtained approval for this research from the Research Ethics Board (REB) at the University of Alberta for adherence to its ethical guidelines in addition to the guidelines provided in Chapter 9 of the Tri-Council Policy Statement. The Chapter is called, "Research involving the First Nations, Inuit and Metis People of Canada" (TCPS-2).

This research used the purposive and snowball sampling techniques to select participants. The purposive sampling technique identifies and selects an interview participant assumed to possess ample information on the problem being investigated, based on her/his knowledge or real-life experiences (Ritchie & Lewis, 2003). Purposive sampling was used to recruit evacuees, those who evacuated, and band officials, including those with a managerial role during evacuations. Snowball sampling was also used to identify and select interview participants. All of the interviewees were asked if they wanted to recommend anyone else to whom I should speak regarding flooding risk impacts and evacuation experiences, including those who might have had different experiences. Table 3.2.2 provides details about the participants recruited for interviews. I interviewed only three long-term (three-year) evacuees that were in Kashechewan during the fieldwork because the remaining evacuees were in Kapuskasing, Ontario.

Before commencing the interviews, I tested the interview guide by interviewing the research assistant. Based on the feedback, I revised the guide. I completed 41 semi-structured, in-depth interviews. Most lasted one hour. These interviews provided participants an opportunity to share ways in which actual flooding or flooding risks impacted them. They also shared their experiences before and during evacuation and upon returning to Kashechewan. I completed the 41 interviews during five weeks of fieldwork. Qualitative interviewing is culturally appropriate when researching with Indigenous communities and respecting their traditional way of life and customs (Kariippanon & Senior, 2017). The interviewing method allowed participants to share their stories, narratives, and experiences (Brannen, 2007). I continued interviewing participants to the point of theoretical saturation (Aldiabat & Le Navenec, 2018).

The interviews started with background questions about the participants and the community. The first part of the guide comprised questions about the flooding risk impacts,

including impacts on traditional spring hunting and the harvesting of meat from geese. The second part of the guide covered questions on residents' multiple evacuation experiences and emergency preparedness, including the positive and negative experiences during their stays in host communities. The third and last part focused on emergency preparedness and coping capacity by asking residents if they and the community became better, worse, or remained the same as a result of frequent flooding risks and recurring evacuations. All interviews began with easy questions designed to start a conversation.

The audio recordings of the interviews were transcribed by a professional transcriber. The transcribed data were coded and analysed in NVivo (version 11) while using a mix of descriptive and analytical coding schemes (Gibbs, 2007). During descriptive coding, I made categories using the terms and words, such as precautionary evacuation, which were locally and commonly used by the interview participants. I also derived analytical codes from the research literature, previous studies, and my understanding of the rich qualitative data collected.

Participant Category	Participant Number
Young Adults (18-30)	4
Participants >30 & <56	8
Single Parents	3
Long-term Evacuees (three years)	3
First Nation Elders	4
Band Office Officials	3
Employees of Other Departments	9
Community Leaders	7
Total	41
Male	68% (28)
Female	32% (13)
Band Member	90% (37)
Non-Band Member	10% (4)
Total	100% (41)

Table 3.2.2. Interview Participants.

3.3. Results

3.3.1. Flooding Impacts

Spring flooding risk regularly affects the First Nation in Kashechewan. The community has been affected this way since its establishment in 1957. Among the six major recorded floods (1966, 1972, 1976, 1985, 2006, and 2008) that occurred since 1957, the 1976 and 2006 floods had the most significant effects on Kashechewan. The flooding risk and its impacts significantly increased after the dike was built in 1995-97. This chapter focuses on flooding events from 2004 onward and consecutive evacuations from 2004 to 2008 and between 2012 and 2019.

3.3.1.1. Impacts on Community Infrastructure

High floodwaters in the Albany River due to spring breakup ice jams seriously threaten the community infrastructure by blocking and backing up sewage, for example, in basements of houses via sewerage system. Sewage backup in washrooms, particularly in basements, also disrupts the functioning of the community high school and elementary school and health clinic. The effluent backup into the basements of 38 houses because of high floodwaters in 2006 caused mold, which made the houses uninhabitable.

> *"The sewage system that we have is not adequate to carry the spring thaw that goes into our sewage system. So, that overflows, and the sewage backs up into our houses, and that's what causes—what you see—that they're [contractor] building 52 [new] units, but they tore down the 38 [old] units that were there prior to that, because they had basements. The drainage system we have is not that adequate because that's where most of water rises up the river, starts to seep into our drainages and that's how the water goes into our manholes and floods because our sewage system cannot handle all the water that's coming in and backs up into our houses. I lost everything one time that [seepage] was in my basement. There was about five feet [of effluent] water in our basement."* (Participant 12)

Breakup ice jams also affect the water treatment plant. During the fieldwork, I noted that the plant appeared old, outdated, and consisted of obsolete technology. In 2005, the ice breakup

jammed the intake pipe of the water treatment plant, leading to a declaration of emergency and the evacuation of 1,100 residents for two months because E. coli was found in the treated tap water. The jammed ice also damaged the intake pipe and the plant could not draw water from the river to supply the community after treatment.

> *"I was working at the airport as night security. So, when I woke up that afternoon, there was an evacuation already—not cause of the flood; cause of the intake, cause it broke. Before the main flood came, it destroyed the intake where the ice got blocked. So, they couldn't get water cause the ice was jammed in that intake, so they couldn't make water. Our reservoirs were kept getting lower, and [at] that point that they had no choice [but] to shut down the plant and pumps that run the water to the community. That's why they started doing that [2005] evacuation."* (Justin Wesley, Plant Operator)

Prior to the incidence of E. coli in 2005, residents had been on a boil water advisory for two years (Gray, 2005). Breakup ice jams and high-water flow in the river also affect the water quality and trigger a boil water advisory.

> *"Whenever there is a risk of flooding, usually there is a boil advisory cause, there's the lagoon [effluent pond] thing and that actually overflows and [water] goes in that lagoon and then goes back in the river. It overflows during the spring month[s]. Yeah, it goes back right into the water [treatment] plant. Then, we notice that our water goes a bit brown. Yeah, and they would do a boil advisory, and they would put more and more chlorine in it."* (Georgina Wynne)

The ice bridge of the 312 kilometres winter ice road built downstream on the Albany River causes breakup ice jams. The jams also affect the ice road because of the rapid increase in floodwaters upstream of the bridge and downstream of Kashechewan, and the jams flood the ice road, making it non-functional. Notably, the ice bridge caused a jam and triggered the 2006 flooding. Every spring, to prevent ice jams, several holes are drilled in the ice bridge, which is six to seven feet thick. However, the freeze-up conditions block the holes and result in jamming.

The elementary and high schools are often affected by high floodwaters. Valentino Kamalatisit, who works for the Hishkoonikun Education Authority (HEA),[35] said that the 2013 floodwater damaged the furnace system of the high school and that toilets were also backed up because sewage was backed up in the pipeline. The damaged furnace system and backed up toilets led to the school being closed for about two weeks.

Spring ice breakup also disrupts the local health clinic, which offers health services to residents. The clinic's nursing staff is often evacuated earlier than residents if there is a backup of sewage in the basement due to high flows, disrupting the provision of health care services, or if there is a fear that flooding will occur.

> *"Our health services get affected just about every year. The sewage backs up into the basement, and the building becomes unsafe for [the clinic] to deliver services to our people. There was a year when we got evacuated because they had to shut down the clinic. So, we had to leave, and then we ended up staying out [in host communities] for about six to eight weeks."* (Jenesse Martin)

After the nursing staff is evacuated, residents have no access to health services at the clinic. When residents are expected to be evacuated in five to 10 days due to flooding risk, Health Canada holds medications that would otherwise be shipped to the clinic for patients in Kashechewan. During the hold-up period, patients needing medication do not get their prescriptions refilled until arrangements are made in the host communities.

3.3.1.2. Impacts on Traditional/Cultural Activities

Flooding risk also disrupts the cultural activities of the First Nation, particularly during spring. Hunters and their families camp on their traditional hunting grounds to hunt and harvest goose meat, which is a traditional food. Every spring, these hunters and families are evacuated from their camps by the band, which uses helicopters to return them to the community. This reduces cultural activities to a couple of weeks compared to about three months in the past.

[35] The HEA provides educational services and supports to elementary and secondary school students living on reserve.

"Our goose hunting season is really affected cause we're supposed to stay out there for weeks, but it's cut down because people start to get evacuated. I only go for one week with the kids because of the evacuation. If it wasn't for that, I probably would have stayed the whole [spring] time there." (Late Byron Koosses)

"The spring hunting has been affected because people cannot stay out there [in camps] anymore. They [band] go and pick them up by helicopters, bring them back, put them on a plane and away they go [evacuated], that's the effect. Usually when we go out on the land, we teach our young ones how to prepare [harvest] wildlife—so we could use [the meat for] a long time." (Elder William Sutherland)

Spring hunting has been a form of cultural recreation for families, who camp on the traditional territory of the First Nation. The regular disruption has affected this. It also has significant cost implications for hunters who sell food, because the hunted meat cannot be harvested and is often wasted. In addition, the camping and hunting has costs associated with the required equipment, including vehicles and supplies. For example, one elder revealed that camping and hunting cost him about CAD 3,000. Hunters harvest the goose meat by smoking it to preserve it for consumption later in the year. The reduced time span has restricted the hunters' ability to harvest the meat.

"We used to go like, family recreation out [camping] somewhere, and family gathering, social gathering in the bush, and people would get together, celebrating spring—and you would go [with] families. Then, they [band] said, "evacuation"—it screws everything up. It displaced everybody—their lives. Socially, we lost everything." (Elder David JB Wesley)

"They preserve [harvesting] the geese at their camps. They can't do that here cause they have to smoke [the meat], and that takes a few days, and with the evacuation they wouldn't have any time to do any of that. So, it's lost food. I lose money because I make some of [my] living from selling some of the geese. Since these past six, seven years I haven't made any money because I haven't been able to preserve the geese with smoke, so [I] have been forced to freeze them, and nobody buys geese when they're just frozen." (Elder Wille Friday)

Hunters are airlifted by the federal authorities from their camps once an emergency is declared. They must leave their vehicles and other expensive equipment, including snowmobiles, in their camps. Many participants shared their concerns about losing their snowmobiles, vehicles, and hunting equipment, and camp supplies.

The regular disruption is also affecting the transmission of traditional knowledge from elders to the younger generation. Experienced hunters cannot spend ample time on the land in their camps, which means that their children will not learn how to survive in the bush and how to smoke and thus preserve the harvested meat.

> *"We couldn't train our young people anymore in the camp because there's gonna be an evacuation. There's a lot of important [traditional] things that we have to train our young people, but we don't have that anymore. Like, the harmony of the land, the importance of the land, the spiritual connection of the land, and those things that we have to teach our people, and especially preparing [harvesting] our meat—how to make it last long[er] for the summer. That's [something] we can't do that anymore."* (Chief Leo Friday)

Many participants said that before the dike was constructed in 1997, they used to stay in their camps as late as June each year. After the substandard dike was built, their spring hunting pattern changed because of recurring precautionary evacuations due to the potential dike failure. Hunters remain fearful for the safety of their families left in Kashechewan.

> *"Before that [dike], a lot of people used to [go] out on the land. People used to go [camp] at the end of March or early April and come back after the breakup [May or June]. Then after the dike was made, hardly anybody goes out anymore because they're afraid that the high [flood]water will overflow the dike. We're worried about the river; we're worried about the kids, about our families that we left behind."* (Chief Leo Friday)

3.3.1.3. Impacts on Local Economy

The Kashechewan economy is also affected during flooding season. Local businesses are among those affected the most because of frequent evacuations. A participant who has a small grocery store and a gas station said that he faces serious financial difficulty as his sales revenue significantly decreases during spring, which affects his ability to pay his suppliers. Another participant revealed that the daily wage employees at the Northern Store go weeks and sometimes months without pay during the frequent evacuations.

> *"We have 50 employees—the majority are women. They're the first ones on the flights out [evacuated]. […] It'll be good for the community to have everybody back, and it'll also be good for the [Northern] Store as well for sales. I mean, cause, if you think about it, we've lost 450 customers out of this community. We've lost those sales, so we're trying to make up those sales through the last three years."* (Michelle Della Fortuna, Northern Store Manager)

3.3.1.4. Socio-Cognitive Impacts of Flood Risk

As spring approaches, the residents' stress and anxiety increase because of the uncertainty of flooding risk. During March and April, residents start getting worried because of the fear of being flooded: this fear has become a new part of life in the community. An elder said that the First Nation is unsure about the level of floodwaters in the Albany River and it is becoming more difficult to predict floods. For example, one participant revealed that residents were ordered to evacuate in 2013 and then the order was called off before the actual evacuation started.

> *"So, every year, come March, you could see the panic in the community that they are unsure of their future in here, and that's when the Chief and council start to talk about it. The uncertainty of people, the way they think just prior to April and knowing that this is coming and it's already in their system [minds], and they know that they're in a risk again, and that's not a good feeling. So, if you have that kind of mentality, then it bothers."* (Elder David JB Wesley)

"When spring comes around, and they [residents] know there's gonna be a [ice] breakup, when I go to the kids in the classroom, they talk about it. They say, "Cause of breakup are we gonna get flooded?" So, I told them, "It's not up to me to, it's up to Mother Nature." People start to get worried and they start to set things up on their mind about their kids, their grandkids. People start to get worried lots when spring comes around. It really is stressful. It's too stressful and it's too dangerous." (Elder William Sutherland)

3.3.2. Short-Term Recurring Evacuations and Residents' Experiences

3.3.2.1. Evacuation Stress and Anxiety

Already stressed because of the uncertainty of the flooding risk, the residents face additional stress and anxiety due to the expected precautionary evacuation every spring. Precautionary evacuations have become a new fact of life. Many participants said that repeated evacuations are more stressful for parents, elders, and older residents.

"Every spring, every little child you talk to is just, "Are we gonna evacuate now?" It's already set in their mind that when March comes around, they know there's gonna be a breakup, and they know there's gonna be an evacuation. So, it's already settled in their mind." (Elder William Sutherland)

A participant said that residents are living in a place where they must evacuate every spring. He explained that this new way of life is not healthy mentally, emotionally, and physically, particularly for elders and those who feel homesick in host communities during an evacuation.

"People are really very stressed out when that time [evacuation] comes because they worry. They worry about their kids, especially the grandparents, they are worried more. And [for] the elders, [evacuation is] even more hard on them because they can't move around, and they have to travel over 400 kilometres to get to [host communities]. Mentally [they] are hurting their bodies, too, when they can't have that settlement in their souls or in their mind or in their hearts. It's really hard on them." (Chief Leo Friday)

One female participant said that dealing with the dread of being flooded and the stress of evacuation is more challenging for her as a single mother. Single mothers are concerned about the safety and well-being of their children because they have no partner with whom to share the uncertainty of flooding risk and the problems faced during an evacuation.

> *"As the springtime comes, and as we get closer to the breakup, it causes a lot of stress in my home with my kids. My kids get start to panic. Back in 2006, I know they witnessed the [flood]waters [and ice], and it causes a lot of fear with them. It is annoying to have this feeling. It gets stressful because I dread the thought of going out [evacuating] with my kids, and having to worry about them, and not knowing where we're going. And being a single mum, I worry how my kids are gonna be out there."* (Jenesse Martin)

> *"I'm a single mother with my [two] kids, and I don't have a boat sitting outside. I panic; I can't sleep, anxiety builds. I don't feel safe until I know I'm on a plane and in the air, and that's something I don't want to keep on living with. I don't like feeling scared. In the past, they barely got us out that time [2006 flooding] and that was scary. They had the big army helicopters, and everybody was there—with their bags and suitcases and kids—and that's where we got airlifted out because the airport flooded, and the water was surrounding the whole dike at that time. I was terrified. It was rushed. I wasn't prepared. I ran home and packed my suitcase, and I just threw stuff in. I forgot my wallet; I forgot my son's medications. I didn't have time to think and pack [while we were] being evacuated [means that] you're taken away from your home; you're taken away from all your comfort."*
> (Tamara Koosees)

Most participants said that their stress level rises the longer the evacuation carries on. The minimum and maximum short-term evacuation durations have been three nights and over three months, respectively. Almost all participants said that the shorter evacuations were less stressful than the longer ones.

"I just don't like being out of the community for so long. I don't mind the one week, but longer than that, it's too much. I want to go home cause I'm homesick, as a family, that's how we felt. Kids want to go home too." (Valentino Kamalatisit)

"The longer you stay, the more stress you have—you stress out cause people are missing their traditional lifestyle. They want to come back. The biggest [thing is that] we miss out [on] the traditional lifestyle—every year. Now we get that evacuation to the city life—we don't want that." (Elder David JB Wesley)

3.3.2.2. Family Separation and Death

Separation of families causes additional stress. For example, one female participant said that she and her family were together during evacuations between 2013 and 2016, but before 2013, they were often evacuated to different host communities.

"Whenever we get evacuated, it creates a lot of problems, for instance, the first time there was an evacuation in the community, back in 2006, my family members were in Ottawa, Peterborough, Sault Ste Marie, and Thunder Bay. So, I have to travel almost across Ontario to go visit them. You cannot tell the organizers "I want to be with my family. I want to go to this town"." (Participant 12)

Another participant said that she and her family were separated in 2013 and scattered in seven host communities across Ontario, which increased her levels of stress and loneliness.

"It was very frustrating. I got separated from my family every time. When we get evacuated, we [siblings] all got sent to different places, and that takes even more away from the support that I have as a single parent. So, it was very frustrating." (Tamara Koosees)

It was noted that the incidences of family separation have been lower recently due to the community being better prepared because of their annual evacuation experiences.

"When they told me [we] had to leave, then I would say, "Where's my dad going? Where's my sister and my brother going?" My brother's going to Kapuskasing, and I end up in Cornwall. It's just hard. Especially when we had an experience

once, and I lost my cousin [who died]. Some of them out at Thunder Bay, some of them were in Kapuskasing, and me way down there at Cornwall. I lost one of my cousins there actually. I wasn't here for those family burials. It's hard to communicate, especially when you feel [the] loss [of] your loved one. We worried about losing a loved one. I experience[d] that already, and you're helpless." (Rodney Wynne)

The death of an evacuee during an evacuation is the most difficult experience for a family. The grieving family must return Kashechewan from the host communities. The authorities arrange an airplane for the family to make a one-day trip for the burial and to perform traditional rituals.

"My uncle died in Thunder Bay when I was at Long Lac during evacuation. We had to ask [the] Liaison drive me to Thunder Bay where my family is. A different place. [I was] sad because my family members weren't there. My dad, my mom, my granny, and my aunts, my uncles, they were wondering. They were all in Thunder Bay. They have to keep [my uncle's body] there for a while, and we have to come home [Kashechewan] for a day trip only [to] put [bury] our uncle in the graveyard. There's a big plane there. Two flights of big planes, maybe 40 or 50 [extended family]. I was happy that they [authorities] help out. I hate leaving [my dead uncle] alone, going back to [the host community]." (Mathew Wesley)

3.3.2.3. Racism and Other Fears

Many participants said that they experienced racism in some host communities, while some decided not to tell people where they were from to avoid hearing racist comments.

"I was sent out [evacuated] with my son seven/eight times, and I've been sent out every year since I was pregnant with [my second child]. We're isolated up here [Kashechewan]. Us being sent [evacuated] to a city, you've got racism; you got people [in host communities] who don't want us there, and that puts a lot of people on guard. I was on guard. People are being hollered at, stuff [is] being thrown at them—Go home! You're not wanted here!"—teasing." (Tamara Koosees)

"Sometimes I would get asked, "Where are you from?" I would hide it, so they won't say something about it. If I say, "Kashechewan," you know, [I] would be afraid that somebody would start saying stuff about me, about our life, where I'm from, "Oh, you're from Kash. Okay, You're the reason our taxes are high." I will not tell where I'm from [because] in Thunder Bay, when I went to visit my family there that time, cause there was a lot of [racism] happening there during the evacuation. It just brought me a lot of more fear for my community that was going through that. That's one of the things that I hated." (Dorothy Williams)

In addition to racism, participants also had other concerns. For example, some participants were fearful of their children being kidnapped by strangers. Other participants had the fear that the Children's Aid Society (CAS) might take their children away from parents and keep them in their custody.

"There were some kids. A man grabbed them while they were playing in the hallway and took them into a room. That affected the whole community. Everybody was talking about it, not just the people that were based in that [host] community, and that brings out fear. It's fearful. Nobody wants their kids to be kidnapped or anything done to them. We have to be more on our toes. Some people are on guard—I was on guard." (Tamara Koosees)

The community leaders were concerned about the excessive use of alcohol. Some evacuees, particularly young adults were involved in alcohol abuse. One participant said that those who have alcohol addiction would drink more in the host communities and might get too drunk and die.

"Elders [are] concern[ed] because of our grandkids, our children that are drinking, because that's what happened. So, we came home with a couple of them because their mothers and fathers were drinking, and we're afraid that CAS [Children's Aid Society] will grab them [children]. At one point, they did."
(Paul Wesley)

3.3.2.4. Recurring Evacuations and Preparedness

Many participants said that they are prepared for the expected evacuations well in advance. For example, they pack their bags, shift their households to the upper floor, manage their grocery supplies, and protect their property against vandals by sealing doors and windows with plywood.

> *"People are usually prepared by [March], that they don't plan anything around [spring]. I'm prepared. I prepare my stuff one to two weeks ahead of time. If I have to go in a matter of hours, this is what I'll take: important documents and clothes. Anything I can't take that's really, really important to me, I store them high; the preparedness is a little bit more organized each year as it goes."* (Participant 15)

> *"We're ready. Just a couple of days before we hear there's gonna be [an] evacuation, I pack up. [In my family] everybody's prepared to pack a small bag of clothes and their important identification and medications. I only take two pairs of clothes, and just our [electronic] gadgets, iPod, and camera. We're just gonna buy clothes over there [city]."* (Late Byron Koosses)

3.3.3. Long-term Evacuation Experiences

Three interview participants were long-term evacuees who had lived in Kapuskasing for almost three years because their houses were among the 38 that were demolished due to mold. Spring flooding and evacuations affected long-term evacuees the most. Their houses were demolished. As a result, household items were either damaged or destroyed. One long-term evacuee said that his house in Kashechewan had been demolished so he and his family had to move to Kapuskasing. As a result, he had to quit his job in Kashechewan and had been unemployed.

> *"I used to have a job at the airport, but due to flooding of the [38] houses, I had to resign from that job because I couldn't go back and forth to Kapuskasing to be with my [evacuated] family. So, financially, it was tough. It affected me very much, you wouldn't believe. It has affected me financially, emotionally, I would even say physically—just draining."* (Participant 41)

A participant named Paul Wesley recalled that nobody knew until the very last minute that the authorities were going to demolish the houses. *"I felt like crying,"* he said. *"We all did."* Wesley and his family returned to Kashechewan once, for a funeral, before the homes were demolished. Another time the Chief and Council met with residents in Kapuskasing to let them know about the demolition. Wesley recalls the residents asking for more time to empty their houses. *"I said 'at least give us a week, a plan.'"* But the only things the residents could take, in the end, were the clothes they were wearing when they left the first time, and whatever they could grab. *"There's nothing,"* he said. *"We never had time to grab our [hunting] guns and stuff to put [for safety] away. Most [of it] was destroyed by mold."*

The demolition and long-term evacuation were not only stressful but caused culture shock for the evacuee families, particularly for children, who now were forced to accept a different way of life in a new community. During the three-year stay in Kapuskasing, the evacuees had to face many challenges, such as an inability to hunt and fish. One of the evacuees said the experience brought back memories of being in a residential School.

> *"I was mad. I was feeling so depressed [about] not having money in my pocket. I was broke. It was dictated again [Residential School] what I had to take, where I have to go, where I have to live. My children lost a lot of education; they lost a lot of hope. They were depressed all the time, and I just hated to see that. [Something] I didn't like to see was the people [evacuees] that were living in Kapuskasing. They were hit by something called culture shock. They couldn't do what they're used to doing while they're here. They couldn't go snaring to get a rabbit because it was [on] somebody's property. They got chased down by a police officer. Everything went down slow. I couldn't go hunting, fishing, all that stuff. Everything was different. Those freedom [on the communal land] over there [Kashechewan], that [city] wasn't our living; that's somebody else's living, not ours.*" (Participant 41)

One of the participants said that the long-term evacuation had a profound effect on his children.

"Staying over there [Kapuskasing] has bothered them [children] because their schooling wasn't that good, it was terrible. My children needed counselling. Then, of course, their self esteem is just low. I know they were happy before this evacuation. I [have] seen a change in my own children. They're down all the time. They're not happy for where they're situated right now. I tried putting my children in the public school. They weren't accepted." (Participant 41)

A participant who returned to Kashechewan from Kapuskasing and moved into the newly allotted house in November 2016 said that he and his family remained depressed during their three-year stay. He said that living in Kapuskasing for so long resulted in him and his family feeling disconnected from the First Nation after returning to Kashechewan.

"There was no relationship anymore with our people. Strange, you know. They all have their heads down each time we come and bury someone. No more handshakes; no communication. When that happened and we went back to Kapuskasing, it felt strange. Our own people are departing from us, like we don't want to come home, because we [have] adjusted [to living] over there [Kapuskasing] now."
(Paul Wesley)

A long-term evacuee said that he is tired of living with flooding risk and recurring evacuations every spring, living in constant fear, and living an uncertain lifestyle. He is also hopeful that the expected relocation of the community will yield a better life for future generations, who will escape the uncertainty of living in a flood zone.

"I would like just to see that my children and their children don't have to live the way we live, [which is] emotionally, spiritually, physically draining. That's what I hope for. Maybe they can relocate, and they'll have a better life—better than the life we have right now—always expecting the unknown. That is not a very delightful feeling when you have that, and the [federal] government would not understand that—I don't think so anyway. You tell them, but do they take it? No, they don't. If I [were] to live somewhere—where I don't have to fear the risk of a flood, I will die a happy man." (Participant 41)

3.4. Discussion

This study is first of its kind to examine the frequent spring flooding risk impacts and recurring evacuation experiences of the Kashechewan First Nation, a northern Canadian First Nation community. The increased spring flooding risk affects the community infrastructure, particularly the dike, sewerage system, tap-water treatment plant, and downriver winter ice road. It disrupts the spring cultural activities of camping and hunting and harvesting meat. The precautionary evacuations every spring also significantly disrupt the local economy and daily life of residents. On the positive side, having to deal every spring with an elevated flooding risk and recurring emergency experiences has improved the community's emergency preparedness and coping capacity, on an individual and band level. For example, the incidences of family members being separated have been considerably reduced. However, frequent emergencies negatively affect the sociocultural and psychological well-being of residents before, during, and after evacuations.

Human disturbance of the local landscape, including substandard community infrastructure, contributes to the elevated spring flooding risk. Khalafzai et al. (2019) recently identified the winter road ice bridge as a cause of the flooding from the ice jams. The findings of this study are consistent with those found by Du et al. (2009) and Warren and colleagues (2005). All of these studies identified inadequate community infrastructure as a significant problem; it can lead to a breach of the dike, and the resultant release of large chunk of ice can rapidly submerge the community, block the drainage system, and damage the water storage supply or intake pipe. Literature on flooding in the northern regions affecting community facilities and services has also reported disruptions to sanitation services caused by conventional waste stabilization ponds (also known as tundra ponds) for the treatment of wastewater and solid waste (Warren et al., 2005). My research findings that the frequent flooding risk negatively impacted cultural activities and the local economy in the spring are similar to the findings of Warren and colleagues (2005), who found that cultural and traditional activities and the local economy of communities in the Arctic were affected by spring flooding or flooding risk.

The results of my study concerning sociocultural and socio-cognitive evacuation experiences of evacuees away from home in host communities confirm what other researchers have found, including stress and anxiety, separation of families, and racism. For example,

evacuations negatively affect Indigenous communities because they disrupt the traditional way of life and cultural activities that are sources of traditional food and enjoyment on reserves. This disruption increases emotional stress because it affects the attachment that Indigenous Peoples have to their land and environment as well as communal social relationships (Waldram & Scharbach, 2013; Newton, 1995). Indigenous Peoples tend to have a strong attachment to their land, natural environment, and community, an attachment that provides a sense of security, belongingness, and solidity (Hay, 1998; Newton, 1995). My study found that evacuees encountered racism, which is similar to what Asfaw et al. (2019) found: the racism was experienced in host communities, aggravating the trauma of the evacuees of Sandy Lake, who were already stressed.

The following two findings are unusual and have not been indicated in the literature of flood evacuations in the northern Canadian Indigenous context. First, the most difficult experience of the death of an evacuee during an evacuation and arrangement for burial and traditional rituals by the federal government is not indicated by previous literature of flood evacuation. Policymakers need to consider how to handle emergencies such as a death in the family, which will require evacuees to return to their communities for funerals and burials. Second, the finding that the residents who were long-term evacuees felt socially disconnected from the Kashechewan community upon their return is also unusual.

The work of Maru and colleagues (2014) focuses on the traditions of vulnerability and resilience while considering the remoteness, isolation, and marginalization of Indigenous communities as well as the potential positive and negative effects on community resilience. Using the framework helped me to identify vulnerability reducing and resilience-building responses of residents from the Kashechewan First Nation. The framework developed and tested by Maru et al. (2014) also helped me to approach the problem by reconciling the two conflicting narratives about vulnerability and resilience in remote regions and dismissing a narrow perspective of vulnerability or resilience. In brief, the Kashechewan First Nation demonstrates resilience to spring flooding with an increased emergency preparedness and coping capacity. Nonetheless, recurring evacuations increase the community's social and psychological vulnerability during the spring.

3.5. Conclusion

The spring flooding risk has significantly increased the community's physical and socio-cognitive vulnerability in recent years. Flooding in the Albany River frequently impacts the community infrastructure, traditional spring hunting and harvesting, and the local economy. Dealing with the increased flooding risk and recurring emergency experiences every spring have helped to improve the community's emergency preparedness and coping capacity. However, the First Nation's experiences during the evacuations are negatively affecting their well-being during and after the evacuations.

My research contributes to the literature of spring flooding impacts experienced every year by a remote and isolated First Nation. This study also contributes to the literature about repeated evacuations due to floods in northern Canadian Indigenous communities, while exploring the unique evacuation experiences of the Kashechewan First Nation evacuated every spring from 2004-2008 and 2012-2019. This study contributes to the literature in three areas. First, it highlights the regular impacts of both the actual flooding or flooding risk on the First Nation's infrastructure (e.g., substandard dike, and inadequate housing and sewerage system and water treatment plant), traditional hunting and harvesting, local economy, and sociocultural well-being. Second, it contributes to the evacuation literature by documenting the socio-cognitive experiences of a remote and isolated northern Canadian First Nation community based on individual accounts of evacuations to numerous host communities every year from 2004 to 2008 and between 2012 and 2019. Third, the framework used allowed me to approach the problem by reconciling the two conflicting narratives about resilience and vulnerability in remote regions and dismissing a narrow perspective of vulnerability or resilience and taking advantage of the contributions made collectively by both.

The results of this research have important implications for the community, other Cree First Nations of the Mushkegowuk Tribal Council, and the federal government. First, the relocation of the community from the existing site of Kashechewan to the relatively higher and safer ground (30 km straight line distance) upriver would significantly reduce the physical vulnerability of the First Nation. Second, as advocated by Grand Chief Jonathan Solomon, a new permanent evacuation center, also called a refuge shelter (Zhong, Steer, Abebe, Almashor, & Beloglazov, 2017), may be

put in place at a safer and easily accessible location near the reserve territories of all the at-risk First Nations communities of the Mushkegowuk Tribal Council for use during evacuations. This would help to reduce the physical vulnerability of the First Nations during spring. It would considerably reduce the socio-cognitive vulnerability of the community in addition to contributing to efficient emergency response and effective emergency management while meeting the community's sociocultural needs. Third, in case of evacuation, it would be preferable to evacuate the Kashechewan First Nation to other, safer neighboring Cree First Nations' reserve territories located near the community's spring camping grounds and hunting sites. Another option in this respect is that the evacuees could be granted permission to hunt in areas used by other First Nations. This would reduce the socio-cognitive vulnerability that the community faces during an evacuation to host communities in cities. The traditional hunting would help to reduce the evacuees' stress. Hunting would also provide them access to traditional food. A major limitation of this study is that only three long-term evacuees were included as participants because the rest were in Kapuskasing during the fieldwork.

3.6. Chapter Summary

Chapter 3 introduced the theories of vulnerability and resilience and described the conjoined framework and the flooding impacts on northern communities. The community context, fieldwork activities, and the analysis of qualitative data were also described. The results presented indicate that the increased flooding risk has been regularly and severely affecting the community, and residents' experiences during the evacuations have increased their physical, social, and psychological vulnerability. However, repeated emergencies have improved the community's coping capacity. The chapter concluded that recurring evacuations are negatively affecting the community's well-being during and after evacuations.

CHAPTER 4

Frequent Flooding and Perceived Adaptive Capacity of Subarctic Kashechewan First Nation

4.1. Introduction

This chapter presents the results from survey research with Kashechewan First Nation. The remote and isolated Kashechewan community is located in the flood-prone southwestern James Bay (Subarctic) region of northern Ontario in Canada. The First Nation is regularly affected by the elevated risk of spring flooding. Kashechewan residents have been evacuated 14 times to at least 22 different host communities since 2004 (consecutively from 2004-2008 and 2012-2019) because of actual flooding or flooding risk and potential failure of the dike or due to the E. coli problem. This chapter explores the community's perceived adaptive capacity and adaptive behaviour, which are influenced by the perception of risk amid the frequent and considerable disruption of the daily life of residents.

My research explores the community's perceived adaptive capacity through the lens of individual residents using survey research. The individual lens is used because community resilience-building focuses on the adaptive capacity of individuals, households, and communities—such as people's collective strategic action(s), knowledge, skills, and learning—and is interwoven with and connected to individual resilience at the community level (Boon, 2014; Berkes & Ross, 2013; Miller, 2012; Cutter et al., 2008). I quantitatively analysed perceived capacity using subjective perceptions of residents about their adaptive capacity. Three research questions guided this study:

- How do residents perceive the risk of flooding in Kashechewan?
- How do individuals' flood risk perceptions influence their emergency preparedness and adaptive behaviour?
- What is the perceived adaptive capacity of Kashechewan First Nation?

Before the 1920s, the Cree First Nations communities of the James Bay Lowland did not have permanent settlements, and coped with spring flooding by moving to higher ground and spending most of the year several kilometres inland from James Bay (McCarthy et al., 2011; Newton, 1995). After the establishment of the HBC trading posts along the southwestern James Bay coast, the change in the First Nations way of life from traditional nomadic to modern permanent settlements significantly increased their exposure to spring floods; the Kashechewan community was included in this shift (McCarthy et al., 2011). The major floods in the area took place in 1966, 1972, 1976, 1985, 2006, and 2008 (Abdelnour, 2013; McCarthy et al., 2011). Recently, Kashechewan residents were evacuated every year between 2004 and 2008 and then consecutively from 2012 to 2019. Although some of these evacuations were due to actual floods or flooding risk, others were precautionary, due to substandard community infrastructure, mainly a deteriorating, deficient, and inadequate dike (Barei, 2011). The 5.3 kilometres long by 3.5 meters high dike, built in 1995-97 to protect Kashechewan, consists only of gravel and sand and fails to meet required safety standards (Bhagwandas, 2016; Donnelly et al., 2015; Pope, 2006). The First Nation has coped with the increased flooding risk by repeatedly evacuating during the past decade. In the past, the Cree First Nations of the region adapted to spring flooding by moving several dozen kilometres inland (McCarthy et al., 2011; Newton 1995). The absence of permanent settlements and their nomadic way of life made this relocation easy, cost-effective, and efficient; they would return and remain in the area during other seasons. In other words, the First Nations historically had a better strategy to adapt to the spring flooding hazard.

4.1.1. Community Context

Kashechewan is located on the North Channel (at the river's mouth) of the Albany River in the southwestern James Bay region (Figure 4.1.1). The Albany is the second-longest river (982 km) in Ontario, and flows from the northwest to the northeast of the province. Its Cree name is "Chichewan" meaning "several rivers form one that flows towards the ocean" (Canadian Encyclopaedia, 2015). In Cree, Kashechewan is called "Kakiigachiwan," meaning "water flows forever: as long as the sunshine, as long as grass grows, and as long as the river flows" (L. Friday, personal communication, 24 September 2019).

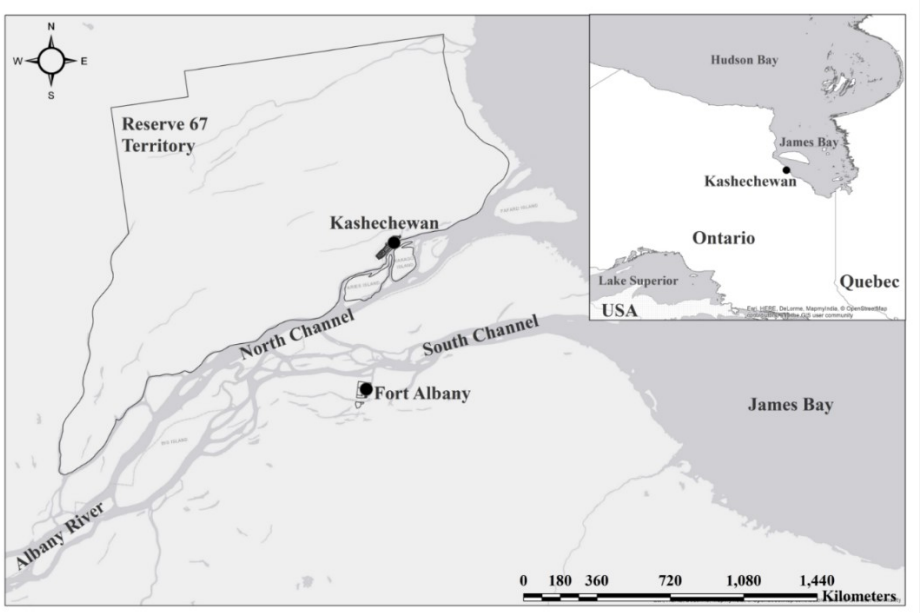


Figure 4.1.1. Fort Albany Reserve 67 and Kashechewan First Nation.

Kashechewan is one of the eight Cree First Nations of the Mushkegowuk Tribal Council. It is in Treaty 9 territory, also called the James Bay Treaty, signed in 1905. The Albany First Nation Reserve 67 was created in 1910 with 225 square kilometres of total area. Kashechewan, a small, isolated, and remote fly-in community, is about 12 (straight line distance) kilometres upstream from James Bay and approximately 13 kilometres (estimated winter ice road driving distance) from the nearest community of Fort Albany, which is at the river's South Channel. The nearest major town is Moosonee, about 150 kilometres to the south of Kashechewan. Fort Albany and Moosonee are accessible to Kashechewan residents in winter via ice road and during other seasons by boat and barge. The quickest access to and from Kashechewan is by air, even though air travel is expensive.

The First Nation's local economy is based mostly on band and government jobs, a few small businesses, and sales of fish, meat, and traditional handicrafts. The community has abundant wildlife, including whitefish, trout, northern pikes, geese, ducks, moose, beavers, bears, wolves, rabbits, and otters. The community has a Northern Store and gasoline station in addition to a few shops which sell daily use items. The cost of living is very high, particularly for food and dairy products, including vegetables, fruits, and milk. Kashechewan has basic infrastructure such as a

health clinic, elementary school and high school, emergency medical service (EMS), a partially functional fire station, electricity grid station, telecommunication tower, and a police station.

The schools' academic activities are disrupted for extended periods of time because of the yearly evacuation. Students could not, for example, complete their full academic year for four successive years (Bhagwandas, 2016). The negative impacts of repeated academic disruptions and subsequently revised schedules included disturbed sleep patterns affecting the mental health of students (McNeill et al., 2017; Harries, 2008). While residing in evacuation centres away from home, the fear of loss of property and belongings cause additional emotional stress among evacuees (ICI-Radio-Canada, 2016). Frequent evacuation and dispersion of family members to different locations across Ontario cause significant emotional distress among residents (McNeill et al., 2017; Bhagwandas, 2016). The cultural activities of hunting and harvesting of goose meat in spring are also affected by the disruption, causing the loss of traditional livelihoods (Bhagwandas, 2016). In brief, the frequent flooding risk and repeated evacuations have resulted in inconsistent and uncertain living conditions for residents, which is emotionally traumatic and socio-culturally disruptive (McNeill et al., 2017; Bhagwandas, 2016).

Kashechewan has 2,000 band members (L. Friday, personal communication, 14 November 2016). Approximately 75% of band members speak Cree (O. Wesley, personal communication, 12 April 2019). About 1,250 band members are under the age of 25, and half are in schools. The community has been dealing with numerous challenges such as poverty, expensive food, boil water advisories, overcrowded and inadequate housing, and deteriorating community infrastructure, particularly the dike (McNeill et al., 2017; Bhagwandas, 2016; Pope, 2006). The community has high unemployment (over 80%) (L. Friday, personal communication, 17 July 2019; Pope, 2006). Kashechewan often experiences boil water advisories because of the operational deficiencies of the obsolete water treatment plant (Pope, 2006). Most of the houses are sub-standard, too small to accommodate large families (9-10 adults), and do not adhere to building or fire codes (Barei, 2011; Pope, 2006). Over 300 residents stayed in Kapuskasing (300 km southwest of Kashechewan) for about three years (2014-2017) because 38 houses located in the low-lying northeast part of Kashechewan were rendered uninhabitable by mold contamination. Triggered by sewage backup due to high spring river flows, the mold also contaminated the health clinic and school buildings, causing evacuation of the community.

4.1.2. Literature Review

The concept of adaptation applied in many fields, including climate change and natural hazards research, is the manifestation of adaptive capacity (Nelson et al., 2007; Smit & Wandel, 2006). Adaptation represents ways and means of increasing the ability of a community to adapt at the local level within their demographic and sociocultural context, transforming capacities into actions (Nelson et al., 2007; Smit & Wandel, 2006; Adger, Arnell, & Tompkins, 2005). The reactive and proactive adaptation actions are often viewed through a narrow technical lens that undermines the role of various local actors and social institutions involved in the process at the community level (Engle, 2011; Nelson et al., 2007; Smit et al., 2000). Adaptive capacity represents potential adaptation options, spontaneous or planned, to be implemented to minimize vulnerability and mitigate hazards risks (Smit & Wandel, 2006; Brooks, 2003; Smit & Pilifosova, 2001). Both perceived and objective/material adaptive capacities are the precondition of people's access to their available resources, such as institutions networks, that help them in coping with and recovering from disasters; they are also the prerequisite of a community's ability to recognize and activate these resources to adapt (Nelson et al., 2007; Grothmann & Patt, 2005; Adger & Brooks, 2004; Smit & Pilifosova, 2001). Adaptive capacity changes over time, for example, in the socio-ecological system in response to actual or expected events, such as natural hazards (Smit & Wandel, 2006). It can be measured at different scales ranging from an individual to a family, a community, a region, or a nation (Engle & Lemos, 2010; Wall & Marzall, 2006). Adaptive capacity can be assessed by measuring and/or characterizing people's ability to adapt (Engle, 2011; Engle & Lemos, 2010). Measurement of adaptive capacity is intended to build theory by identifying and understanding the factors that determine adaptive capacity based on people's response to events and the extent to which their resources are mobilized (Engle, 2011). Characterizing adaptive capacity involves an assessment using the determinants provided in the climate change literature (Engle & Lemos, 2006; Grothmann & Patt, 2005). In this research, I assess the perceived adaptive capacity of the First Nation by characterizing it.

Various approaches have been developed and applied to study and understand the adaptive capacity of socio-ecological systems facing social, environmental, and climate change challenges (Gardezi and Arbuckle, 2019; Whitney et al., 2017). I employed the indicators of the integrated socio-ecological system approach, one of the 11 approaches developed by Whitney et al. (2017).

This approach focuses on a systems-based, integrated, social-ecological understanding of adaptive capacity (Whitney et al., 2017). The strengths of this approach include the analysis of both social and ecological drivers of change and their interdependencies; the main drawback is that it is data intensive. The social indicators of the approach include willingness to change, community infrastructure, risk perception, learning and knowledge, ability to anticipate change, level of trust and participation in decision-making, and quality of governance (Whitney et al., 2017). The ecological indicators include behavioural change and learning, migration capacity, and self-organization of community (Whitney et al., 2017). The temporal scale focuses on the present; learning from the past experience to respond to present challenges and plan for future adaptation (Whitney et al., 2017). The spatial scale is local because it includes community perspectives, preferences, and traditional knowledge (Whitney et al., 2017). This approach focuses on existing socio-ecological change, and the scale of analysis is from individual households to the entire community. It helps in rendering a nuanced understanding of relevant indicators and determinants and offers ample data when dealing with change (Whitney et al. 2017). It is, however, often time-consuming and expensive (Whitney et al. 2017; Grothmann & Patt, 2005). The approach has also helped in identifying and assessing the determinants that contribute to adapting or reacting to socio-ecological change. They include social capital, human capital, infrastructure, governance, and other determinants (Siders, 2019; Whitney et al., 2017; Lockwood, Raymond, Oczkowski, & Morrison, 2015; Maldonado & Moreno-Sanchez, 2014; Boon, 2012; Engle & Lemos 2010; Cinner, McClanahan, & Wamukota, 2009; McClanahan et al., 2008; Eakins & Lemos, 2006; Wall & Marzall, 2006; Brooks, Adger, & Kelly, 2005; Yohe & Tol, 2002).

Socio-cognitive factors, such as the perception of risk, are important for perceived capacity because they influence individuals' motivation and reshape their adaptive behaviour, including disaster preparedness (Henly-Shepard et al., 2015; Grothmann & Patt, 2005). In addition, subjective perceptions can be very different from objective capacities (Gardezi and Arbuckle, 2019; Seara, 2016; Grothmann & Patt, 2005). Using multiple indicators is recommended, for example, by Tol and Yohe (2007) in the public health context; it is also consistent with climate change adaptation literature, such as Brenkert and Malone (2005), who used multiple indicators of human capital, economic resources, and environmental capacity in their study of resilience to climate change, and Grothmann and Patt (2005), who focused on several socio-cognitive

indicators. This chapter presents results from survey research discussed in detail in the Materials and Method section. The qualitative results from the associated in-depth interviews and the participatory flood mapping workshops—which examined the elevated flood risk (Khalafzai et al., 2019), its impacts on the community, and the effects of recurring evacuations on their vulnerability and resilience—are presented in Chapters 2 and 3.

The literature reviewed, related to assessing adaptive capacity, focuses on a range of aspects and determinants. For example, Paton et al. (2007) measured the collective efficacy of Thai citizens affected by the 2004 tsunami, but focused on the provincial scale based on the role of religious affiliation and ethnicity. Keskitalo and colleagues (2010) reviewed studies undertaken in the Nordic countries and Russia, and highlighted how adaptive capacity determinants play out in the Northern, industrialized regional context. Their study focused on the importance of economic resources in a market-based system, technological competition, and infrastructure. Lopez-Marrero (2010) analysed the strategies of adjustment for risk reduction implemented by two Puerto Rican flood-prone communities. She studied how the adaptation of adjustment strategies within a wider context of other multiple risks influenced the communities' future adaptive capacity. Juhola, Peltonen, and Niemi (2013) assessed adaptive capacity at the regional scale in Europe using determinants including technology, infrastructure, institutions, and economic resources. Moreno-Sanchez and Maldonado (2013) estimated the adaptive capacity of the fishing community of Bazan on the Colombian Pacific coast by focusing on its dependence on the natural resource extraction using socioeconomic, institutional, and socio-ecological determinants. Henly-Shepard et al. (2015) studied the perceived preparedness, differential coping capacity, and objective adaptive capacity of the Pacific Island community of Hanalei, Hawaii, which was prone to climate change-related hazards including droughts, floods, and hurricanes. Their study used household characteristics such as financial comfortability, access to savings, homeownership, and use of farmland and livestock.

In the Canadian Arctic and Subarctic context, researchers have assessed the adaptive capacity of Indigenous communities by focusing specifically on the physical aspects of capabilities. Those studies differ from my research because they primarily engaged government officials and agencies at different levels of government, and used qualitative interviews or employed the survey method. For example, Andrachuk and Smit (2012) and Ford and Smit (2004)

used the exposure-sensitivities approach to assess the adaptive capacity of the Tuktoyaktuk Inuit community in the western Canadian Arctic and employed the qualitative interview method and secondary data (e.g., government reports, and census data). Their study used current and future vulnerabilities and adaptive strategies for adaptation amid climatic risks. Adaptive capacity was also assessed within the Government of Nunavut "to synthesize the level of knowledge on climate change adaptation held collectively within Nunavut departments and agencies and identify possible gaps in this knowledge" (CIER, 2009, p. 1). Newton (1995) examined the community-level flood preparedness and coping strategies of northern Indigenous Peoples in Canada. His research focused on how the individual, community, and government levels interrelate when responding to floods.

There is a lack of literature on the perceived adaptive capacity assessment of the remote and isolated Subarctic Indigenous communities in northern Canada, including the James Bay region, particularly literature involving individuals at the community level which uses an integrated socio-ecological system approach. My research is different from others in many ways. First, this is the only study that assesses the perceived adaptive capacity of Kashechewan First Nation, which has been frequently affected because of elevated flooding risk more than any other First Nation in the region and in Canada or elsewhere. Second, I employed an integrated approach to explore how the socio-ecological system uncovers different aspects of perceived adaptive capacity. Third, this research involves a remote and isolated Subarctic First Nation community using quantitative survey research to assess perceived adaptive capacity, which is the first application of the method in the region involving community members. Finally, this study contributes to the literature on the perceived adaptive capacity of a First Nation that depends on cultural spring hunting and harvesting as a source of traditional food, which is threatened by the challenges of spring flooding risk due to warming temperatures.

4.2. Materials and Method

4.2.1. Fieldwork

Five weeks of fieldwork for this study was conducted in October-December 2016 when most residents would be in the community. At the time of this fieldwork, an estimated 1,600-1,650

residents were in the community. I employed the face-to-face survey method conducted with the assistance of a community research assistant for translations when needed. 90 surveys were completed at locations convenient for respondents, with most completed at the coffee shop within the Northern Store. This coffee shop opened in the winter of 2016, and has become social hub for residents in Kashechewan; consequently, I was able to survey residents with a range of characteristics (Table 4.2.1). The other surveys were completed at the band office, health clinic, high school, police and paramedic stations, the social welfare office, and respondents' houses. 70% of survey respondents were recruited by the research assistant and the interviewer, while the other 30% approached us to participate in the study.

All those residents above age 18 were potential respondents for the survey. The sample size n = 90 is 7.5% of the targeted population N = 1200 at the time of the fieldwork. I employed convenience sampling to select respondents because the respondents were readily available, and the response rate is generally very high compared to other sampling techniques (Bryman & Bell, 2016). However, the sampling technique used may not include all segments of the community. I addressed this issue by involving residents from all age groups above 18, with an equal participation of males and females, and representation of respondents from diverse subgroups, such as socioeconomic and professional backgrounds. Involving all subgroups of the target population in the sampling frame helped me to avoid under-coverage, which minimized selection bias. Indeed, I focused more on the sample sources while designing the data collection method by ensuring that all the subgroups were included, reaching out in person to all subgroups of individuals in the community; I also ensured the selection criteria reflected the target population without excluding any useful socioeconomic, sociocultural, and demographic subgroup. A wide range of people completed the survey, including individuals working for many local agencies, female and male community leaders and elders, those working in small businesses (such as grocery stores and gasoline stations), entrepreneurs, single mothers, students, people with disabilities, and a few those staying in Kapuskasing (long-term evacuees). The statistical goodness-of-fit test also established that the sample data represented the data that was expected in the actual population. The results of this research can only apply to the First Nation's natural socio-ecological settings (generalized to empirical theory) and cannot be applied to wider theory (analytic generalization). Nonetheless, adaptive capacity is essentially context- and location-specific and dynamic; therefore, it cannot be generalized to broader contexts because of socioeconomic, political,

institutional, and demographic factors (Engle, 2011; Engle & Lemos, 2010; Smit & Wandel, 2006).

Description	% (No.)	Description	% (No.)	Description	% (No.)
Male	51% (46)	Married*	52% (52)	Employed	66% (59)
Female	49% (44)	Unmarried	38% (38)	Unemployed	34% (31)
Total	**100% (90)**		**100% (90)**		**100% (90)**
Age Group	**% (No.)**	**Education**	**% (No.)**	**Income (CD$)**	**% (No.)**
18 – 29	32.2% (29)	None	7.8% (7)	Up to 10,000	31.1% (28)
30 – 39	22.2% (20)	Grade 1–9	15.6% (14)	10001–30000	28.9% (26)
40 – 49	21.1% (19)	Grade 10–12	43.3% (39)	30001-50000	21.1% (19)
50 – 59	13.3% (12)	Grade > 12	33.3% (30)	50001 +	18.9% (17)
60 – 69	6.7% (6)				
70 +	4.4% (4)				
Total	**100% (90)**	-	**100% (90)**	-	**100% (90)**

* Married includes common law partners and widows/widowers.
Table 4.2.1. Demographic Information of Respondents.

4.2.2. Development of Survey Instrument

The relevant literature, such as Siders (2019), Whitney et al. (2017), and Maldonado and Moreno-Sanchez (2014), provides a range of determinants, such as social capital and human capital, and socio-cognitive indicators to assess social, ecological, or integrated (socio-ecological) adaptive capacity, particularly at the community level. Furthermore, the community characteristics of Indigenousness, remoteness, isolation, and marginalization (through colonization process) led to the use of socio-cognitive indicators. Table 4.2.2 provides detail of the determinants, indicators, and measures applied along with the academic sources. The literature also offers a set of dimensions for the determinants and indicators to assess adaptive capacity across scales, including individual households and the whole community, while focusing on perceived adaptive capacity (Whitney et al., 2017; Grothmann & Patt, 2005). The factors of perception, such as whether the risk can be reduced and protection from the potential dike failure, were included to examine the

adaptive behaviour of residents. I selected the socio-ecological indicators keeping in mind the First Nation's sociocultural community-specific context. Assessing adaptive capacity is a challenging task because of its latent nature, which is shaped by diverse and dynamic context-based and location-specific factors (Berman, Quinn, & Paavola, 2012; Engle 2011). The determinant of economic capital was not included due to a high unemployment rate, overdependence on government social assistance, and reliance on traditional hunting and harvesting for food and livelihood. In addition, economic capital was not included because the community members' livelihoods do not depend on agricultural and farming activities, including the cultivation of land, orchards, dairy farming, and livestock. Their major sociocultural activities and sources of traditional food are hunting, fishing, and harvesting of meat. Nonetheless, according to Grothmann and Patt (2005), the socio-cognitive model involving factors of risk perception and perceived adaptive capacity is better suited to explain individual proactive adaptation than the socioeconomic model. Adaptive capacity also is assessed in a specific context, at the scale of the events and at the scale of analysis, and therefore, it lacks an absolute measure (Growthmann & Patt, 2005).

In social capital, the indicators of reciprocity, expectation, and participation in decision-making by the band and by the federal government were included. They were used because the First Nation is a close-knit community which also is dependent upon natural communal resources (the reserve is communal property); residents help each other in times of need. The higher levels of trust, community involvement, expectation, and norms of cooperation act as valuable resources for individuals and facilitate collective action (Henly-Shepard et al., 2015; Adger et al., 2004). In terms of human capital, the indicators of awareness of flood mitigation measures, flood-related traditional knowledge, and other knowledge systems, and information using local FM radio and the Internet social media platform were included. Different sources of information, knowledge systems, and technologies are required to access and obtain reliable flood-related knowledge and information. The indicators of availability and functioning of a healthcare facility, schools, and a water treatment plant were included in the infrastructure determinant. The governance determinant included help and support provided by the band and by the government during floods and evacuations and the timely flood- and evacuation-related information provided by the band. Both the availability of essential community infrastructure and the ability of a local government to deliver adequate basic civic services play an important role in assessing perceived capacity vis-à-vis the quality of governance at the local level. I combined the indicators of infrastructure and

governance determinants (collectively named governance) to analyse individuals' levels of happiness or satisfaction concerning the delivery of public services. Similarly, the other determinants comprise the indicators of anticipation, organization, preparedness, resilience, flexibility or the ability to learn, and experiences of past flooding and evacuation events. These six indicators helped in assessing perceived capacity by examining the community-specific pertinent issues associated with the determinants. For example, the more an individual had experienced flooding, the higher would be their perceived adaptive capacity.

The indicators and their respective questions used in the survey form were transformed into a Likert Scale (Wall & Marzall, 2006). All indicators are ordinal variables comprised of five Likert scale options: strongly agree, agree, neutral, disagree, and strongly disagree. For example, the study included the statement "the band involves me in solving the flooding and evacuation problems in Kashechewan" for the indicator of participation in decision-making to measure the level of satisfaction or happiness of residents. The average value of all indicators in each determinant was used to conduct inferential statistical analysis. The survey form (Appendix D) also included several questions on the demographic characteristics of respondents, including age, gender, marital and employment status, and education and income levels. During the fieldwork, the survey form was shared with the CAC members and community leaders and revised based on their input. This was to ensure that the wording of questions was appropriate given the common language used by community members. The survey form was also tested by interviewing the research assistant before commencing interviews of respondents.

Determinant	Indicator	Description and Source	Measure Perception
Social Capital/ Resources (4 Indicators)	Reciprocity	• Individuals' perception that they will be provided help by other community members when needed (Henly-Shepard et al., 2015; Lockwood et al., 2015; Maldonado & Moreno-Sanchez, 2014; Moreno-Sanchez & Maldonado, 2013)	Perception/ Satisfaction Measure (PSM)
	Expectation	• Individuals' perception that they can and will support themselves, their families and anyone who needs help (Henly-Shepard et al., 2015; Maldonado & Moreno-Sanchez, 2014; Moreno-Sanchez & Maldonado, 2013)	
	Participation in Decision-making	• Individuals' perception that (i) the local (band), & (ii) the federal governments involve them in solving the floods and evacuations problems (Whitney et al., 2017; Cinner et al., 2009; Eakins & Lemos, 2006)	
Human Capital/ Resources (5 Indicators)	Awareness	• Individuals' perception that they are aware of the flooding problem and the flood control measures taken by the band/federal government (Maldonado & Moreno-Sanchez, 2014; Moreno-Sanchez & Maldonado, 2013; Wall & Marzall, 2006)	Awareness/ Access/ Utilization/ Satisfaction Measure (AAUSM)
	Knowledge	• Individuals' perception of use of flood-related Cree traditional knowledge and other knowledge systems for risk reduction/mitigation (Engle & Lemos, 2010; Cinner et al., 2010; Yohe & Tol, 2002)	
	Information	• Individuals' perception of receiving the information on floods and evacuations provided by (i) the local FM radio and (ii) the Internet (social media) and access to the required technology, and equipped with skills to get the information (Whitney et al., 2017; Engle & Lemos, 2010; Swanson et al., 2009; Brooks et al., 2005; Wall & Marzall, 2006)	
Governance (6 Indicators)	Health Education Tap-water Band Support Govt. Support Information	Individuals' satisfaction level about the availability, provision, support/help, and quality of: • Healthcare services provided by the community health clinic • Education provided by the elementary school and high school • Safe tap-water supplied by the local water plant (Engle & Lemos, 2010; McClanahan et al., 2008; Wall & Marzall, 2006; Brooks et al., 2005) • The band provided help/support during flooding and evacuation • The federal govt provided help/support during floods/evacuations • The band provided timely information on flooding and evacuations (Engle & Lemos, 2010; Wall & Marzall, 2006; Brooks et al., 2005)	Availability/ Provision/ Satisfaction Measure (APSM)

Other Determinants (6 Indicators)	Anticipation Migration/ Organization Resilience Flexibility Experience Preparedness	• Individuals' ability to anticipate (change) in the event of future flooding (Whitney et al., 2017; Maldonado & Moreno-Sanchez, 2014) • Individuals' willingness to relocate from existing location (Whitney et al., 2017; Cinner et al., 2009) • Individuals' perception of the degree to which they oppose or prevent impacts and their ability to recover from impacts (Whitney et al., 2017; Lockwood et al., 2015; Boon, 2012) • Individuals' recognition/perception of the degree to which they are compliant or their willingness to invest in change to adapt (Whitney et al., 2017; Engle & Lemos, 2010) • Individuals' capacity to learn from past experiences (both individual and ancestral) of events and perception of being resilient (Whitney et al., 2017; Engle & Lemos, 2010) • Individuals' perception of risk, improved preparedness, and ability to mitigate losses (Whitney et al., 2017; Henly-Shepard et al. 2015)	Socio-cognitive/ Recognition Measure (SCRM)
Perception (4 Factors)	Risk Risk Reduced Dike Safety Traditional Knowledge	• Individuals' risk perception from very high to very low • Individuals' perception of risk reduction (Can the risk be reduced?) • Individuals' perception of protection from the potential dike failure • Individuals' perception of the usefulness of flood-related traditional knowledge (Henly-Shepard et al., 2015; Grothmann & Patt, 2005)	Socio-cognitive/ Recognition Measure (SCRM)

Table 4.2.2. Determinants and Indicators of Perceived Adaptive Capacity.

4.2.3. Data Analysis

I used descriptive and inferential statistics to analyse data. The risk perception and adaptive behaviour data were analysed using SPSS descriptive statistics. The skewness and unsuitability of data determined the use of specific statistics (Paten et al., 2004). For inferential statistics, the nonparametric one-sample Chi-square ($\chi 2$) (also called the goodness-of-fit test) statistic was used to determine whether each indicator's sample data was consistent with its hypothesized distribution. In other words, the observed values were compared with the expected values to determine if the sample data represented the data expected to be found in the population. The $\chi 2$ test also determined which indicators as one-sample have a greater effect (size) than others in assessing the perceived adaptive capacity. In fact, effect size indicates the proportion of variance

in one category of an indicator explained by variance in the other, which was calculated using the following formula.

$$ES = \frac{\chi 2}{\mathrm{N}\,(\mathrm{J}-1)}$$

ES = Effect size value

χ2 = Chi-square value

N = Sample size

J = Number of categories of the variable

This study employed Spearman's (rho) correlation coefficient to test if there was a significant, monotonic relationship between ordinal (rank-ordered) variables. Numerous researchers have employed correlation for analysis to assess adaptive capacity, for example, Dı´az-Reviriego, Ferna´ndez-Llamazares, Salpeteur, Howard, and Reyes-Garcı´a (2016) used Spearman's correlation. The effect size of the correlation between the determinants was also estimated by squaring the values of rho. For instance, the effect size of rho 0.356 will be rho 0.1276 or 12.76%. The larger the effect size, the larger will be the impact, assuming other things remain the same (Fritz, Morris, & Richler, 2012).

The Friedman's χ2 two-way ANOVA tests by ranks of related samples was performed, because the data are related rather than independent samples. Friedman's χ2 measured two or more comparable indicators from the same sample to compare their distributions. Kendall's W test was conducted to calculate the effect size estimates, which cannot be calculated directly from Friedman's χ2 (Fritz et al., 2012; Kraemer et al., 2003). Kendall's W determines whether an agreement between mean ranks of indicators has been reached, and if the strength of the agreement increases or decreases in addition to its relative strength (Cafiso, Graziano, & Pappalardo, 2013). Kendall's W calculated the effect size using the following formula developed by Tomczak and Tomczak (2014), which assumes the value between 0 (suggesting no relationship/agreement) and 1 (indicating a perfect relationship/agreement):

$$W = \frac{\chi 2}{\mathrm{N}\,(\mathrm{k}-1)}$$

W = Kendall's (K) value

χ2 = Friedman's value

N = Sample size

K = Number of indicators of the determinant

To interpret the effect size, this study followed the guidelines of Gignac and Szordorai (2016), that recommend the correlations of 0.10, 0.20, and 0.30 interpreted as relatively small, moderate, and relatively large based on statistical power analysis and the interpretation of results from a normative viewpoint. I decided not to use Cohen's (1988, 98) guidelines because they are too exigent (Ganac & Szordorai, 2016). While different statistics, methods, and guidelines are available to measure and interpret statistical results, all have certain limitations because "no statistical method is immune to misinterpretation" (Greenland et al., 2016, p. 347; Kraemer et al., 2003). In addition, the statistics employed should be considered within their context because a measure suitable for one problem may not necessarily be appropriate for another (Fritz et al., 2012; Wilkinson 1999).

The principal component analysis (PCA), also called dimensionality reduction, was conducted to estimate how the determinants are associated with one another, the direction of their relationship, and the relative importance of these directions. In other words, the analysis was conducted to reduce the four determinants ("with as much of the variability in the data as possible") to a smaller number ("for as much of the remaining variability as possible") while containing their maximum of the information (Awal et al., 2016, p. 285). Nelson and colleagues (2010) and Awal et al. (2016) also used PCA to determine which determinants contributed more to adaptive capacity. PCA is commonly used by researchers in different fields, including the social sciences (Awal et al., 2016).

4.3. Results

4.3.1. Perception of Flooding Risk

On a scale from very high to very low, almost half of the respondents (48%) perceive that the flood risk in Kashechewan is very high, about one third (17%) stated that it is high, and 27.8% stated that the risk is moderate. Few respondents perceived the flood risk to be low (4.4%) or very low (3.3%). 5.6% of respondents said they are not sure about the level of risk (Table 4.3.1). Age influenced survey respondents' risk perceptions, with older respondents having higher flood risk perceptions. Out of 64.5% of the total respondents who perceive that it is very high or high, 90% were over 40 years old. Risk perception among older (40-59 years) and elder (60 and above) respondents is higher than among younger (18-39 years) respondents; 77.4% of older and 80% of elder respondents perceive that the risk is very high or high as compared to 53% of younger respondents. Risk perceptions were also higher for those with higher levels of formal education. However, out of 69 respondents with Grade 10 education and above, 18 (26.1%) respondents perceive that the risk is moderate. As shown in the following table, 43% of respondents think that the flooding risk in Kashechewan can be reduced. More than half of respondents (56.7%) strongly agree or agree that the dike is helping a lot to protect Kashechewan, with 22.2% stating that it does not help a lot, and 21% of respondents are not sure. 76% of respondents think that the best solution to the flooding and evacuation problems is to relocate the community from Kashechewan and over 82% have shown their willingness to be relocated.

The results indicate that the risk perception increases with an increase in residents' age over 40 years, particularly in elders 60 years and older. Also, the higher the education of residents, the higher the flood risk perception. Although many respondents acknowledge that the dike has saved the community in the past, most of them perceive that the desired solution to the frequent flooding risk and recurring evacuation problems is to relocate, and a significant majority (over 82%) are willing to relocate to Site 5, thirty kilometres (straight line distance) upriver from Kashechewan.

Perception of flood risk of women respondents is slightly higher (33.4%) as compared to men (31.1%) who think that it is very high or high. About 17% of men and 11% women perceive

that the risk is moderate. The higher percentage (25.6%) of men respondents think that the flood risk in Kashechewan can be reduced as compared to (17.8%) women. However, 12.2% men and 14.4% women perceive that the flood risk cannot be reduced. The perception of women and men concerning protection from dike failure is almost the same (i.e., 28.9% and 27.8% respectively) who strongly agree or agree that the dike is helping a lot in protecting Kashechewan. About 12% of women and 9% of men respondents are not sure about it.

Risk Level	**% (No.)**	**Can Risk be Reduced?**	**% (No.)**	**Description**	**Perception of Dike**	**Willingness to Relocate**
Very High	48% (43)	Yes	43% (39)	Strongly Agree	16% (14)	58% (52)
High	17% (15)	No	27% (24)	Agree	41% (37)	24% (22)
Moderate	28% (25)	Don't		Not Sure	21% (19)	11% (10)
Low	4% (4)	Know	30% (27)	Disagree	14% (13)	7% (6)
Very Low	3% (3)			Strongly Disagree	8% (7)	0% (0)
Total	100% (90)	-	100% (90)	-	100% (90)	100% (90)

Table 4.3.1. Perception: Flooding Risk and Protection from Dike Failure.

4.3.2. Perception of Emergency Preparedness

Over 82% of respondents strongly agree or agree that they are prepared for future flooding and evacuation as opposed to only 5.6% who disagree, and 12.2% who are not sure. More than 77% of respondents perceive that flood experiences have better prepared them to avoid or mitigate damage in comparison to only 2.2% who think otherwise, and 20% who are not sure. None of the respondents strongly disagreed in both cases. The results indicate that the community's emergency preparedness and coping capacity have increased, and residents perceive that they are better prepared for the future mainly because of frequent flood emergencies.

The perception of emergency preparedness between women and men is the same (41.1%) who strongly agree or agree that they are prepared for future flooding and evacuation. Surprisingly, the perception of women and men is also the same (38.9%) that flood experiences and stories helped better prepare them to reduce flood losses. A higher number of men (34.5%) strongly agree

or agree in comparison to women (27.8%) that they have become better as a result of frequent flooding risk and evacuation every year. Also, a higher number of men (43.3%) than women (38.9%) respondents strongly agree or agree that they will be willing to be relocated from Kashechewan because of the increased flooding risk.

4.3.3. Contribution of Indicators to Perceived Adaptive Capacity

In social capital, the indicators of expectation (21%) followed by reciprocity (11%) are relatively greater contributors to perceived adaptive capacity than participation in decision-making by the band and the federal government. The effect size is relatively large and medium for expectation and reciprocity, respectively. The effect size implies that the variability in the mean rank scores of expectation and reciprocity are accounted for by their corresponding categories (strongly agree to strongly disagree). The human capital indicators of information (social media), other knowledge, and traditional knowledge contribute to the perceived capacity more than the remaining two indicators with a relatively large and medium effect size of 20%, 15%, and 11%, respectively. Support and help during flood and evacuation (22%) and information on flooding and evacuation (22%) provided by the band contribute more to the perceived capacity than support and help provided by the federal government (19%) and education provided by schools (16%) in Kashechewan in the determinant of governance. The effect size is relatively large for the first indicator and medium for the remaining two. In the other determinants, indicators of migration/organization (16%), preparedness (13%), personal resilience (12%), and experience (11%) contribute more to the perceived capacity than the other two indicators, with relatively moderate effect size. Among the perception factors, flood risk (19%) plays a more major role in reshaping adaptive behaviour and emergency preparedness than does the perception of safety from dike failure (8%) and usefulness of traditional knowledge (9%), while risk reduction was found to be statistically insignificant. Table 4.3.3 divides all the 21 indicators into three categories based on the values of one-sample $\chi 2$ (p-value = .000; except for expectation and tap-water p-value = .001) and effect size. In Table 4.3.3, the indicators are listed in order of highest value to lowest value in terms of contributing more in perceived capacity than others, and in the contribution of the variables in determining perception of residents. The first category indicators are relatively high contributors followed by the second and third categories with a relatively medium and small

contribution, respectively. The Kendall's W value (.19) indicates the 19% effect size of all the 21 indicators of the four determinants.

Category	Indicator	One-Sample $\chi 2$	Effect Size (%)
Relatively high contributors	1. Help/Support (by Band)	80.667	22
	2. Information (by Band)	78.333	22
	3. Expectation	73.889	21
	4. Information (Social Media)	73.333	20
	5. Help/Support (by Govt)	66.444	19
Relatively medium contributors	6. Organization (Migration)	57.733	16
	7. Educational Services	57.444	16
	8. Knowledge (Other)	52.778	15
	9. Preparedness	47.067	13
	10. Healthcare Services	44.444	12
	11. Resilience (Personal)	42.111	12
	12. Experience (Flooding)	40.667	11
	13. Reciprocity	39.689	11
	14. Knowledge (Traditional)	39.000	11
Relatively small contributors	15. Participation (Band)	28.111	8
	16. Awareness (strategies)	27.956	8
	17. Anticipation (Future)	26.889	8
	18. Information (FM Radio)	26.600	7
	19. Participation (Govt)	26.444	7
	20. Flexibility	20.489	6
	21. Safe Tap-Water	18.222	5
Perception	1. Flood Risk	61.333	17
	2. Cree Knowledge Value	33.444	9
	3. Safety by Dike Wall	29.111	5

Table 4.3.3. One-sample Chi-square, Effect Size, and Contribution of Indicators.

4.3.4. Interrelationship of Determinants of Perceived Adaptive Capacity

The average values of all the associated indicators were taken for the corresponding determinants. All indicators were weighted equally to analyse the perceived capacity using four determinants. I explored the interrelationship between the determinants to measure the perceived capacity based on the average values/scores of all related indicators within each determinant. The stronger the relationship, the higher the perceived capacity of individuals. Correlation is a useful statistic because it estimates the strength as well as the direction, positive or negative, of the association between variables. The statistical analyses allowed me to make comparisons and rank perceived adaptive capacity (Siders, 2019). In other words, the determinants that are perceived to be associated with lower flood losses, for example, due to the timely provision of early warnings, imply that these determinants rank higher in perceived capacity because of the nature of the strength of their interrelationship.

Table 4.3.4 presents the statistically significant correlation between the four determinants with p-value <= .004 (2-tailed). There is a strong positive relationship between social capital and human capital with an effect size of 12.67%. In other words, a 12.67% increase in the variance of social capital will have the corresponding 12.67% increase in the variance of human capital, indicating the size of the relationship in percentage between the two. The estimated effect size (12.67%) is because of the impact of the known variables between the two determinants and the remaining 87.33% impact is due to unknown variables. Similarly, the correlation between social capital and governance is strong, positive with an effect size of 12.39%. Social capital is also positively and strongly correlated with the other determinants with a 21.81% effect size. Human capital and governance are also positively and strongly correlated and have a 21.81% effect size. Human capital is positively correlated with the other determinants and has the strongest strength of all with an effect size of 22.66%. Finally, governance and the other determinants are positively correlated but with medium strength and an effect size of only 8.94%. Notably, the average of all the correlations (rho = 0.403) indicates a large, strong relationship with a decent average effect size (16.23%). In social and behavioural sciences, the effect sizes generally "tend to be small or medium," however, "small," "medium," or "large" refers to the size of the effect, but not necessarily to its importance or impact (Murphy et al., 2014, p. 8/17). For example, a flood prevention measure might lead to a small change, but if the change translates into saving the lives

of many people, the effect will be considerable. The positive, stronger interrelationship between the determinants implies higher perceived capacity, which enables individuals to activate their objective capacity while utilizing their physical resources. In brief, the results indicate that the respondents' perceived adaptive capacity to floods is high as demonstrated by the positive, strong interrelationship between the determinants. As stated earlier, the Kendall's W indicates the 19% effect size of all the 21 indicators. The inferential statistical results are also consistent with the descriptive results of high perception of risk, and increased emergency preparedness and coping capacity.

Determinant	rho	Effect Size (%)
1. Human Capital & Others	.476	22.66
2. Social Capital & Others	.467	21.81
3. Human Capital & Governance	.467	21.81
4. Social Capital & Human Capital	.356	12.67
5. Social Capital & Governance	.352	12.39
6. Governance & Others	.299	8.94

Table 4.3.4. Bivariate Correlation of Determinants.

4.3.5. Contribution of Determinants to Perceived Adaptive Capacity

The results indicate a 29% effect size and a very good agreement between the four indicators of human capital. Similarly, this study found a 26.6% effect size with a very good agreement between the indicators of other determinants. The results show a 19.3% effect size with a good agreement between the indicators of social capital. The data revealed a fair agreement between the indicators of governance with an effect size of 11%. In summary, the results indicate that the indicators of human capital followed by the other determinants are relatively high contributors to the perceived adaptive capacity. The contribution of the indicators of social capital and governance to perceived capacity is relatively small compared to the indicators of human capital and other determinants. Table 4.3.5(a) provides detail of Friedman's $\chi 2$ (p-value = .000). See Appendix-4.3.5 (a & b) for details of the mean ranks and paired comparison.

Furthermore, the PCA results with one component solution for the determinants and the variation they collectively explain in the overall perceived adaptive capacity support the results of

Friedman's $\chi 2$. The PCA with one component solution loads (weights) for each determinant are positive, with human capital (0.793) and the other determinants (0.770) contributing more to perceived adaptive capacity than social capital (0.750) and governance (0.710). In other words, the determinants have strong component loadings that suggest that there is a strong relationship between the determinants. The minimum acceptable component loading (absolute value) is higher than 0.3. Overall, the proportion of variation collectively explained (common variance) by all determinants is 57.25% (Table 4.3.5(b)).

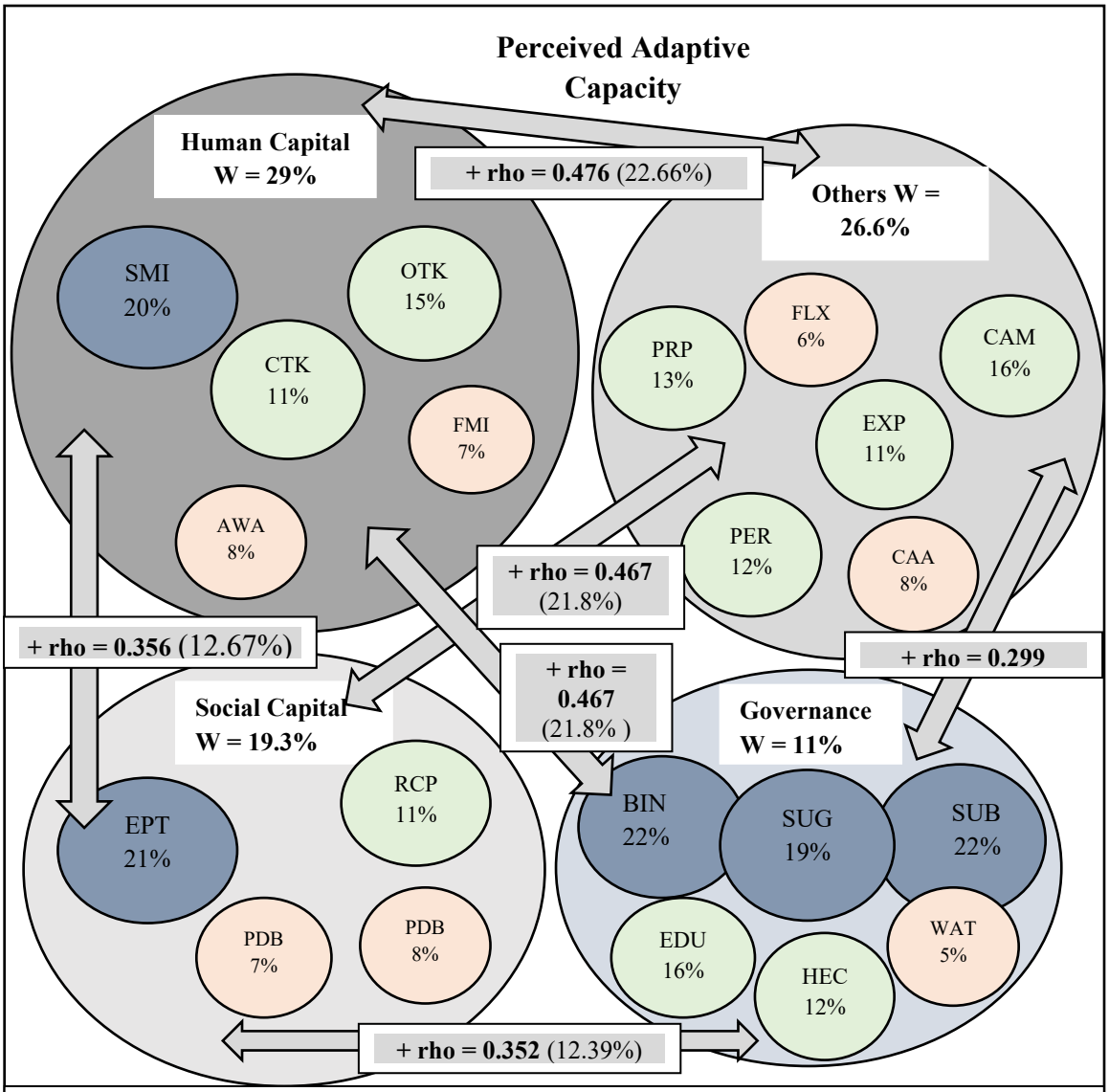
Determinants	**Friedman's ($\chi 2$)**	**Kendall's W Effect Size**
Human Capital	104.569	29.0% (0.290)
Others	119.760	26.6% (0.256)
Social Capital	52.163	19.3% (0.193)
Governance	49.687	11.0% (0.110)
Perception	104.620	38.7% (0.386)

Table 4.3.5(a). Friedman's ANOVA and Effect Size of Determinants.

Determinant	**Component Load (Weight)**	**Communality Extraction**
Social Capital	0.750	0.563
Human Capital	0.793	0.629
Governance	0.710	0.504
Others	0.770	0.594
Variation Collectively Explained: 57.25%		

Table 4.3.5(b). Principal Component Analysis (Component Matrix) of Determinants.

Figure 4.3 presents a visual representation of the contributions of the 21 indicators and determinants that were used to reveal the community's perceived capacity as well as the strength and direction of interrelationships between the 4 determinants of social capital, human capital, governance, and the other determinants; it also shows all related indicators in each determinant.



"+" = Positive Relationship; "Rho" = Correlation; "%" = Effect Size; and "W" = Kendall's W.
Abbreviations: Social Capital: RCP = Reciprocity, EXP = Expectation, PDB = Participation (Band), PDG = Participation (Govt); **Human Capital:** AWA = Awareness, CTK = Cee Traditional Knowledge, OTK = Other Knowledge, SMI = Social Media Information, FMI = Local FM Radio Information; **Governance:** HEC = Healthcare, EDU = Education, WAT = Safe Tap-Water, SUB = Support (Band), SUG = Support (Govt), BIN = Band Information; and **Others:** CAA = Anticipation, CAM = Migration, FLX = Flexibility, PER = Resilience, PRP = Preparedness, & EXP = Experience.

Figure 4.3. Visualization of Kashechewan First Nation's Perceived Adaptive Capacity.

	Indicators: One-sample Chi-square ($\chi 2$) effect size in percentage	Principal Component Analysis	
	Relatively high contributors.	Variation collectively explained	57.25%
	Relatively medium contributors.	Good collective variation	40-60%
	Relatively small contributors.	Kendall's W of 21 indicators	19%

4.4. Discussion

Siders (2019) identified and listed 158 indicators and determinants after reviewing 274 studies. I used 21 socio-cognitive indicators of four determinants and the integrated socio-ecological system approach to determine the community's perceived adaptive capacity. The approach used is the most appropriate having regard to the First Nation's unique context concerning Indigenous social and cultural way of life, and their physical vulnerability to the ecological phenomenon of spring flooding.

The findings of high perception of risk and increased emergency preparedness are similar to the findings of Lo (2013), Henly-Shepard et al. (2015), and Shao et al. (2017) who found that individuals with a high perception of risk are more likely to adapt their behaviour in comparison to those with low risk perceptions. Adaptive behaviour also is influenced by people's perception of the availability and capability of mitigation measures and available adaptation options to deal with hazards risks (Gardezi and Arbuckle, 2019; Henly-Shepard et al., 2015; Yohe & Tol, 2002). The high perception of risk is likely due to the frequent experiences of dealing with flooding risk, including recurring evacuations, ice jam events, and warming spring temperatures. In addition, Rehamn (2012) found that frequent experiences of hazards risks shift the approach from traditional relief and recovery to preparedness, particularly at the community level.

The research finding that there is a strong interrelationship between the determinants of social capital, human capital, governance, and the other determinants is also indicated by the adaptive capacity to climate change literature—such as Engle and Lemos (2010); Gupta et al. (2010); Posey (2009); Walls and Marzall (2006); and Adger, Brooks, Bentham, Agnew, and Eriksen (2004) —who found that a positive correlation between determinants of adaptive capacity exists at varying scales. These positive, monotonic relationships between the determinants also are supported by the disaster risk management literature, such as Reininger et al. (2013); Seng (2013); Kawachi, Subramainian, and Kim (2008); Nakagawa and Shaw (2004); Haque (2000); and Buckland and Rahman (1999).

The conclusion that human capital, particularly the contribution of indicators of awareness, knowledge, and access to and use of information, contributes to adaptive capacity is similar to the findings of Alberini et al. (2006); Engle and Lemos (2011); and Shao et al. (2017), who also found

that these indicators act as enhancers of adaptive capacity. Similarly, the conclusion that the other determinants—such as experience, flexibility, and resilience—contribute to the improved adaptive capacity are consistent with the climate change literature, such as Smit and Pilifosova (2001) and Engle and Lemos (2010).

The finding that social capital acts as an enhancer of adaptive capacity is also consistent with the findings of Henly-Shepard et al. (2014) and Paton et al. (2007). The relationships between community members promote social cohesion through community networks and strengthen the social system by sharing and accessing available resources, which results in higher social capital (Wall & Marzall, 2006; Pelling, 1998). In contrast, loss of access to communal resources increases people's vulnerability, which results in reduced adaptive capacity (Adger et al., 2004). The results of the indicators of governance determinant are supported by the findings of Gupta and colleagues (2010) who found that the level of adaptive capacity is enhanced with the availability of adequate infrastructure, quality of civic services, and good governance of local institutions.

This research findings show that the elevated flooding risk and frequent emergencies have considerably influenced the risk perception and emergency preparedness of residents of Kashechewan. Particularly, after the 2006 flood and the recurring emergencies every spring, residents' perception of risk has significantly increased. This, in turn, has changed the adaptive behaviour of residents. The increased risk perception has motivated residents to take adaptation responses, such as improving emergency preparedness and willingness to relocate from the existing flood-prone site. The high perception of risk and improved emergency preparedness and the reshaped adaptive behaviour of residents have also resulted in their high perceived adaptive capacity. In brief, the findings suggest that the elevated hazard risks and frequently occurring emergencies motivate people to modify their spontaneous and proactive adaptation responses for DRR at both the household and institutional levels. My research contributes to the literature on adaptive capacity by focusing on the perceived capacity of the First Nation. The adaptive capacity literature mainly focuses on objective capacity. This research shows that perceived capacity is as important as the objective capacity to determine total adaptive capacity.

The work of Grothmann and Patt (2005) focuses on the importance of perceived adaptive capacity, which has been largely neglected in climate change research. The integrated socio-

ecological system framework developed by Whitney and colleagues (2017) was useful for assessing the adaptive capacity of a resource-dependent, remote and isolated First Nation community while focusing on human cognition and psychological factors in the face of social, environmental, and climate change.

Based on theory and empirical evidence, I suggest that policymakers should consider the psychological aspects of adaptation by adding perceived capacity into the assessment of total adaptive capacity. A recommendation for the academic and practitioner communities is to consider including both perceived and objective capacities when measuring and characterizing total adaptive capacity, particularly of remote and isolated Indigenous communities.

4.5. Conclusion

Kashechewan First Nation's perception of risk and its perceived adaptive capacity are both high. The high perception of risk and the experiences of recurring, yearly flood emergencies are the main contributors to the community's increased emergency preparedness and coping capacity. The strong positive interrelationship between determinants (of related samples) suggests that the community's perceived adaptive capacity is high. Both high perception of risk and perceived adaptive capacity likely have reshaped the adaptive behaviour of the community. Human capital and the other determinants are relatively higher contributors to the perceived adaptive capacity, followed by social capital and governance determinants. Translating the high perceived capacity into greater overall adaptive capacity would enhance community resilience.

This study contributes to climate change adaptation literature in three areas. First, the study assessed the perceived adaptive capacity of an isolated and remote First Nation. This research used the lens of an individual resident at the community level and employed survey research using the integrated socio-ecological system approach. This is perhaps the first application of the approach and survey method to assess perceived adaptive capacity in the Arctic and Subarctic regions of Canada. This research, therefore, provides a basis for researchers to further expand on the survey method to assess the overall adaptive capacity of Kashechewan First Nations and other Indigenous communities in the region. Second, understanding the perceived capacity of Indigenous communities can help researchers and policymakers better understand their adaptive responses to the impacts of climate change and natural hazards. Notably, policymaking and planning for

resilience-building to deal with climatic risks require a nuanced understanding of both perceived and objective adaptive capacities. Finally, the high perception of risk and perceived capacity and the resultant change in the First Nation's adaptive behaviour have motivated them to relocate from the existing flood-prone, low-lying area to a relatively higher and safer site 30 kilometres (straight line distance) upriver.

4.6. Chapter Summary

Chapter 4 introduced the concepts of adaptation, perceived adaptive capacity, and the assessment of perceived capacity using the system-based, integrated, socio-ecological approach. It also described the community context, fieldwork activities, development of the survey, and the use of different statistics for data analyses. The descriptive and inferential statistical results presented show that the First Nation's risk perception and perceived adaptive capacity both are high, which are reshaping their adaptive behaviour. The chapter concluded that translating the high perceived capacity into greater total adaptive capacity would enhance community resilience.

CHAPTER 5: CONCLUSION

5.1. Introduction

This Ph.D. dissertation examined the elevated risk of spring flooding and recurring evacuations experienced by the Kashechewan First Nation located in the flood-prone, low-lying southwestern James Bay Subarctic region. The application of mixed methods research, particularly the use of participatory flood mapping workshops, including on-sites walks and photography, involving community members, has been first of its kind to investigate frequent spring flooding in the lowlands of James Bay. The aim of this research is to examine how the Kashechewan First Nation is affected by and responds to floods. The specific objectives of this research are to:

- Explore Kashechewan First Nation's traditional and local spatial knowledge concerning the elevated spring flooding risk.
- Examine Kashechewan residents' experiences of actual flooding or frequent flooding risk impacts and recurring evacuations.
- Analyse residents and the community's perceived adaptive capacity to the increased flooding risk.

Specifically, this dissertation has examined the factors that have elevated the spring flooding risk; community members' flood-related observations on changes in the Albany River, in their landscape, and the local environment; and how the Kashechewan First Nation has coped with flooding hazard in the past and what is their perception of reducing the increased risk of flooding (Chapter 2). This thesis also has explored how the increased flooding risk has affected the First Nation; and how the regular flooding risk and recurring evacuation experiences of residents have affected their vulnerability and resilience (Chapter 3). Finally, this dissertation determined the flooding risk perception of residents; how individuals' flooding risk perceptions influenced their emergency preparedness and adaptive behavior; and the level of perceived adaptive capacity of Kashechewan First Nation (Chapter 4).

For the interpretation of the qualitative and quantitative datasets, the two sets of inferences were combined into a coherent whole called meta-inference. I used the qualitative data (semi-structured interviews and participatory flood mapping) findings to confirm quantitative data

findings that the First Nation's perception of risk is high. Likewise, statistical analysis of quantitative survey data suggested that the community's emergency preparedness and coping capacity have increased because of frequent emergencies that were supported by the qualitative interview data providing the same results. The finding of a significant change in the adaptive behavior of residents was verified by the qualitative data as well as quantitative data. Furthermore, the finding that flood-related traditional and local spatial knowledge is useful was reached using the quantitative data was illustrated by qualitative interview data in which participants provided detailed accounts of what the knowledge was and how it was used. The finding from the quantitative data in numbers that residents frequently use the social media platform to get information on flooding and evacuation was elaborated in narrative form during the qualitative interviews. Similarly, the finding of the perception of protection from the dike failure from quantitative data was enhanced by qualitative interview data in which participants clarified why the First Nation believed that the dike would breach if there will be severe flooding in the future.

First, the results of this research show that spring flooding has occurred seasonally over many generations in the southwestern James Bay region and has not increased significantly over time (Khalafzai et al., 2019). Nonetheless, the spring flooding timing and extent has changed, particularly in recent years with warming springs in the region along with the earlier spring season, snowmelt, and rapid runoff. Flooding impacts are exacerbated by landscape and resource developments, including inadequate community infrastructure, substandard dike, and downriver winter ice road, which have increased the frequency and scale of spring breakup ice jams. These ecological changes have caused an increased risk of flooding for the Kashechewan First Nation.

Second, results indicate that spring flooding risk has significantly increased the vulnerability of the community. Spring flooding has been frequently impacting community infrastructure, traditional spring hunting and harvesting, and the First Nation's economy. Residents' experiences during the evacuations have increased their physical, social, and psychological vulnerability. Recurring evacuations are negatively affecting the community's well-being during and after evacuations. Dealing with the frequent flooding risk and recurring emergency experiences have improved the First Nation's emergency preparedness and coping capacity.

Third, the results indicate that residents' risk perception and perceived adaptive capacity are high and are reshaping their adaptive behavior. The strong positive interrelationships between human capital, social capital, governance, and other determinants also suggest high perceived adaptive capacity. The results also indicate that residents' emergency preparedness has also improved. Climate change adaptation and DRR planning to mitigate the impacts of natural hazards also requires a nuanced understanding of the perceived capacity that contributes to overall adaptive capacity. In brief, translating the high perceived capacity into greater total adaptive capacity would contribute to enhancing community resilience. As a result, socio-cognitive and psychological indicators must be included by researchers to determine adaptive capacity, particularly of remote and isolated Indigenous communities.

5.2. Contributions to the Literature

The findings of my research presented in this thesis contribute to the literature on natural hazards, DRR, and climate change adaptation. This research project has focused on isolated and remote northern Indigenous Peoples and natural hazards, an area that has received very little attention in the Canadian Arctic and Subarctic regions (Newton et al., 2005). This research is especially unique because it has brought new methodological and theoretical insights into the research, combining multiple methods—qualitative and quantitative—to facilitate an in-depth investigation of the spring flooding phenomena by employing a mixed case study approach. The theoretical frameworks employed also make this research significant as they focus on community vulnerability and resilience and positive characteristics, such as enhanced capacities and improved preparedness, rather than merely focusing on vulnerability or resilience and pointing out weaknesses. The use of multiple culturally appropriate participatory techniques makes this dissertation unusual because it has illuminated the Kashechewan community-specific spring flood-related traditional and local spatial knowledge, which can be useful for a better understanding of localized flooding risks and the breakup ice jams hazard-specific characteristics for DRR. This research is the first to examine the drivers of the elevated spring flooding risk, the breakup ice jamming phenomenon and hazard characteristics, and the resource development and area's landscape, and warming spring in the region. In particular, this research is unusual in terms of the documentation of flood-related traditional and local spatial knowledge of Kashechewan elders detailed in Chapter 2 for the benefit of its existing and future generations. In addition, the

application of the participatory flood mapping techniques can be a useful method for continuous flood mapping, monitoring, and DRR activities for the Kashechewan First Nation community and other remote and isolated Indigenous communities experiencing similar problems.

This thesis makes several significant contributions to five different areas. First is the community-specific traditional and local spatial knowledge concerning spring flooding hazard characteristics and river morphology, including breakup ice jamming phenomenon, warming spring temperatures, and ecological changes due to resource development. The First Nation's flood-related traditional and local spatial knowledge enabled my research to identify the major drivers of increased spring flooding risk and recurring evacuations every year. The invaluable and eroding spring flood-related traditional and local spatial knowledge of Kashechewan First Nation was not documented prior to my research. These findings complement the existing spring flooding data collated by natural scientists and contribute to the literature on the spring breakup ice jamming phenomenon. In particular, the findings contribute to the literature on natural hazards and risk reduction; the documented traditional knowledge can help scientists to better understand ecological and climate changes to mitigate natural hazards risks. The methodological approach and multiple culturally appropriate participatory techniques employed gave voice to community members and helped in illuminating their perceptions, perspectives, and invaluable indigenous observations, which can be beneficial for the scientific community. For example, the reduced span and safety level of winter ice roads because of warming temperatures in northern Canada are sporadically discussed in the literature; the finding of the dramatic flooding of 2006 caused by the ice jamming due to the ice bridge of the ice road is unusual and contributes to the literature. The finding contributes particularly to the literature on ecological change and increased hazards risks caused by resource development activities.

The second area is evacuations due to actual flooding or flooding risk. My research contributes to the literature on evacuations due to the increased flooding risk. This research has explored the experiences of the short-term evacuations of residents that happened 14 times since 2004 (consecutively from 2004-2008 and 2012-2019). The findings are unique because there is a lack of research about how people and a community are affected by recurring evacuations. This research also revealed the impacts of frequent flooding risk on traditional hunting and harvesting and the local economy. My research has also unveiled the consequential negative effects due to

repeated evacuations on band members' sociocultural, emotional, and spiritual well-being. Furthermore, the finding of enhanced resilience and coping capacity essentially because of annually repeated flood emergencies is a significant contribution to the literature as it lacks such unique experiences of, and recurring emergencies faced by any community elsewhere. In addition, these research findings also provide some insights into the experiences of long-term evacuees, which has received very little attention by researchers. One study by Wilson et al. (2012) examined the impacts of short- and long-term evacuations from volcanic ashfall and ash-storms on farmers. My study found that long-term evacuees who had to stay in Kapuskasing for three years felt socially disconnected from their community upon their return to Kashechewan.

Third, this research contributes to the adaptation literature due to its examination of perceived adaptive capacity. The existing literature on adaptive capacity predominantly focuses on objective capacity, with a very few studies exploring perceived adaptive capacity. For example, Gardezi and Arbuckle (2019) examined the perceived adaptive capacity of US farmers' for decision-making to use cover crops by activating their material resources. Grothmann and Patt (2005) compared the perceived capacity with the objective capacity of residents of Cologne, Germany to assess their proactive adaptation to riverine flooding. The results of my study suggest that the socio-cognitive aspect (i.e., perceived capacity) is equally important as the objective capacity for proactive adaptation and the assessment of the total adaptive capacity of a community.

The fourth contribution is the use of multiple methods, including flood mapping workshops, semi-structured interviews, and surveys to understand the problems of the elevated risk of spring flooding and recurring evacuations. The use of multiple methods and employing the integrated socio-ecological system approach involving the band members of a First Nation community is the first application of the method in northern Canada to assess perceived adaptive capacity to spring flooding risks. In addition, the use of flood mapping workshops and structured interviews contributes to the literature by showing that survey research involving northern Indigenous communities can be culturally appropriate.

The fifth and last contribution is involving traditional knowledge and scientific knowledge about warming temperatures and the spring breakup ice jamming phenomenon contributes to bridging the gap between the two diverse knowledge systems. The two-eyed seeing model

developed by Canadian Institute of Health Research (CIHR, 2007, 2009) was also used. The model promotes learning to see from two eyes—with one eye on the strengths of Aboriginal Peoples' knowledge and ways of knowing, and the other on the strengths of mainstream knowledge and ways of knowing. It suggests the gap between the mainstream Canadian society and Aboriginal communities can be bridged through partnerships, knowledge exchange, and research on significant challenges facing First Nations and other Aboriginal Peoples (Castleden et al., 2016; Furgal et al., 2010). This collaborative approach offers more opportunities for DRR.

5.3. The Way Forward

Based on the results of this research, the people of Kashechewan by majority would prefer to be relocated from the existing high-risk, flood-prone site to the relatively higher and safer ground (30 km straight line distance) upriver because of the increased flooding risk and physical vulnerability of the community. Keeping in mind the increased spring flooding risk and physical vulnerability of the community, the planning and groundwork should be started as early as possible. Most importantly, the allocation of the required funding by the federal government for establishing a new community shall begin the relocation of the First Nation. The following five recommendations are based on the three specific research objectives and the subsequent eight research questions of the three papers. The recommendations are keeping in mind the First Nation's traditional and local spatial knowledge concerning the elevated spring flooding risk, their experiences of impacts of actual flooding or frequent flooding risk and recurring evacuations, and the community's perceived adaptive capacity to the flooding risk.

During the implementation period (expected 5-7 years) of relocation, there are several recommendations for a range of right-holders, including the Kashechewan First Nation and the Mushkegowuk Tribal Council, and the provincial and federal governments. First, during evacuations, the Kashechewan community should preferably be evacuated to neighboring reserve territories of Cree First Nations located near their spring camping and hunting grounds. The traditional activities of hunting, trapping, and fishing on the ancestral lands and waters of Cree First Nations and harvesting of hunted meat are an integral part of their traditional way of life. These activities also are essential for their spiritual, cultural, and economic well-being (Government of Ontario, 2017). My first recommendation would help to reduce the sociocultural

and emotional vulnerability of residents during evacuations to multiple host communities concerning negative experiences, including nonacceptance of evacuees in host communities and racism. Second, Kashechewan evacuees should be granted permission to hunt in areas used by other neighboring First Nations. As a part of Indigenous tradition, Cree Peoples show respect for each other; sharing food has always been the priority (Canadian Encyclopaedia, 2018). Traditional food is shared in times of hardship or in times of plenty. This is because Cree People spiritually believe that the Creator requires them to live a good life: peaceful and taking care of each other (Canadian Encyclopaedia, 2018). In times of need, the permission granted by other First Nations of the region to evacuees to hunt and harvest on their hunting grounds would help in reducing evacuees' socio-cognitive vulnerability and ensure their access to traditional food.

Third, the methodological approach that employed participatory techniques can be useful for ongoing spring flood mapping, monitoring, and DRR activities in the southwestern James Bay region as well as other northern Canadian Indigenous communities. Fourth, the understanding to enhance resilience, particularly of remote and isolated Indigenous communities, requires the assessment of both perceived capacity and objective capacity to determine total adaptive capacity. The First Nation's community characteristics, such as Indigenousness, remoteness, and isolation, called for using socio-cognitive variables. Socio-cognition and the socio-ecological aspects are crucial to assess total adaptive capacity, keeping in mind the First Nation's sociocultural context, particularly reliance on traditional hunting, harvesting, and livelihoods. The perceived capacity is essential from the socio-ecological viewpoint because many northern Indigenous Peoples' livelihoods do not depend on agrarian economic sources, such as agricultural and farming activities, including the cultivation of land, dairy farming, or livestock. Finally, the successful relocation experience of Peawanuck First Nation can help to relocate the Kashechewan community to mitigate the flooding risk. The former Winisk First Nation, located about 405 kilometers north of Kashechewan, was at high risk of spring flooding. On 16th May, the 1986 flood wiped out the community (also destroyed by the 1966 flood) settled at the Winisk River's mouth in southwestern Hudson Bay. In 1987, the re-established community called Peawanuck First Nation was relocated 35 kilometers (straight line distance) upriver.

5.4. Future Research

There are several areas of further research that would build on this dissertation.

First, an in-depth investigation of the impacts of recurring emergencies by focusing exclusively on cultural spring hunting and harvesting and the resultant implications is a potential area for research. Some of the implications to look at for future research are the erosion of traditional knowledge, the fading away family cultural recreational activities, and reduced hunting span, including a valuable source of traditional food and income. Future research could expand on this study to learn more about the impacts of long-term evacuations on Kashechewan residents. Future research should include examining the impacts on Kashechewan children's academic performance and socio-cognitive factors such as self-esteem.

Second, there is a need to investigate the breakup ice jamming phenomenon occurring in the Arctic and Subarctic regions across the globe using flood mapping and other participatory techniques and documenting traditional and local spatial knowledge. Another potential area of collaboration for future research with global northern Peoples is the reduced span and safety level of winter ice roads because of warming temperatures using mapping and other participatory techniques.

An interesting topic of future research is developing an exhaustive list of psychological (i.e., perception-based, region-specific) indicators for Indigenous communities that could be useful in assessing total adaptive capacity. The list of indicators can be expanded based on specific community context and the determinants used in my research, such as social capital, human capital, governance, and infrastructure, as well as additional determinants, such as diversification of traditional livelihoods and indigenous sources of income. Additional socio-cognitive indicators, including trust and collective action, technical knowledge and skills, waste disposal and management, sewerage and sanitation services, and power supply and telecommunication services, and income from diversified sources, can be added to examine the perceived capacities of residents. Finally, another potential area for future research is to examine how community-specific and culturally appropriate risk communication between Indigenous communities and emergency management agencies can help in adaptation and enhancing resilience for DRR.

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Appendix A. Five Relocation Options.

Location	Pros	Cons
Option-1: Existing Site o Add 30 feet of aggregate fill in community o New additional homes and some mobile homes o Existing water plant upgraded to increase water pressure o New water and sewer lines o Keep existing power distribution o New elementary school, band office, education authority offices o New police and fire protection facilities o New regulated dump site o Airport terminal o All improvements from report apply.	o Barge accessible seasonally o Remain on traditional lands o Some new homes and facilities o If done in phases; minimum disruption o Shot-erm employment.	o Still spring flooding and ice jams, but not in community o No long-term economic potential for community members o No long-term economic opportunities o Existing water source o River is too dry in the summer and fall o Vulnerability to the effects of climate change o Climate change impacts forest fires, insects, diseases and will affect traditional hunting and fishing.
Option-2: New Community at Fort Albany o New housing subdivision o Sharing of some community services o Adjacent to existing Fort Albany community o One band council o Raised ground elevation for new facilities o Power sources in existence o Existing community decommissioned o All improvements from report apply.	o Larger First Nation community o Lends to more political influence o Adjacent to traditional lands o Barge access o New houses and home service o Next to Albany River o Easy to phase in.	o Isolated community o Forced merger with Fort Albany o No long-term economic benefits o No long-term employment o No post-secondary education or training accessibility for youth o River is too dry in summer & fall o Vulnerability to the effects of climate change o Climate change impacts forest fires, insects, diseases and will affect traditional hunting and fishing.
Option-3: New Community at Site 5 o 30 kilometres road from barge to community o New homes, health clinic, water and sewage treatment plants o Community built on higher land o Power lines run from previous community o Existing community decommissioned o All improvements from report apply o Transfer of trailers and portable facilities (police station, etc.).	o Adjacent to traditional lands o Next to Albany River o New community o Phased in means minimum disruption o Short-term employment opportunities for community members.	o Spring flooding could isolate community o No long-term economic developments o Lack of youth education, training or post-secondary education o No long-term employment opportunities o River is too dry in summer and fall o Vulnerability to the effects of climate change

		○ Climate change impacts forest fires, insects, diseases and will affect traditional hunting and fishing.
Option-4: Outskirts of Timmins, Ontario ○ Up highway 655 ○ 15 minutes to regional hospital, high school, police, fire and ambulance services ○ Port of regional retail shopping centres ○ Organized recreation facilities and services ○ Large job market and opportunities for training ○ New reserve ○ New homes and municipal services ○ Independent distinct community ○ Keep traditional lands on Albany River and across old Kashechewan for seasonal use only ○ Maintain landing strip and seasonal air access only ○ 15 minutes to Timmins airport ○ Keep economic benefits from development on traditional lands	○ Total solution to existing community problems and isolation ○ Open opportunities and activities for young people ○ Easier access to educational and training opportunities ○ Cost of living drastically reduced ○ Access to train ○ Can go blueberry picking ○ Can go moose hunting	○ Seasonal access to traditional lands ○ Decommission existing community ○ Cultural identity and dislocation
Option-5: Smooth Rock Falls, Ontario ○ New community at Smooth Rock Falls ○ Immediate purchase of 100+ homes now on the market due to mill closure and start moving community ○ Eventually take over community with existing municipal services, hospital, arena, fire hall, and become a reserve ○ OPP station at community would provide policing ○ Maintain rights to traditional lands, seasonal facilities, with air access for community members ○ Community events, hunting, fishing on traditional lands ○ Economic benefits and revenue sharing from economic developments on traditional lands ○ Attend existing schools in Smooth Rock Falls ○ Attempt to acquire local timber rights and mill for future employment and economic autonomy	○ Immediate evacuation to permanent site ○ Use of existing community facilities ○ Potential industrial development ○ Highway accessible ○ Quick and permanent fix ○ Access to train ○ Can go blueberry picking ○ Can go moose hunting	○ No local industries or jobs ○ Still no access to post-secondary education ○ 68 miles from regional shopping ○ Some problems with other residents and reserve boundaries ○ Decommission old site for everything except airport and seasonal use

Appendix B. Qualitative Interview Guide.

Introduction: Hello, my name is Arshad Khalafzai, and I am a graduate student at the University of Alberta. As part of my Ph.D. research project, I am meeting community members to learn how residents of Kashechewan are affected by and respond to floods.

(Read the letter and ask participants to sign the consent form or record their verbal consent.)

Permission: Request for permission to digitally record the conversation.

Background Information:

1. How long have you lived in Kashechewan?
2. Do you have family members here?
3. What is your role/involvement in the community?
4. Can you please tell me your general thoughts about the community? Tell me about your favourite things while living in the community? Is it a close-knit community? Are there any problems in the community?
5. Do you think that the flood frequency (number of floods) has increased/will increase in future? If yes, then please tell me why and how (e.g., occurrence of flooding events more frequently).
6. Do you think that damages from flooding (flood losses) have increased/will increase in future? If yes, please tell me why and how (e.g., more damage/losses to the property, First Nation's community infrastructure, such as the dike).

Flood Impacts:

7. How have you and your family been affected by the flooding in Kashechewan?
    a) Has your home been affected by the flooding?
    b) Has your (or your family's) health and well-being been affected?
    c) Have the activities that you normally do (e.g., hunting, gathering, fishing, social activities) been affected?
    d) Has the flooding caused any financial impacts for you and your family?
8. How has the community been affected by the flooding?
    a) Economic impacts.

b) How has the flooding affected community infrastructure such as drinking tap-water water, electricity, or sewerage system?
c) Have the community building structures such as high and elementary school buildings, health clinic, sports arena, power grid station, grocery store, and telecommunication system been affected by the flooding?
d) Have you experienced any economic impacts from the flooding?
e) Have the floods affected your property such as households, vehicles, and other belongings?

Evacuation:

9. Please tell me have you and your family evacuated during flooding events. If yes, how many times? Which (years) flooding events?
10. Were you in the community or outside of Kashechewan (e.g., for hunting, gathering, fishing or any other business) at the time of issuance of evacuation warning?
11. Who issued the evacuation warning and how it was communicated to you and your family?
12. How did you feel when you were told that you had to leave your home and community? Did you have enough time to get ready to evacuate?

Questions for those who evacuated:

13. Were you able to take what you needed when you had to evacuate? (e.g., pets, clothes, pictures, important documents, sacred things).
14. Did you and your family get any help as you were preparing to leave? If yes, what?
15. Did everyone in the community want to leave? Why or why not?
16. Did you and your family stay together during the evacuation period? If not, why?
17. Can you please tell me about your evacuation experiences?

a) Where did you stay when you were evacuated? How was it?
b) How long were you evacuated?
c) How were the meals?
d) What did you do while you were there?
e) Were any other services provided for you or activities you engaged in?

f) Are there any positive or negative experiences that you remember from the evacuations?

g) How did you feel about being able to go home?

h) What did you and your family face (experience) when you returned home?

i) Was any assistance provided to you and your family after you returned home?

Emergency Preparedness and Coping Capacity (Resilience):

18. What helped you during the past and recent flood emergencies?
19. What sort of things helped you to cope with and recover from flood emergencies?
20. Who do you think were most affected by the flood emergencies and why?
21. How do you think that your community coped with flood emergencies and why?
22. Who (community members) do you think coped least and why?
23. Has the community become better, worse or same as a result of frequent flood emergencies?

Suggestions:

24. Is there anyone else you would like to recommend that I speak to concerning your community's flood experiences? Specifically, someone who may have had a different experience from your own.
25. Would you like a copy of the results once the study is completed?

Thank you again very much for participating in this interview. If you have any concerns or wish to get in contact with me, I can be reached at khalafza@ualberta.ca.

Appendix C-1. Participatory Flood Mapping Workshops Guide.

Specific Objective 1: To examine residents' observations on changes in the frequency and intensity of flooding and flooding risk.

1. What was happening with the river water flows levels, particularly during spring in 1950s, 1960s, 1970s, 1980s, 1990s, 2000-2010, and 2011-16?
2. Please tell me about the changes you have been observing on the land, in the local environment, landscape, river, and climate and weather during 1950s, 1960s, 1970s, 1980s, 1990s, 2000-2010 and 2011-16?
3. How have you dealt with changes in (on the land, local, environment, landscape, river, and climate and weather) and ecology, etc. and change in the spring flooding pattern?
4. How the community had been dealing with flooding in the past?
5. What changes have you observed in dealing with flooding in the past and presently?

Prompts

Question No.1. Environmental or Ecological

i. Are floods occurring every year or every second, third, fourth year or more?
ii. Are floods occurring more frequent than in the past (decadal)? If yes, why?
iii. How floods are occurring today as compared to flooding in the past? For example, flood occurrence 15-20 years and 25-35 years ago and so on.
iv. Are floods occurring more suddenly (rapid onset) with faster pace (speed) in recent years than in the past? For example, 10-20, 20-30, 30-40, 40-50, and over 50 years ago.
v. Is there more flood water in terms of quantity and height?
vi. Are flood waters affecting (covering) more area and land these days as compared to the past events? (10-20 and 20-30, 30-40, 40-50, and over 50 years ago).

Question # 2. Socioeconomic

i. Are there more losses and damages to houses and properties in recent years as compared to the past? For example, 25-40 years ago.

ii. Are you and your community being affected more frequently and severely due to floods in recent years as compared to the flooding in the past?

iii. Are you and the Kashechewan community facing more economic losses in recent years than in the past? For example, 10-20, 21-30, 31-40, and 41-50 years ago.

Anything would you like to add to what you have not shared already, for example, flooding stories and past flooding events, etc.

Appendix C-2. Flood Mapping Interview Guide.

Introduction: Hello, my name is Arshad Khalafzai, and I am a graduate student at the University of Alberta. As part of my PhD research project, I am meeting community members to learn how residents of Kashechewan are affected by and respond to floods.

*Read the introduction letter and ask participants to sign the consent form or record their verbal consent.

Permission: Request for permission to digitally record the conversation.

Changes in Albany River:

1. What changes have you observed that have been occurring in the Albany River? Such as
   a. In the river water levels.
   b. On the riverbanks?
   c. In the river width.
   d. In the riverbed.
   e. In the amount of sand/silt.
2. What changes have you observed that have been occurring on the land? How was it in the past during the 1960s, 1970s, 1980s, 1990s and so on.
   a. Kashechewan above the sea level?
   b. What type of land/topography was in the past?
   c. What type of changes you have observed that have occurred on the land in recent past and have been occurring presently?
   d. How has dike affected/or is affecting the Kashechewan topography?
   e. Do the area's topography and its nature make the area prone to flooding?
   f. Which areas are low lying in and around Kashechewan?
   g. Which are higher grounds in and around Kashechewan?
   h. How far and how much are safer/higher grounds?
3. How have/are the development activities affected/affecting the area's topography? Such as
   a. New housing and construction.
   b. The DeBeers Mining Company's activities.

c. Any other development activities.

4. Has there been erosion of land in the area, around the river, or the riverbanks?
   a. Erosion upriver and downriver.
   b. Gravel settlement upriver and downriver.
5. What changes have you observed in the creeks and/or tributaries that are around the Kashechewan community?
   a. Which creeks and/or tributaries in and around Kashechewan can contribute to spring flooding in the community?
   b. How much is the risk of flooding because of creeks and/or tributaries in and around Kashechewan?
6. Does the winter ice road have any negative impacts on the land and/or in the river?
   a. How the winter ice road is affected due to spring flooding or warming temperatures?
   b. Has the timespan of winter ice road affected by warming?
   c. What was the timespan of winter ice road in the past? Has it increased, decreased, or same?
7. Does Kashechewan experience/face the flooding risk/hazard in other seasons (e.g., summer)?
8. What changes have you observed in muskeg or wetland.

Suggestions:

Is there anyone else you would like to recommend that I speak to concerning your community's flood experiences? Specifically, someone who may have had a different observations, knowledge, and experience from your own.

Thank you again very much for participating in this interview. If you have any concerns or wish to get in contact with me, I can be reached at 780-243-6901 or khalafza@ualberta.ca

Prompts:

Onset of Flooding:

- Slow Onset: (i) Days, (ii) Week and (iii) More than Week, etc.
- Sudden: A few hours.

Speed of Flood Water and Ice (comparing the normal river flow):

- Fast flow of flood water and ice.

- Medium flow of flood water and ice.
- Slow-paced flow of flood water and ice.

Duration of Flooding:

- Time the river flow started (onset of flooding).
- Time the flooding ended (floodwater receded).

Extent of Flooding:

- The area that was under the floodwater.
- The area that directly and/or indirectly affected by the flooding in the past.

Direction of Flood Water and Ice:

- Floodwater inflow in Kashechewan.
- Floodwater outflow of Kashechewan.
- The areas in the community in which floodwater remains stagnant.

Flooding Water Height:

- In the community (within dike).
- Outside of the community (around the dike).

Base Maps for Flood Mapping Workshops:

- Map 1: Past flooding events that occurred in the past and the areas flooded in and around the community.
- Map 2: Ice breakup and ice jams sites that caused minor and/or major flooding events.
- Map 3: Relatively higher and safer ground on and off (near) the reserve territory.

On-site Walks/Walkthrough and Photography:

- Walkthrough flood mapping in the community (within the dike).
- Walkthrough flood mapping around the community (outside the dike).
- Walkthrough flood mapping around the airport, etc.

Appendix D. Survey Form: Perceived Adaptive Capacity.

1. How many years have you lived in Kashechewan? ☐

2. Do you have immediate family in Kashechewan? ☐ Yes ☐ No

3. Are you a member of any social group? ☐ Yes ☐ No

   If yes, type of social group ☐

4. On a scale from very high to very low, how do you rate the danger (risk) of flooding in Kashechewan? (Choose one only)

   ☐ Very High - 5 ☐ High - 4 ☐ Moderate - 3

   ☐ Low - 2 ☐ Very Low - 1 ☐ Not Sure - 0

5. Please rate how strongly you agree or disagree with each of these statements?

i) I can tell if there will be flooding in the next spring (anticipation of flooding).

☐ Strongly Agree - 5 ☐ Agree - 4 ☐ Neutral - 3

☐ Disagree - 2 ☐ Strongly Disagree - 1

ii) I can and will support myself, my family, and anyone who needs help (reciprocity).

☐ Strongly Agree - 5 ☐ Agree - 4 ☐ Neutral - 3

☐ Disagree - 2 ☐ Strongly Disagree - 1

iii) I will ask the community members for help if needed (expectation).

☐ Strongly Agree - 5 ☐ Agree - 4 ☐ Neutral - 3

☐ Disagree - 2 ☐ Strongly Disagree - 1

6. Can the risk of flooding be reduced in Kashechewan?

Yes - 3	Don't Know - 2	No - 1

7. In your view, the best solution to solve the flooding and evacuation problems is to… (Choose only one)

i) Relocate the community from existing site.
ii) Move community away from flood area while remaining on reserve & return after flood.
iii) Live with flooding while taking traditional methods and still be prepared.
iv) Change the existing practices keeping in view the level of floodwaters.
Other (please specify):

8. I will be willing to be relocated from Kashechewan due to flooding?

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

9. If you and your family would be willing to be relocated, please explain where (Select all that apply).

i) Close to the existing settlement (within 10 kilometres).
ii) Within Reserve but further away from the existing settlement (more than 10 kilometres).
iii) Outside Reserve but fairly close by (within 50 kilometres).
iv) Outside Reserve but (within 50 kilometres).
v) We are not willing to be relocated at all.

10. I am happy with the band helping me and my family during flooding and evacuations.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

11. I am happy with the federal government helping me and my family during flooding and evacuations.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

12. I am happy with the information provided by the band on flooding and evacuation.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

13. I am happy with the health services provided by the Health Clinic in Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

14. I am happy with the education provided by the schools in Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

15. I am happy with the safe tap water supplied by the water treatment plant in Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

16. The band involves me in solving the flooding and evacuation problems in Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

17. The band involves me in solving the flooding and evacuation problems in Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

18. I feel that the dike is helping a lot in protecting Kashechewan.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

19. I am aware of flood control programs by the federal government to protect Kashechewan.

Strongly Agree 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

20. I am using Cree traditional knowledge to reduce damage from flooding.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

21. I think that Cree traditional knowledge and practices are useful in reducing the flood losses.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

22. I use local FM Radio to get information on flooding and evacuation.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

23. I use social media platform to get information on flooding and evacuation.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

24. I have the ability to quickly recover from flooding and evacuation losses.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

25. I am prepared for future flooding and evacuation.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

26. Flooding experiences and stories helped better prepare me and my family to reduce losses.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

27. I have become better as a result of risk of flooding and evacuation every year.

Strongly Agree - 5	Agree - 4	Neutral - 3
Disagree - 2	Strongly Disagree - 1	

28. Sex/Gender

Male	Female

29. Marital Status

Married	Single	Common Law	Widow/Separated

30. Age. _____ years.

31. Education Level

None	Grade 1-9	Grade 10 - 12	Undergrad & above

32. Employment Status

Employed	Unemployed

33. Occupation

34. Family Size

35. No. of Children under 14 years of age in your family

36. No. of Elders over 65 years of age in your family

37. Family Income Level Per Year

Up to 10K	10K – 30K	30K – 50K	50,000 & above

38. Band Membership

Yes	No

Appendix E. Ethics Approval by Research Ethics Board, University of Alberta.

7/27/2016
https://remo.ualberta.ca/REMO/Doc/0/7FSHRMQOVU8KN0F66G2TRJ0EC8/fromString.html

Notification of Approval

Date: July 14, 2016

Study ID: Pro00065168

Principal Investigator: Muhammad Arshad Khalafzai

Study Supervisor: Tara McGee

Study Title: **Flooding hazard and remote First Nations communities: The case of Kashechewan, northern Ontario.**

Approval Expiry Date: Thursday, July 13, 2017

Approval Data: July 14, 2016

Thank you for submitting the above study to the Research Ethics Board 1. Your application has been reviewed and approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Anne Malena, PhD

Chair, Research Ethics Board 1

Note: This correspondence includes an electronic signature (validation and approval via an online system).

https://remo.ualberta.ca/REMO/Doc/0/7FSHRMQOVU8KN0F66G2TRJ0EC8/fromString.html

Appendix F. Consent Form for Participation.

Consent Form

Please check the circle beside each statement if you agree with it and sign your consent at the bottom.

- o I will be interviewed by the research himself and that no one else will be present except for the community research assistant.
- o I am aware that the researcher will ask about my perspectives on how the community was affected by and responded to flooding.
- o I am also aware that the researcher will ask me about flooding evacuation(s) and flooding adaptation.
- o The researcher has answered my questions about this study.
- o It has been explained to me that my participation is voluntary.
- o I am free to withdraw from this study until December 31, 2016.
- o I am under no obligation to answer any questions that I do not feel comfortable with.
- o I may refuse to disclose any information that I do not want to.
- o I am aware that the conversation will be audio recorded.
- o I understand that the researcher will keep information gathered during the meeting confidential.
- o I understand that the researcher and his supervisor may use information (collected through interviews and survey) and/or short quotes from this interview/survey, but that no information on my identity will be released unless I give permission to use my name.

I have been informed by the researcher:

- o That only the researcher and his Ph.D. supervisor Dr. Tara McGee will have access to the data during this project,
- o That after completion of this research, Dr. McGee will be the only person who would have access to the data for 20 years, and
- o That Dr. McGee will store the data in a locked filing cabinet.

I have also been informed by the researcher that the data and information will be kept for potential future uses with a possibility that it may be needed:

- By the Kashechewan First Nation/Band Officials,
- By Dr. McGee and her future graduate students for research, and
- By the researcher for potential future research project.

The researcher has also informed me that only Dr. Tara McGee will have control over the data and information. Moreover, the researcher has explained to me that if someone else wants to work with the data and information, he/she will have to get permission from the Kashechewan First Nation as well as obtain formal approval from the Research Ethics Office (REO) at the University of Alberta.

Name of participant: _____

Signature of participant: _____ **Date:** _____

Please select one of the following statements which you wish to choose in regard to identification of your name.

- I Do Not grant permission for my name to be identified or disclosed with the information that I have provided/am providing during the interview.
- I do grant permission for my name to be identified or disclosed with the information that I have provided/am providing during the interview.

Signature of participant: _____ **Date:** _____

Name of researcher: _____

Signature of researcher: _____ **Date:** _____

Appendix G. Letter to Chief and Council.

To: Chief Mr. Leo Friday and Council

Kashechewan First Nations, Northern Ontario

My name is Arshad Khalafzai. I am a PhD student at the University of Alberta, Department of Earth and Atmospherics Sciences, Human Geography Program. Professor Dr. Tara McGee is my supervisor.

The research I am interested in is flooding impacts on Kashechewan People. I would like to study how people are affected by and respond to the increasing frequency and intensity of flooding events currently and in future, including how traditional knowledge is used for flood adaptation. My research will also look at how Kashechewan People perceive flood and flood hazard risk. In this regard, I would like to examine people's flood adaptation practices, presently and in the future. My research will also look at what experiences of flood and flood evacuation people have. Furthermore, I will study what contribution traditional knowledge can make to adapt to floods. At this point, it is important to mention that the research will only start once I have arranged funding for my fieldwork.

I plan to visit Kashechewan as early as I could to meet with Chief and Council members and community elders. The purpose of my initial visit will be to discuss and plan the research process. The research process and design will be developed with your input and guidance including framing of research question, formulating aim and objectives, devising research methods and techniques. The findings of this study will help for present and future adaptation of the community to the impacts of flooding. After completion of the research, results will be presented to the Chief and Council and to the larger community of Kashechewan.

I thank you in advance for your interest and seek your support for this research. My personal aim for this research is that it is meaningful and useful for Kashechewan People.

The plan for this study is being reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta. For questions regarding participant rights and ethical conduct of research, the Research Ethics Office can be contacted at (780) 492-2615.

Dr. Tara McGee, supervisor can be reached at:

Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, Alberta T6E 2E3 ~ Email: tmcgee@ualberta.ca

Meegwich,

Muhammad-Arshad K. Khalafzai
PhD Student,
Email: khalafza@ualberta.ca

Appendix H-1. Friedman's ANOVA (Related Samples) Mean Ranks.

Determinant/ Indicator	Mean Rank	Determinant/ Indicator	Mean Rank	Socio-Cognitive Factor/Variables	Mean Rank
SOC:		**HUC:**		**PCP:**	
RCP	2.91	AWA	2.53	FRP	1.83
EPT	2.84	CTK	2.36	FRR	1.89
PDB	2.13	OTK	2.53	PPD	3.13
PDG	2.12	FMI	3.98	UTK	3.15
		SMI	2.61		
GOV:		**OTH:**			
HEC	3.53	CAA	2.81		
EDU	3.29	CAO	4.51		
WAT	2.58	PRP	4.05		
SUB	4.02	PER	2.34		
SUG	3.72	FLX	3.32		
BIN	3.86	EXP	3.97		

ABBREVIATIONS:

Social Capital (SOC): RCP = Reciprocity, EXP = Expectation, PDB = Participation in Decision-making (Band), and PDG = Participation in Decision-making (Govt).

Human Capital (HUC): AWA = Awareness, CTK = Cee Traditional Knowledge, OTK = Other Knowledge, SMI = Social Media Information, and FMI = Local FM Radio Information.

Governance (GOV): HEC = Healthcare, EDU = Education, WAT = Safe Tap-Water, SUB = Support Provided by Band, SUG = Support Provided by Govt, and BIN = Information Provided by Band.

Other Determinants (OTH): CAA = Anticipation, CAM = Migration/Organization, FLX = Flexibility, PER = Personal Resilience, PRP = Preparedness, and EXP = Experience.

Perception Factor (PCP): FRP = Flood Risk Perception, FRR = Flood Risk Reduction, PPD = Perception of Protection from Dike Failure, UTK = Usefulness and Traditional Knowledge

Appendix H-2. Friedman's ANOVA (Related Samples) Paired Combinations.

Determinant / Indicator	Standardized Test Statistic	Significance	Adjusted Significance	Determinant Indicator	Standardized Test Statistic	Significance	Adjusted Significance
SOC:				**HUC:**			
RCP – EPT	**0.346**	**0.729**	**1.000**	**AWA – CTK**	**0.707**	**0.480**	**1.000**
RCP – PDB	3.782	0.000	0.001	**AWA – OTK**	**0.000**	**1.000**	**1.000**
RCP – PDG	4.128	0.000	0.000	AWA – FMI	- 5.152	0.000	0.000
EPT – PDB	3.724	0.000	0.001	AWA – SMI	- 4.573	0.000	0.000
EPT – PDG	4.070	0.000	0.000	**CTK – OTK**	**- 0.707**	**0.480**	**1.000**
PDB – PDG	**0.058**	**0.958**	**1.000**	CTK – FMI	- 6.859	0.000	0.000
				CTK – SMI	- 5.280	0.000	0.000
				OTK – FMI	- 6.154	0.000	0.000
				OTK – SMI	- 4.573	0.000	0.000
				FMI – SMI	**1.579**	**0.114**	**1.000**
GOV:				**OTH:**			
HEC – EDU	**0.857**	**0.392**	**1.000**	CAA – CAO	- 6.096	0.000	0.000
HEC – WAT	3.386	0.001	0.011	CAA – PRP	- 4.462	0.000	0.000
HEC – SUB	**1.753**	**0.080**	**1.000**	**CAA – PER**	**1.653**	**0.098**	**1.000**
HEC – SUG	**0.697**	**0.486**	**1.000**	**CAA – FLX**	**- 1.853**	**0.064**	**0.0959**
HEC – BIN	**1.195**	**0.232**	**1.000**	CAA – EXP	- 4.183	0.000	**0.000**
EDU – WAT	**- 2.530**	**0.011**	**0.171**	**CAO – PRP**	**- 1.633**	**0.102**	**1.000**
EDU – SUB	**2.610**	**0.009**	**0.136**	CAO – PER	- 7.749	0.000	0.000
EDU – SUG	**1.554**	**0.120**	**1.000**	CAO – FLX	- 4.243	0.000	0.000
EDU – BIN	**2.052**	**0.040**	**0.603**	**CAO – EXP**	**- 1.912**	**0.056**	**0.837**
WAT – SUB	**2.610**	**0.009**	**0.136**	PRP – PER	- 6.116	0.000	0.000
WAT – SUG	4.084	0.000	0.001	**PRP – FLX**	**2.610**	**0.009**	**0.136**
WAT – BIN	4.582	0.000	0.000	**PRP – EXP**	**0.279**	**0.780**	**1.000**
SUB – SUG	**1.056**	**0.291**	**1.000**	PER – FLX	- 3.506	0.000	0.007
SUB – BIN	**0.558**	**0.557**	**1.000**	PER – EXP	- 5.837	0.000	0.000
SUG – BIN	**- 0.498**	**0.618**	**1.000**	**FLX – EXP**	**2.331**	**0.020**	**0.297**

Social Capital (SOC): RCP = Reciprocity, EXP = Expectation, PDB = Participation in Decision-making (Band), and PDG = Participation in Decision-making (Govt).

Human Capital (HUC): AWA = Awareness, CTK = Cee Traditional Knowledge, OTK = Other Knowledge, SMI = Social Media Information, and FMI = Local FM Radio Information.

Governance (GOV): HEC = Healthcare, EDU = Education, WAT = Safe Tap-Water, SUB = Support Provided by Band, SUG = Support Provided by Govt, and BIN = Information Provided by Band.

Other Determinants (OTH): CAA = Anticipation, CAM = Migration/Organization, FLX = Flexibility, PER = Personal Resilience, PRP = Preparedness, and EXP = Experience.

Appendix I. Ten Large Laminated Posters Gifted to the Community High School.

Poster 1.

Kashechewan First Nation: Fort Albany Reserve 67 Height (Elevation) in Meters from Sea-Level

Words of an Elder

"For the longest time, this place hasn't been the best due to the lack of functional waterways. So, this place has been wet for way too long".

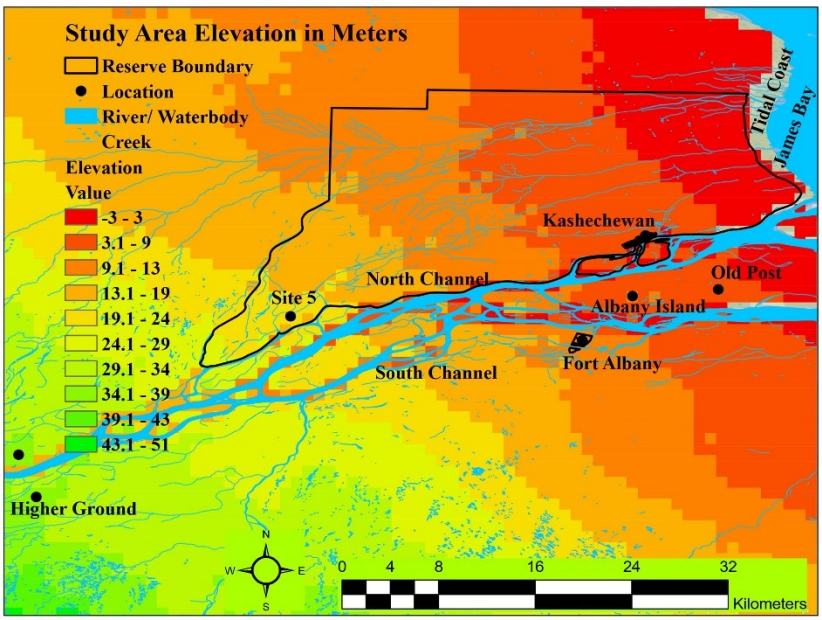
(Kenneth Hughie)

Additional Information

The landscape of southwestern James Bay region is muskeg, peat swamp, soft and wetland. Mostly, the reserve territory is low-lying and at the risk of spring flooding. Most of the sea coastline (3-5 kilometers inland) is tidal, mudflat, and below sea-level. Kashechewan is only a few feet higher than the Albany River and 27 feet above sea level. The reserve territory's height (elevation) decreases as it gets closer to James Bay and the land is less muskeg while moving away from the bay.

According to Elders, Kashechewan falls under the government declared flood zone. The relatively higher and safer ground (Site 5, which has about 24 meters height) on the reserve territory is about 30 kilometers upriver and 3 kilometers inland. This map highlights the elevation (height) of Kashechewan and focuses on the reserve territory. Most of the reserve territory is at risk of flooding. Kashechewan is at **very high risk** of flooding.

Low-Lying Flood-Prone and Muskeg Area



Poster 2.

Observations of Kashechewan Elders on Changing Climate and Weather

Words of Community Leaders

"The [increased] flow has something to do with the water the break up why lots of water all of sudden when they [community] don't expect the high waters in the springtime. In the past, we never used to experience or heard of the flood before [1976] in this community. They [community] think it's something to do with climate change. You tend to see something is coming, and all of a sudden it's not, and sometimes you don't see something that's coming, and all of a sudden it is. That's how sneaky the weather is right now."

(Chief Leo Friday)

Chief Leo Friday

"The winters are getting milder; the winters are getting shorter. Climate change is not something that's gonna happen. It's happening it's been happening for a while now. Mother Nature is changing. They [Elders] observe the winter. And they also observe the temperature during the winter time, and how much snow. The less snow, the less blanket, so the frost goes deeper. The more snow, the frost is not as thick. So, they observe these things, and they also look at the muskeg how much water is out in the muskeg."

(Grand Chief Jonathan Solomon)

Grand Chief Jonathan Solomon

Additional Information

Elders say that winter used to be colder and longer and has now been reduced by up to two weeks, starting later in the 3rd or 4th week of November, because of climate change. Elders also say that 15 to 20 years ago, snowfall would occur by mid- or sometimes early October and would be up to the knees by mid-November. That no longer happens. About 20 years ago, by the end of October or early November, Kashechewan people would skate on the frozen river and go out on the land to camps for hunting and harvest the hunted meat as traditional food.

For the past few decades, there is an early spring and snowmelt. Spring is two to three weeks shorter. Kashechewan hunters used to go out hunting and would stay on their camping grounds until early June. Now, they return earlier in April because of the early ice breakup and the risk of spring flooding. The hunting pattern of hunters also has changed because of warmer weather, which causes an earlier spring ice breakup and has increased the risk of flooding. Nowadays, hunters cannot stay longer on the land and return to Kashechewan in mid-April because of the compulsory precautionary evacuation every year during the spring season.

Poster 3.

Observations of Kashechewan Elders on Changing Climate and Weather

Words of Elders

"The weather is getting warmer, the winter's getting shorter. Because, when I'm growing up, this time of year should be skidoo down the river, go to my camp. The river would be frozen by now [in November]."
(An Elder)

"There's hardly anybody that stays in the bush for two months, they only stay, like a week or two."
(Oliver Wesley)

"Way back, we used to hunt late April. Now, the geese start arriving late March. It [flood risk] affects the hunting because of early spring, early warmth."
(Edward Sutherland)

"The increased [river water] flow has to do with snow lots of snow and warm weather and when it rains. That's what triggers [causes] lots of water [flooding]."
(Oliver Wesley)

Additional Information

In recent years, the increased temperatures together with too much rainfall in the spring season have caused a quick snowmelt. As a result, a large amount of river water flows downriver. For example, too much snowfall and a warm weather that remained for several days caused a major spring flood in 1976 in Kashechewan.

Elders think that warmer weather is the main cause of spring flooding in Kashechewan. Heavy rain and snowfall that continues for days also increase the probability of spring flooding. Increased temperatures cause earlier snowmelt in the spring season and affect the timing and amount of river water flows.

The increased temperature causes the sudden snowmelt, especially when there is a large amount of snow and results in spring flooding. Notably, the increased temperatures cause spring flooding more than rainfall during spring.

Photos taken in mid-November 2015 in Kashechewan highlight the changes occurring on the land (ecological) and pattern of migratory birds.

Vegetation was not observed in Kashechewan in the past as shown in the photo taken during mid-November.

Migration pattern of migratory birds also has changed. The migratory birds presence in Kashechewan during mid-November was not observed in the past.

Other species were not observed in the area a few decades ago. For example, the specie shown in this photo was seen in Kashechewan during mid-November,

Poster 4.

Observations of Kashechewan Elders on Changing Climate and Weather

Words of Elders

"The weather is getting warmer, the winter's getting shorter. Because, when I'm growing up, this time of year should be skidoo down the river, go to my camp. The river would be frozen by now [November]."
(An Elder)

From right to left: Elders Philip Goodwin, William Sutherland, Sinclair Wesley (Sr.), Oliver Wesley and Edward Sutherland busy in a flood mapping workshop held in November 2016.

"There's hardly anybody that stay[s] in the bush for [hunting] two months, they only stay [now], like a week or two."
(Oliver Wesley)

"Way back, we used to hunt late April. Now, the geese start arriving late March. It affects the hunting because of early spring, early warmth".
(Edward Sutherland)

Additional Information

Kashechewan elders observe changes in the weather conditions (hydro-meteorological changes) including the amount of snow (on the reserve territory and far upriver), ice thickness, and freeze-up conditions during winter, and river water flows, temperature, and rain and snowfall in spring. Their observations and forecasting these hydro-meteorological factors help them to determine the likelihood of a flood. If the water flow at the Hat Island gauging station (150 kilometers upriver) is 5,000 cubic meters per second or more; then Chief and Council declare an emergency in Kashechewan for evacuation because of spring flooding risk.

An Elder who has been Flood Watch Coordinator explained that the band started aerial monitoring of the river ice breakup and ice jams using a helicopter after the 2006 flooding. He also said that he had not observed any major change in the river water flows during this period.

Unlike in the past, it is getting harder for Elders to predict the weather conditions in the southwestern James Bay region. The unpredictability, for example, the sudden increase in temperature or heavy rain or snowfall or a combination of both during the spring season results in ice breakup and increases the flood risk. The increased risk of spring flooding forces hunters to return to Kashechewan from their camps and hunting grounds for expected evacuation.

Poster 5.

Cree Traditional Knowledge

Elders say that the Kashechewan community is losing Cree traditional knowledge. For example, an elder explained that traditional flood preparedness practices such as preparing canoes with necessary food and other supplies and preparing a camp at a safer place for temporary relocation to avoid spring flooding impacts are disappearing because of reliance on the ring-shaped dyke wall.

Words of Community Leaders

"Sometimes I think we seem to put the traditional knowledge aside, but it is very important. Like, the observation that my grandfather used: traditional knowledge is something that's very valuable, even with climate change and how do you adapt to that? What we used to do prior to 1976 we used to get ready. I remember my grandfather, he would go up the airport road, and he used to build a pad over there [with] branches, trees up to five/six feet, and he would put a tent on top of that. So when the spring came, that's where he would go and live on top of that pad instead of staying here. You were more prepared. But I think, you know, okay, we got a dyke around us, we don't have to worry."

(Grand Chief Jonathan Solomon)

November 2015: Photo with Kashechewan Chief and Council after a meeting.

Kashechewan Elders busy in a flood mapping workshop and on-site walk and photography conducted in November-December 2016.

"We have to train our young people, but we don't have that anymore. Like, the harmony of the land, the importance of the land, the spiritual connection of the land, and those things that we have to teach our people, and especially preparing our meat. How to make it last long for the summer. That's we can't do that anymore. That's how much interference we have from the flood and the river system that we have, it's [getting] really hard."

(Chief Leo Friday)

Poster 6.

Ice Breakup in Albany River

Words of Elders

"The spring breakups are almost the same every year but, sometimes [happen] more sooner now. [With] the slow breakup, we don't expect any flooding, because [ice] just moves, kilometre-by-kilometre. But the blockage is different where the ice jams up. Yeah, the regular breakup doesn't create any blockage. You [Muhammad Arshad Khalafzai] have to be an "Indian" to understand [spring flooding]." **(William Sutherland)**

"When there's breakup in those three [sub]rivers [Mammamattawa, Ogoki, and Kenogami] at the same time, that's a high risk of flooding. [If] it's only one breakup, and then another breakup comes, it's not noticeable, the ice is thinner. It's one at a time that's normal." **(Oliver Wesley)**

"They [Elders] observe the winter – how it was at this time of the year. If it's freezing over – did we have high water or was it low? And they also observe the temperature during the winter time, and how much snow. The less snow, the less blanket, so the frost goes deeper. The more snow, the frost doesn't – the ice is not as thick – with less blanket of snow. So, they observe these things, you know, and they also looked at the muskeg – how much water is out in the muskeg." **(Grand Chief Jonathan Solomon)**

The Albany River Spring Ice Breakup 2017

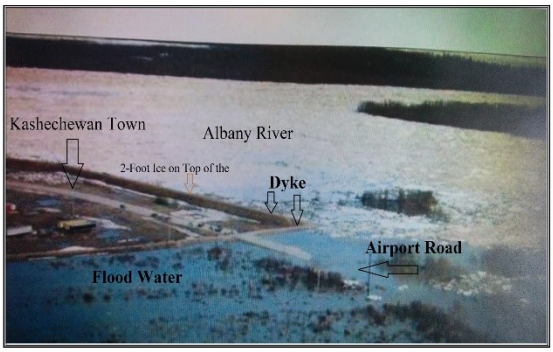


Photo of 2006 Spring Flooding in Kashechewan: A very close call for the community

After the 2006 flooding and engineers' report about dyke wall deficiencies, Elders started monitoring the river ice breakup and ice jams using a helicopter. Elders say that they had not observed any major changes in the river ice breakup. However, the ice breakup events that occur at different locations in the Albany River system far upriver increase the risk of ice jams both upriver and downriver. Elders also say that the ice breakup process used to take a longer time because of colder weather and that in the past the water and ice flow continued without frequent ice jams.

Poster 7.

Ice Jams in Albany River

Words of Elders

"Nobody knows where ice jams where it's gonna happen, but we know a few places that always happens, but no one is sure where [ice jams] gonna happen exactly." **(William Sutherland)**

"See that curve there [four to five kilometers downriver]? That's where it jammed downstream when the 1976 flooding occurred. That's where it jammed, the ice, and that water built up it accumulated the water level, and that's how we got flooded because of the ice jam."

(Oliver Wesley)

The Albany River Spring Ice Breakup 2018

"If [ice] breakup with snow in it, there will be ice jams because ice forms a wet snow they stick [together] because of wet snow."

(An Elder)

Additional Information

Elders say that the warmer weather is causing more frequent ice jams, and the wet snow on ice adds to the ice jamming process. They also say that predicting ice jams is difficult because an ice jam can occur anywhere in the Albany River and creeks. However, there are a few typical ice jams sites in the upriver and downriver, particularly near the islands and the location where Albany River divides (called confluence point) into the North and South Channels. The ice jams include Kaapimaapiskat and the Fafarid Island located upriver near the confluence point and downriver at the river's mouth (near the James Bay), respectively.

The recent noticeable changes Elders have observed include the more frequent occurrence of ice jams and increased number of ice jamming sites because of warmer weather and the changing climate. The warmer spring season has also contributed (added) to the jams unpredictability.

Poster 8.

312 Kilometers Long Ice Road Connecting Kashechewan with Other First Nations

The ice bridges and ice ramps of the ice road built for crossing the Albany River and creeks also cause ice jams.

Words of Elders

"They [Winter Road Company] build ice bridges, ice crossing, and as they build [ice bridge], it causes a dam effect, [because] it dries up downstream, and floods upstream about 48 inches each year." **(Edward Sutherland)**

"When they [Winter Road Company] built the ice bridge our river overflows because of the ice bridge. The river and creeks in our camping area overflows. One time we were almost flooded, near our campsite, where the chopper land, 100-150 yards away. The flood came this way. It never happened in the past." **(A Band Member)**

Additional Information

The downriver ice bridge caused an ice jam and resulted in the 2006 flooding, with a cost of $20.2 million. Every spring, several holes are drilled in the 6-foot to 7-foot thick ice bridge to prevent ice jams. However, the cold weather blocks the holes and results in ice jamming. ***"The drilled holes don't help,"*** says Elder William Sutherland, ***"and since then, we have problems with the flooding. That's where the ice stops downriver from Kashechewan and that's where it creates flooding."***

312-KM Ice Road Connecting First Nations Communities of James Bay

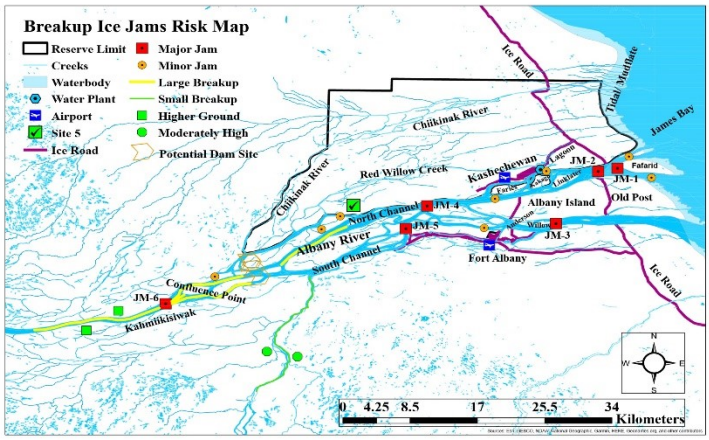
Source: Winter Road Company (http://www.winterroadcompany.ca)

The warming weather has reduced the span and safety of the 312-kilometer-long ice road. The duration of ice road was about three months during winter from January to March because the winter season used to be longer in the past. As a result, the ice road would open a few weeks earlier and would last longer. An experienced ice road construction and maintenance worker said, "the first time [16 March 2013] I experienced when the road was all gone, it was all melted". He also says that as a result of global warming traveling to the neighboring First Nations communities in the area is becoming limited with the reduced safety level of the ice road.

Poster 9.

Kashechewan First Nation Spring (Ice Break and ice Jams) Flooding Features

This map highlights the flooding features of Kashechewan identified by Elders based on their traditional and local spatial knowledge about the reserve territory. The map shows ice breakup and ice jams and higher ground on-reserve and off-reserve territories. There are 6 major typical ice jams sites, shown as JM-1 to JM-6. The 3 downriver ice jams, JM-1 to JM-3, are dangerous and can cause the sudden and rapid flooding reaching several meters high, and leaving little or no time to evacuate. The ice jams JM-1 and JM-2, located 4-5 kilometers downriver in the North Channel, seriously threaten Kashechewan. The ice jam JM-1, near Fafarid Island, caused the 1976 and 1985 floods. The jam JM-2 is at the river crossing and caused the 2006 flooding because the holes drilled in the 6-7 feet thick ice bridge froze and blocked the river flow. The increased river flow caused by JM-2 in 2006 pushed the ice (2 feet higher) on top of the dyke wall. Within a few hours, the airport runway and the airport road were flooded with 2 feet and 5 feet of floodwater, respectively. The entire community was evacuated by helicopters.



The ice jam JM-3 in the South Channel causes flooding in Fort Albany and can also be dangerous for Kashechewan by blocking and reversing the river flow and then diverting it into the North Channel. The downriver ice jams are more dangerous than the upriver ice jams; when the upriver ice jams occur, Kashechewan residents get many days to evacuate. The minor ice jams upriver and downriver do not cause flooding. But they contribute to the major ice jam's flooding. Several islands in the two channels can cause ice jams and add to flooding. The downriver islands of Fafarid, Linklater, Kakago, and Faries in the North Channel, and Willow and Anderson in the South Channel can contribute to the ice jams JM-1 and JM-2, and JM-3, respectively. The Albany Island causes the ice jam JM-3. The upriver islands near the location where the river divides into 2 channels (called Kahmiikisiwak) causes the ice jam JM-6. The off-reserve higher ground ('Kahmiikisiwak') has a height of 115-140 feet, which is over 100 feet higher than Kashechewan located about 55 kilometers upriver. Another off-reserve relatively higher ground located about 40 kilometers in the southwest of Kashechewan has a height of around 100 feet. Constructing a dam and moving the ice road upriver can prevent or reduce ice jams.

Poster 10.

Social and Economic Implications and Relocation of Kashechewan to Site 5

Words of Elders

"The community is growing, and the government doesn't want to build more houses, and the people that are in the houses are overcrowded and I think it would be wiser to start thinking about the development of the new community and start implementing it."
(Chief Leo Friday)

"I'm hoping the government will give us new roads, a new water sewer system and new housing, new school, new hospital for our people. I know they spend millions and millions of dollars on evacuations, and if you add that up for a long time, it's cheaper for us to move upriver."
(William Sutherland)

"But the reality is, someday it's gonna be flooding, that's why they [community] have to relocate, regardless. We need to convince the government that we need to relocate. It's just not pleasant to be in [Kashechewan] because you're displaced. You're just stressed out, and you can't enjoy life that's what it is. It [flooding] happened already a few times, and they [government] weren't convinced. I think they want us to die. You know what, that's in back of our mind, that's I think they're trying to, like, get rid of Indian problem. That stays in our mind that mentality still exists today."
(Oliver Wesley)

"I think relocation is not gonna happen tomorrow. It's gonna be years. It's gonna be a long process. The studies that need to be done, tendering, engineering, and everything. They're not gonna finish the whole process within three years. Let's not worry about the infrastructure, the housing they can be replaced but a loss of life cannot be replaced."
(Grand Chief Jonathan Solomon)

Additional Information

Before the early 1920s, the Cree of the Hudson Bay and James Bay Lowland did not have permanent settlements and dealt with spring floods by moving to higher ground in the spring season. The permanent settlements increased their exposure to the flood risk. Elders say that their community leaders agreed to relocate from Old Post, Albany Island to Kashechewan in 1957 to gain the treaty benefits that the government had promised along with the on-reserve resettlement. Elders say that they must relocate.

In the October 2016 study conducted by the First Nation, 89 percent band members voted in favor of relocation from Kashechewan to Site 5 because they do not want to lose their ancestral lands and want to live on the reserve territory.

MoU (Memorandum of Understanding) signed between Chief and Council Kashechewan and the Canadian Government to explore options for relocation of Kashechewan to a safer site.