Inuit Qaujimajatuqangit in Community-based Monitoring of Ecological Changes in *Igluligaarjuk* (Chesterfield Inlet)

by

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A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements of the degree of

Master of Environment

Department of Environment of Geography

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University of Manitoba

Winnipeg, Manitoba

Abstract

Studies have shown that climate change and other anthropogenic activities like infrastructure developments, shipping, and mining have changed the Arctic ecosystem. Such changes have cumulative impacts on the social and ecological system related to the Inuit. Indigenous Knowledge (IK) and Community-based monitoring (CBM) are crucial in monitoring the changes and their impacts. This research identifies the ecological changes and their impacts on the Chesterfield community. It documents how the community uses Inuit Qaujimajatuqangit (IQ) indicators to monitor the changes. Next, it discusses the challenges and implications of knowledge integration during CBM. Community-based qualitative research was used as a methodology including interviews with fifteen Inuit hunters, Elders, and knowledge holders, and two workshops. Recommendations from Indigenous research frameworks and tools were incorporated throughout the research. This research finds that the community has observed changes in sea ice, rivers, lakes, land, animals, and marine ecosystems. Climate change, shipping, and mining in Baker Lake are the primary reasons for the changes. These stressors have impacted the social, cultural, economic, and ecological aspects of the community. Some of these impacts (for example, a decrease in the abundance of seals) are tangible whereas others (for example, impact on knowledge) are intangible. Changes in the sea ice and increasing shipping are the main concerns of the community.

Keywords: Community-based monitoring, Inuit Qaujimajatuqangit, climate change, shipping, mining, cumulative impacts

Acknowledgment

I would like to thank all the community members of Chesterfield Inlet, the Aqigiq Hunter and Trapper Organization (HTO), the Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society), and officials of Hamlet of Chesterfield Inlet who supported this research through coordination and involvement. I am thankful to those Elders, hunters, and knowledge holders who participated in this research through interviews and workshops, without whom it would be impossible to carry out this project. I am grateful to Jason Ippiak who helped me throughout the research by taking me out on the lands, identifying and coordinating with interviewees, interpreting the interviews, and giving me opportunities to learn the Inuit ways. Thank you to Larry Jr Ittinuar for working with me as an Inuit researcher, coordinating interviewees, and helping to interview. I am also grateful to Simon Aggark for supporting and coordinating the interview participants. Thank you to Philippa Aggark for interpreting the interviews. I would like to thank Barney Aggark and David Kattegatsiak for their support throughout the research.

I am extremely thankful to my supervisor Dr. Nicole J. Wilson for your supervision, continuous support, suggestions, directions, and encouragement throughout this research project. I will forever be grateful for your guidance, mentorship, and funding for my master's program. My journey as a researcher at the University of Manitoba would not have been possible without you. I am thankful to my committee members, Dr. John Sinclair and Dr. Bruce Erickson. Your suggestions, guidance, and critiques helped me shape this research.

This research was funded by the GENICE II: Reimagining Monitored Natural Attenuation as an Oil Spill Response Tool in the Arctic Project, Genome Canada LSARP grant, the Social Science and Humanities Research Council Insight Development Grant (# 430-2021-00126), and Canada Research Chair (CRC) program.

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List of Abbreviations

CBM	Community-Based Monitoring
HTO	Hunters and Trappers Organization
IK	Indigenous Knowledge
IP	Indigenous People
IQ	Inuit Qaujimajatuqangit
KIA	Kivalliq Inuit Association
NLCA	Nunavut Land Claims Agreement
TK	Traditional Knowledge

Chapter I

1.1 Introduction

Community-based monitoring (CBM) activities are increasing in the Arctic to address environmental problems observed in the region (Hansen, 2018; Reed et al., 2020). The practice of integrated resource management between the local and various other institutions, including the government, which is a widely practiced type of CBM, has also increased in recent decades (Mantyka-Pringle et al., 2017a). Effectiveness of running in remote places, ability to run throughout all times of the year even during a crisis like a disease breakdown, use of "approaches of inclusive, enhancing self-determination and empowerment of Indigenous Peoples in environmental governance", creation of local opportunities (Mercer et al., 2023, p. 2), use of Indigenous Knowledge (IK), and contribution to "better-informed decisions" are some of the reasons behind the increase of CBM in the Arctic (Danielsen et al., 2021, p. x). CBM could be defined as the process where people, parties, and organizations work together to monitor, assess, and react to issues in the community (Whitelaw et al., 2003). CBM in Indigenous communities is centered around their traditional knowledge (TK) (Johnson et al., 2015).

The Arctic region has experienced rapid changes like increased temperature, declined sea ice, and changed ecological functions change driven by climate change (Gérin-Lajoie et al., 2018; Ndeloh Etiendem et al., 2020). Maritime activities in Canada started increasing when the whaling and fur trade started in the Canadian north. Military activities and exploration of mines in the Arctic region led to a significant increase in shipping (Lajeunesse & Lackenbauer, 2023). Today major portions of maritime activities in the Canadian Arctic are because of resource extraction and mining (Lasserre, 2023).

Along with the rapid increase in temperature, human-induced disturbances related to infrastructure development, mining, and extractions have severely impacted the ecosystem and disproportionately impacted the communities that rely on natural resources (Mantyka-Pringle et al., 2017a; Proverbs et al., 2020). The increasing shipping and its impacts are of increasing concern in Nunavut (Carter et al., 2019), and so is the impact of mining on the ecosystem (Bernauer, 2015). The natural resource-based livelihoods of the local communities are severely affected (Proverbs et al., 2020) through

the impacts on traditional harvesting, increased travel risk, and reduced access to traditional foods (Healey et al., 2011).

Inuit communities in the Arctic have been monitoring changes through their knowledge and observation. Inuit Knowledge or Inuit Qaujimajatuqangit (IQ) is a holistic body of knowledge that includes Inuit attitude, behavior, values, language, culture, knowledge, and way of life (Ikaaravik, 2018) which is not just knowledge of bio-physical resources (Karetak et al., 2017; Wilson et al., 2020), but a complete set of ideas, skills, knowledge, and observations gained by the Inuit (Henri & et al., 2020). IQ comprises a holistic sense of the ecosystem developed through intergenerational experiences using and preserving natural resources (Gearheard et al., 2010). Inuit use knowledge indicators to detect the changes and conditions (Berkes et al., 2007). Through their close relationship with the ecosystem, their experience, observation, and knowledge, they have an in-depth understanding of status, patterns, and change in nature making them day-to-day ecological monitors (Gill et al., 2011). Indigenous People (IP) through their observations, knowledge, and experience have helped them navigate a complex and ever-changing environment for millennia. However, their diagnoses of the ecological crises and their tradition of building a "self-determined future" have been challenged globally (McGregor et al., 2020, p. 36).

There is an increasing practice of linking IQ with scientific knowledge to address such negative impacts on the community and to make important decisions about environmental resources (Mantyka-Pringle et al., 2017a). Most impact assessments in the Arctic only examine ecological aspects without including social, economic, and cultural elements of the community, even though studies have pointed out this gap many times (Proverbs et al., 2020). Resource managers, government, and scientists repeatedly overlook intangible impacts on the community because of their compounded and cumulative nature (Turner et al., 2008). This adds significant damaging outcomes to the community. Some of the examples are "loss of identity, emotional and psychological losses, and cultural losses" (Turner et al., 2008). As ecological changes in the Arctic adversely affect Indigenous communities, it is essential to examine the cumulative impacts of anthropogenic stressors like resource development and human-triggered

changes like changes in climate, sea ice, and water on humans and the environment (Proverbs et al., 2020). Indigenous-led CBM programs however have the potential to support cumulative impact monitoring, knowledge preservation, and transmission to younger generations, and sustainably manage the environment through the promotion of Indigenous governance and self-determination (Reed et al., 2020). There is a need for further engagement on how CBM can support Indigenous self-determination in environmental management and decision-making (Wilson et al., 2023).

In partnership with Aqigiq Hunters and Trappers Organization (HTO) and The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society), I carried out community-based qualitative research to find answers to my research questions. I have divided my thesis into four chapters. Chapter II and Chapter III are formatted according to the format of possible journals for publication. Finally, the overall conclusion is presented in the last chapter.

1.2 Literature Review

1.2.1 Understanding Community-Based Monitoring

CMB involves careful and consistent observation of social and ecological changes, which involves a collaborative approach with the local community to document, analyze, and respond to particular aspects of the community (Johnson et al., 2015). CBM activities are increasing in the Arctic in response to the ecological crisis and the way to address environmental issues observed in the region (Hansen, 2018; Reed et al., 2020). The widespread practice of CBM and its success in achieving sustainable environmental management has replaced professionally driven environmental monitoring in the Arctic (Hansen, 2018).

CBM has the potential to expand the environmental knowledge of those involved, increase trust and integrity, and promote social bonding (Fernandez-Gimenez et al., 2008). It can also increase community participation in decision-making and the generated data can be used for future actions and resource management (Hansen, 2018). Despite depending on Western scientists who travel to Arctic regions only in favorable seasons and weather conditions, the CBM could run through the year, and all areas (Gill et al., 2011). Bringing different knowledge systems together during CBM is meant to direct innovative practices and foster the legitimacy of the process (Alexander et al., 2019).

Despite such opportunities, there are multiple challenges associated with CBM that have to be sorted out for the rightful implementation of such programs with Indigenous communities. Insufficient funds and resources at the community level is one of the reasons behind the inability of continuous data production in the Arctic region (Lamari et al., 2018). Political economy plays a significant role in shaping CBM. Like other environmental monitoring, funds for CBM programs generally come from corporations, academic organizations, and government bodies that have political interests at least at a certain level and would not fund the program without political or economic benefits from the region (Biber, 2013; Cohen et al., 2021). So many CBM programs are initiated not just because of community needs or requests (Cohen et al., 2021). The most important challenges in CBM are rooted in the problems and politics of linking and integrating IK and Western scientific knowledge systems (Armitage, 2005; Cohen et al., 2021).

1.2.2 Knowledge Extraction

Non-Indigenous researchers conducting research on or with IP often select inappropriate subjects unrelated to the community. As a result, they may ask the wrong questions and take data and knowledge without contributing to the Indigenous community or their research priorities (McGregor et al., 2018). The concept of "integrating" IK into practice is used as a form of extraction (Gaudry, 2011). Knowledge integration is "the desire to assimilate heterogeneous knowledge (via data, analysis, or claims) through processes of co-production" (Klenk & Meehan, 2015, p. 160). The extraction of knowledge has been a common phenomenon in Indigenous research (Gaudry, 2011). Western science tends to have a narrow view that fails to acknowledge Indigenous beliefs and values. As a result, understanding of IK can tend to be constrained in selective "data" (e.g., pre-set graphs, maps, and lines). Often, the final meaning deviates from the original view but is concluded in a way that knowledge holders view as such (Nadasdy, 1999, p. 15). IP have to change their opinions forcefully to fit the "institutions and practices of state management rather than to their own beliefs, values, and practice" (Nadasdy, 1999, p. 1).

1.2.3 Colonial form of research leading to distrust between knowledge holders

The next challenge is the distrust between the IK holders and Western science knowledge holders. Many scientists and managers think IK only existed in the past, is basic, and is outdated in the current scenario. They take it as just the strategy and political move adopted by IPs to claim control over natural resources (Nadasdy, 1999). Research has a negative colonial history which still exists in many forms in the Arctic (Yua et al., 2022). For instance, historical research in Inuit communities took IP as a sample for experiments and tests. Studies were done *on* them but never *with* them (Inuit Tapiriit Kanatami, 2018). This ignorance, denial, and historical wrongdoings in the name of research and knowledge integration on the IP has kept room for suspicion in Indigenous communities over Western science (Nadasdy, 1999).

1.2.4 Exclusion or denial of Indigenous worldviews

Indigenous worldviews are often excluded from extractive forms of IK research. According to Nadasdy (1999), western studies on the community focus on particular aspects that can be categorized, quantified, and analyzed. For example, individual species or specific components of an ecosystem like water, ice, forestry, or mining. However, IK is holistic, oral, and qualitative, gained through experience and survival over the generations, and is often not categorized based on Western scientific categories. Though acknowledging Indigenous worldviews and considering them in the decision-making process is a significant way to decolonize the historical relationship between Indigenous nations and settler colonizers, many Western science studies, even today, are interested only in those that can be conceptualized, modeled, or tested in western science process (Simpson, 2004). Integration in transdisciplinary research could be an epistemological barrier when multiple stakeholders involved in the CBM programs have different worldviews who might take the knowledge system differently (Klenk & Meehan, 2015).

The next problem lies in the denial of the IP's way of describing their knowledge and resources. Scientists often do not understand their language of knowledge expression, and they consider it useless or unacceptable (Whyte, 2018). For instance, IQ gained more acceptance in the academic community only when the knowledge aligned with academic language (e.g., stock, harvest) (Armitage, 2005). IP expresses their knowledge about the environment differently than the scientific community. For example, IK is embedded in their songs, stories, rituals, and cultural practices. Many observations are communicated through supernatural stories or spirituality in the non-human components of nature (Whyte, 2018). Thrupp (1989) gives an example of how Western science introduced a new term, "agroforestry" during the 1970s and 1980s to validate and accept the mixed cropping system practiced by farmers in Third World countries for millennia. IP in Yukon understand water as a living being and have a spiritual relationship with it whereas settlers and non-Indigenous resource managers take it just as a resource. The modern water ideology, which is an entirely different ontology than that of IP, "unsettles conventional water governance" (Wilson & Inkster, 2018, p. 518).

It is challenging to fit IK within collaborative management without scientizing them or without losing the value of such knowledge and removing it from the context (Parlee & D'Souza, 2019). Collaborative management of the environment is "a participatory decision-making process in which the management of a natural resource is shared between users and other actors, such as national, and subnational governments, Non-Governmental Organizations (NGOs), and/or local cooperatives" (Tagliari et al., 2021, p. 133). Environmental governance is "the set of rules, laws, policies, institutions, structures, networks and processes that shape the behavior of actors in the use of a natural resource" (Argente García et al., 2023, p. 2). Western science often "scientizes" the IK by evaluating it with Western experimental methodologies and "laboratory controlled trials" to legitimize it, because of which the IK may get ignored, displaced, and lose its importance (Thrupp, 1989, p. 19). Additionally, IK is mostly preserved and transmitted through generations by oral tradition. During the documentation, studies focusing on IK are often translated and documented in English within the written text using Western concepts and terminology. This Eurocentric way of defining IK principally contradicts Indigenous ideologies (Battiste & Youngblood, 2000). As a result, IK, including Inuit Qaujimajatuqangit (IQ), is often ignored (Armitage, 2005).

1.2.5 Power relations and decision making

While it may not be intentional, resource managers and colonial governments use the data to shift the power towards them and act as sole decision-makers (Nadasdy, 1999). Because of the use of such scientific instruments, methods, and theories, western scientific knowledge is prioritized and valued more, whereas IK, opposite to Western societies, is displaced, and ignored (Simpson, 2004; Thompson et al., 2020). This often puts managers and Western science at the center of power and resources to make decisions. IK can be integrated with Western scientific knowledge meaningfully only when the power of decision-making shifts towards IK holders (Nadasdy, 1999). IP rights to exercise self-determination are not recognized and are challenged, even in today's world (Murphy, 2019). Collaborative approaches to governance are increasingly being designed to bring the community into the decision-making process. However, analyses

have found that they tend "not to incorporate concepts related to Indigenous self-determination, nationhood, and inherent rights" (Von Der Porten et al., 2015, p. 136). They tend to position IP only as a stakeholder limiting their right to self-determination (Reed et al., 2020; Von Der Porten et al., 2015).

1.2.6 Indigenous Knowledge and Its Legitimacy

IK uses multiple diverse practices for resource management including "multiple species management, resource rotation, succession management, landscape patchiness management, and other ways of responding to and managing pulses and ecological surprises" (Berkes et al., 2000, p. 1251). It is holistic, refined through implementation and experiences, passed through multiple generations, adapted based on the time regime (Berkes et al., 2000), and holds a deeper, more context specific-knowledge about the changes on their lands than Western science (Mantyka-Pringle et al., 2017a). For instance, ninety-nine different words for different kinds of ice are used by people in Yupik people (Oozeva et al., 2004). IK is not just confined to the small local region, rather it has larger implications. Local-scale knowledge could be scaled up along with the IK of other surrounding communities to have larger regional-level implications (McDonald et al., 1997). The use of IK is growing because of the recognition of its contribution to managing varied ecological concerns including biodiversity, landscape, resources, and species management (Berkes et al., 2000).

Their knowledge is complementary to scientific and Western knowledge (Riedlinger & Berkes, 2001). IPs can and do monitor their environment as effectively as the Western scientific community (Dale & Beyeler, 2001) with less investment and increased community ownership (Thompson et al., 2020). Many studies suggest that data taken at the community level are as accurate as the data taken by trained researchers. However, such data still must be validated by scientific standards to be considered for decision-making. Communities in response are forced to produce data that could be validated by government actors who are in the power to make decisions (Cohen et al., 2021). Experiences, beliefs, and local ways of knowing are hardly prioritized as compared to data generated from scientific methodologies which could be presented in figures,

statically analyzed, or regionally implacable (Cohen et al., 2021). Since the eighteenth century, European colonization has advanced Western science as the only source of knowledge and means of social and economic development. It imposed the European knowledge system as the only valid knowledge (Orlove et al., 2022).

Some scholars argue that TK is not able to use "controlled experiments" and a quantitative approach however, there is no evidence to prove such. Instead, there are Indigenous practices across the world that use controlled experiments. There are also examples where quantitative analysis is used as part of Indigenous practices—for example, the use of quantitative data for bird counts (Berkes, 2018, p. 13). IK has been operating successfully and more importantly, with their ability of sustainably using and managing the resources (Dentzau, 2019) and IP have relied just on their knowledge for a living without exploiting nature (Mazzocchi, 2006). However, comparing two different knowledge systems to validating IK with the standards and methodologies of Western science, and extracting only those that fit the Western criteria "threatens Indigenous Knowledge systems with dismemberment and dispossession" (Nakashima & Rou´ e, 2002, p. 1).

There are differences in these two knowledge systems' approach, methodology, objectives, and transmission of knowledge (Mazzocchi, 2006). IK should not be taken as less analytical than Western science but as a different knowledge system complementary and supplementary to Western science (Tsuji & Ho, 2002). It should be respected and promoted as equally important as Western knowledge. The exclusion of the knowledge system in academia is a violation of human rights. The Eurocentric domination over their knowledge by Western science creates a system where IK, proven through thousands of years for managing ecosystem sustainability, is misunderstood and devalued (Nuñez, 2018).

1.2.7 Approaches to overcoming problems by incorporating Indigenous Knowledge

Historical inequalities in the research in the Arctic excluded IK and worldviews and prevented their involvement in the decision-making process. This colonial form of research still exists in many forms in the Arctic that has helped continue the domination

of the Western knowledge system (Yua et al., 2022). Despite such challenges of knowledge integration between IK and Western knowledge systems, the approach of knowledge co-production has slowly changed in recent times with the increase in Indigenous academics reviving the Indigenous methodologies (Rankin et al., 2023). Change in this research paradigm has been essential considering historical unethical studies on the Indigenous communities (Bennett, 2012).

Scholars have long worked on finding the correct alternative approaches for knowledge co-production that support Indigenous self-determination and worldviews (Smith et al., 2023) through the development of multiple models and frameworks that avoid colonial problems and challenges of knowledge integration (MacRitchie, 2018) and respect and support IP and their knowledge and their worldviews (McGuire-Adams, 2020). Examples of such approaches are; Braiding Sweetgrass by Kimmerer for weaving IK of plants with Western science (Kimmerer, 2014); Yua's Co-production of knowledge (CPK) framework of generating new knowledge by bringing together Indigenous and scientific knowledge (Yua et al., 2022); and McGuire-Adams's Anishinaabeg research paradigm where the Anishinaabe perspective is engaged in research (McGuire-Adams, 2020).

Two-eyed seeing is one of them that keeps IK at the center without disregarding Western knowledge (Smith et al., 2023). Two-eyed seeing is an approach to integrating traditional and Western scientific knowledge with the incorporation and respect of the similarities and differences they bring (Mantyka-Pringle et al., 2017a). The framework was first introduced by Eskasoni Elders Albert Marshall and Murdena Marshall (Bartlett et al., 2012). It is the framework in which multiple views can come together to generate common findings (Bartlett et al., 2012) and provides opportunities to know how TK could be as important as Western knowledge in answering research problems (Wilson et al., 2019). It also provides opportunities to look into what knowledge system would be best for a particular scenario (Bartlett et al., 2012). Barlett et al. (2020) have noted eight guiding principles that Two-eye Seeing has for knowledge co-production between Indigenous and Western knowledge systems. They are,

1. "Acknowledge that we need each other and must engage in a co-learning journey.
2. Be guided by Two-Eyed Seeing.
3. View "science" in an inclusive way.

4. Do things (rather than “just talk”) in a creative, grow forward way.
5. Become able to put our values and actions and knowledges in front of us, like an object, for examination and discussion.
6. Use visuals.
7. Weave back and forth between our worldviews.
8. Develop an advisory council of willing, knowledgeable stakeholders, drawing upon individuals both from within the educational institution(s) and within Aboriginal communities” (Bartlett et al., 2012, p. 334).

1.3 Conceptual framework

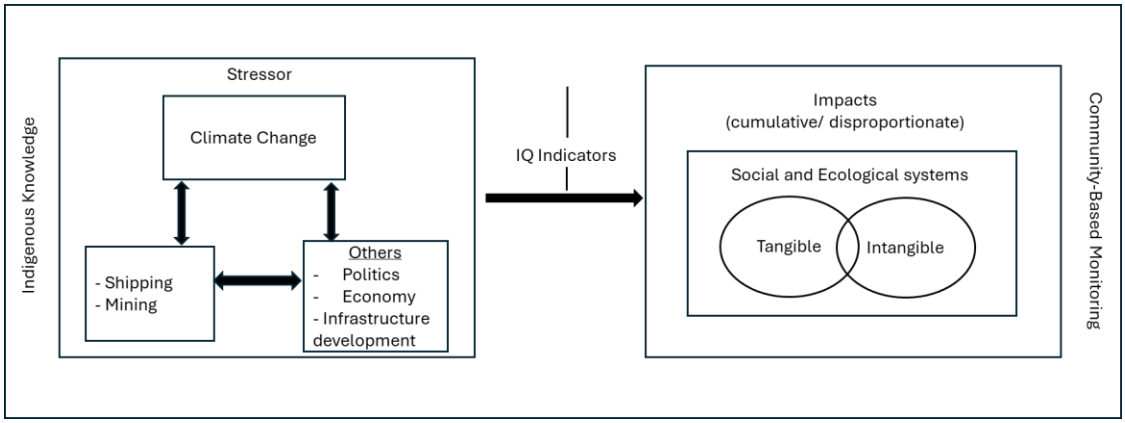

Figure 1. 1 Conceptual framework illustrating the relationship among Indigenous knowledge, stressors, and impacts on community.

The conceptual framework illustrates how stressors of changes and their impacts on social and ecological systems are related to Inuit knowledge and their monitoring of the ecosystem. Climate change, shipping, mining, politics, economy, and infrastructure development in the Arctic and other parts of the world are the primary reasons behind the changes in the Arctic.

Such stressors have brought massive changes directly or indirectly in the social and ecological systems associated with the community (Mantyka-Pringle et al., 2017a). These stressors and changes have disproportionately affected Indigenous communities of the Arctic with cumulative impacts on the social, cultural, and economic aspects of the community (Hovelsrud et al., 2011; Mantyka-Pringle et al., 2017a). Such impacts could be tangible or intangible. For example, the impact on the knowledge transfer could be

intangible whereas decreased use of the seal's skin for traditional drums could be the tangible impact.

CBM of changes and their impacts are based on IP's knowledge and worldviews. Knowledge indicators to compare past and predict future patterns, live experiences, and knowledge passed down from parents are used for such monitoring. The Arctic has a long history of colonial, extractive, and unethical forms of research on IP and their knowledge system (Yua et al., 2022). The growing number of Indigenous-led CBM programs in recent times that support Indigenous self-determination, knowledge, and worldviews have been replacing such forms of research *on* IP.

1.4 Research Objective

This research aimed to find answers to how has *Igluligaarjuk* changed ecologically and how that has impacted the community. The specific objectives of the research are to,

1. Examine the ecological and physical changes observed in and around *Igluligaarjuk*.
2. Document the IQ and indicators used by the community to monitor the changes.
3. Identify the challenges of incorporating IQ with CBM.
4. Analyze the cumulative impacts of changes along with shipping on the community.

1.5 Research Setting

1.5.1 Inuit of the Arctic

Inuit have lived in the Arctic for eons, with archeological evidence of twelve thousand years ago (Bonesteel & Anderson, 2008). Inuit encountered European explorers during the 15th century (Bonesteel & Anderson, 2008). Hudson Bay Company controlled the fur and pelt trading in the Canadian north until the twentieth century and the Inuit depended on its trading posts for the exchange of essential goods with fur. The mining and exploration of minerals, metals, and oil & gas started in the early 20th Century. This, along with the development of military bases and hydroelectricity, started affecting largely Inuit lives, their culture, settlement, and the natural resources they depended upon (Bonesteel & Anderson, 2008; Prażmowska-Marcinowska, 2023).

Since European colonization of the Arctic and the Inuit through whaling, trading, and missionaries in the 1700s, there have been continuous social changes, largely over the last 60 years (Cunsolo Willox et al., 2013a). Some of the changes they went through were

> forced community resettlement and mandatory relocation from traditional homelands; sedentarization; land dispossession; a history of residential school attendance and the removal of children from their communities; loss of language; and systematic spiritual and cultural assimilation from the presence of missionaries (Cunsolo Willox et al., 2013a, p. 257).

These forced changes disconnected the Inuit from their traditional life and land, disturbed social relations, and forced them to adopt a new way of living.

Inuit make up the largest IP community in the Arctic having jurisdiction over more than half of the region's land. There are four Inuit lands in Canada, collectively called Inuit Nunangat. Inuvialuit Settlement Region, Nunatsiavut, Nunavik, and Nunavut comes under it (Inuit Tapiriit Kanatami, 2024) which are the home to 53 Inuit communities (Prażmowska-Marcinowska, 2023).

Four Land Claims Agreements, "the James Bay and Northern Quebec Agreement in 1975, the Western Arctic (Inuvialuit) Agreement in 1984, the Nunavut Land Claims Agreement in 1993, and the Labrador Inuit Land Claims Agreement in 2005" have been

signed in Canada (Bonesteel & Anderson, 2008, p. ix). The Nunavut Land Claims Agreement (NLCA) was officially signed in 1993, based on which the Nunavut and its government were formed. The Nunavut Act passed in 1993 created a new framework of governance that gives equal political power as other territorial governments (Légaré, 2008). Nunavut is home to 70% of the total Inuit in Canada and 85% of its population is Inuit (Légaré, 2008). Twenty-five municipalities in Nunavut are in three regions: Qikiqtani, Kivalliq, and Kitikmeot.

1.5.2 Shipping in the Arctic

Canada has a long history of Shipping and IP in the Arctic have been involved in maritime activities for millennia for subsistence livelihood and travel (Wang & Aporta, 2024a). However, the first dramatic increase in shipping activities in the Canadian Arctic was associated with the whaling and fur trade until the mid-eighteenth century. It boomed again during World War II and the Cold War for military purposes (Lajeunesse & Lackenbauer, 2023). The Canadian Arctic was a strategic area and many airfields, and weather and radar monitoring military stations were established during this time. During the 1970s, exploration and mining in the Arctic significantly increased shipping. The Geological Survey of Canada in the 1950s revealed high deposits of minerals and hydrocarbons in the Canadian North and their exploration during the 1960s which became the turning point of the dramatic growth of shipping in Canada (Lajeunesse & Lackenbauer, 2023).

Since the past decades, there has been a rapid growth in shipping activities in the Arctic (Wang & Aporta, 2024a). From 1990 to 2015, the shipping traffic increased by three times in the Arctic (Carter et al., 2019) and five times since 2000 (Lasserre, 2023). Shipping in the Canadian Arctic is framed by resource extraction. The global market reach and economy that these resources generate play a significant role in shaping Arctic shipping (Lasserre, 2023). As the contribution of the Arctic to the global financial system is increasing, more international shipping is being involved. In recent years, the total ship tonnage has increased in the Arctic indicating a substantial increase in mining ships (Lasserre, 2023).

1.5.3 Mining in the Arctic

Mining in Canada has a long history (Dana & Anderson, 2014; Wang & Aporta, 2024a). Inuit “used copper from the Coppermine River to make tools and weapons” (Dana & Anderson, 2014, p. 344). Massive exploration and mining in the Arctic during the 1960s (Lajeunesse & Lackenbauer, 2023). As demand grew in the global market, mining exploration of minerals in the Arctic increased (Koke, 2009).

The Kivalliq region of Nunavut has huge deposits of minerals and resources. Exploration of mines in the region has a long history. Miners have explored huge deposits of metals and minerals including gold, nickel, uranium, and diamond, mostly around Rankin Inlet and Baker Lake (Dana & Anderson, 2014). The first mine in the region was opened in 1975 in Rankin Inlet (Rodon & Lévesque, 2015). Meadowbank Gold Mine was open in the north of Baker Lake in 2007 (Bernauer, 2010; Dana & Anderson, 2014). Three active mines, Meadowbank Mine and Meliadine Mine in Kivallq and Mary River Mine in Qikiqtani are being operated in Nunavut (Maelzer, 2023). Mining in Nunavut is more open-pit mining of metals and minerals (Nekrich, 2020).

1.5.4 Study Area: Chesterfield Inlet

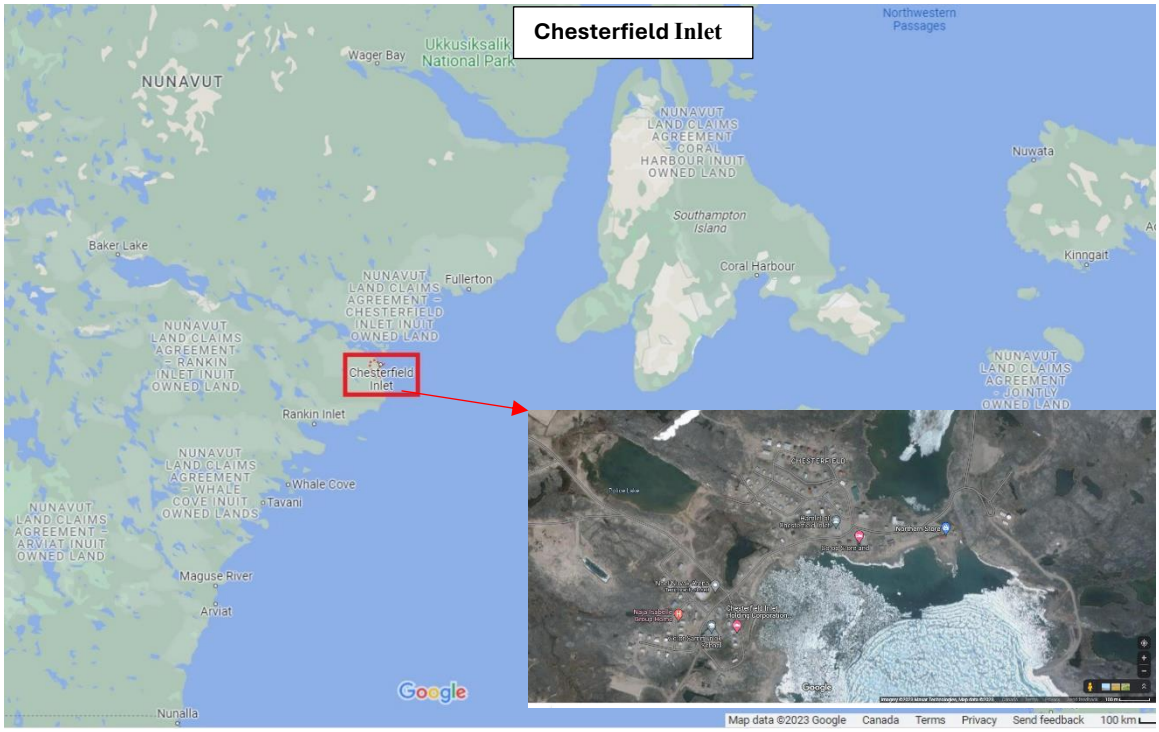

Figure 1. 2 Map of Chesterfield Inlet (Created using Google Earth)

Chesterfield Inlet

Chesterfield Inlet is one of the twenty-five Municipalities of Nunavut and is on Hudson Bay in the Kivalliq region. According to the Hamlet of Chesterfield Inlet, Chesterfield Inlet is called *Igluligaarjuk* in Inuktitut which means “place of few Thule houses.” Explorers were drawn to Hudson Bay and Chesterfield Inlet in their quest for the Northwest passage to China. It was once the center for whaling and trading for Hudson’s Bay Company. The Inlet was the administrative center for the regions north of Churchill, Manitoba until the 1950s. Trading and whaling played important roles in establishing the permanent settlement in Chesterfield Inlet which later attracted other activities like missionaries, boarding schools, and a post for the Mounted Police. The first Roman Catholic church named Notre Dame de la Delivrande was established in 1912. The Royal Canadian Mounted Police established its post in 1921. St Theresa’s Hospital was built in 1931. A day school was opened in 1951, and a residential school named Turquetil Hall was opened in 1955 and was operated until 1969. It was later demolished and replaced by

a community complex in 1985 (Hamlet of Chesterfield Inlet, 2024). According to Canada's 2016 census, the population of the Chesterfield is 437.

1.5.5 GENICE II Project

This research is also a part of the GENICE II research project. GENICE II is a collaborative project aimed at dealing with oil spill threats in the Arctic through large-scale genomics. The project brings universities, scientists, students, and the Inuit community together to understand natural attenuation in the Arctic and the threats of spills on the community. My research contributes to Activity II of the project to co-develop genomics-informed CBM program with Inuit communities that supports Inuit self-determination by combining social and natural science with IQ. My research is funded through the GENICE II project and SSHRC. The ethics approval for this research is under the umbrella approval for the project (HE2022-0385) and approved under a Nunavut Scientific Research License Number 03 015 23N-M. The Open House and workshops, organized with other members of the GENICE II team, provided opportunities to discuss my research questions, present my preliminary findings, and collect comments and critiques to meet my research objectives.

1.5.6 Aqigiq Hunters and Trappers Organization (HTO) and The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society)

Besides the Municipality, this research was conducted in coordination with the Aqigiq Hunters and Trappers Organization (HTO) and The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society) in Chesterfield Inlet. The HTO comes under the Nunavut Wildlife Management Board and the Nunavut Inuit Wildlife Secretariat. The HTO and KIA (Kivalliq Inuit Association) are the designated Inuit Organizations in the Kivalliq region under the NLCA. I collaborated with the members of HTO and the Society throughout the research period.

The Sapujiyiit Society is an Inuit-led Non-Governmental Organization working in Chesterfield Inlet, Coral Harbor, and Naujaat, Nunavut, Canada, among other things, it is

working on developing long-term monitoring of the change in the climate, animals, water, and other resources of the Foxe Basin Kivalliq North area. They also monitor the impacts of shipping and mining on the region (Newell, 2023).

1.6 Methodology

Indigenous people have been researching for millennia and have their own methodologies and ways of knowing. Colonial research continued to be exploitative and unethical to IP for centuries and such methodologies still exist today in various forms (Yua et al., 2022). Those who benefit from such research are primarily Western researchers (Ljubicic et al., 2022; Ryder et al., 2020). Studies and their methodologies are often not designed with Indigenous values, views, and knowledge (Drawson et al., 2017). Indigenous researchers have now challenged this dominion of Western research and have "reclaimed the sovereignty" (Ryder et al., 2020). An Indigenous methodology is a " methodology where the approach to, and undertaking of, research process and practices take Indigenous worldviews, perspectives, values, and lived experiences as their central axis" (Walter & Suina, 2019).

After a long colonial and exploitative history with the IP in Canada, research practices have been changing slowly. Indigenous communities, researchers, and academic institutions have now worked on improving research practices with Indigenous communities (Ryder et al., 2020). Monitoring, studies, licensing bodies, and funders in Nunavut are told to incorporate Inuit values, ethics, and Inuit knowledge (Pedersen et al., 2020a). Various Indigenous methodologies and models are beginning to be put into practice by IPs and Indigenous and non-Indigenous scholars with whom they are partnered. These put Indigenous worldviews, perceptions, values, and knowledge at the center (MacRitchie, 2018).

1.6.1 Positionality

The researcher's positionality or identity, characteristics, and perceptions shape understandings concerning research populations, topics, and the process (Wilson et al., 2022). Positionality refers to "the position the researcher has chosen to adopt within a given research study" (Savin-Baden & Howell Major, 2023, p. 71). I am a South Asian non-Indigenous person, born in Sindhupalchowk district (a homeland to the Indigenous People, Tamang), Nepal. Before I joined the University of Manitoba, I worked with the IP and other communities in community-based conservation in Nepal. I am currently living, studying, and working on the traditional lands where the University of Manitoba is located. In what follows, I discuss Inuit research priorities and research approaches that have been developed to address them.

1.6.2 National Inuit Strategy on Research Priority Areas

Colonial research in Canada has sidelined Inuit involvement in deciding the studies that are related to them and conducted in their homeland. Inuit access to designing research, setting agendas, framing ethical guidelines, controlling data, and benefit sharing of the research has been restricted. However, Inuit are actively asserting their self-determination in research and governance. Acknowledging and implementing Inuit governance is important for ensuring the effectiveness, impact, and usefulness of studies (Inuit Tapiriit Kanatami, 2018). For this, Inuit Tapiriit Kanatami has put forward the National Inuit Strategy on Research with research priority areas; "Advance Inuit governance in research; Enhance the ethical conduct of research; Align funding with Inuit research priorities; Ensure Inuit access, ownership, and control over data and information; Build capacity in Inuit Nunangat research" (Inuit Tapiriit Kanatami, 2018, p. 3)

1.6.3 Inuit Research Methods

Researchers often do not know how to incorporate IQ in the practice at the community level (Pedersen et al., 2020a). Below I discuss two Inuit research methods that Inuit have developed to help guide this process.

1.6.3.1 The Qaggiq Model

The Qaggiq Model is a land-based learning model developed by Janet Tamalik Mariano Aupilarjuk (Mcgrath, 2019). The Qaggiq is a snow camp where people gather, talk, share stories, build relationships, play games, and share knowledge. As a model, the Qaggiq has four small pillars representing homeland, language, living histories, and culture. Inuit and non-Inuit can learn, unlearn, listen, and experience the Inuit values, knowledge, and their worldviews. This is referred to as Qaggiq dialogue where people learn about people and the environment and build relationships with the community (Ljubicic et al., 2022). This land-based learning has been applied by many scholars as an Indigenous methodology. For example, Mearns used this model to find how land, culture, language, and living histories are connected (Mearns, 2017).

1.6.3.2 ScIQ

The ScIQ model is "a concept that was created by Ikaarvik youth researchers to describe a more functional middle ground between science and IQ" (Pedersen et al., 2020a, p. 331). A group of Inuit youth aged 16 to 30 from Nunavut, have developed a framework called ScIQ for the meaningful and ethical engagement of Western researchers with the Inuit. The concept takes IQ as a holistic system of knowledge, values, ethics, perception, and worldviews, and is meant to guide the integration of IQ and Western science. The group recommended forty-five suggestions to meet the necessities and expectations of how research should be done with the Inuit communities and build relationships between scholars and the community. Different recommendations were given to different four categories; "before, during, and after research" and "things that make research easier" (Pedersen et al., 2020a, pp. 331 & 335). I have tried to incorporate such recommendations and suggestions from these models into all stages of this research.

1.6.4 My Approach

This research has used a community-based qualitative research approach as a methodology drawing on insights and recommendations from Inuit research priorities and methods discussed above. The study is primarily focused on the IQ of the Inuit community in Chesterfield Inlet of Nunavut. This research presents the community member's knowledge of changes and their understanding of the impacts on the Chesterfield Inlet and the lands and waters they rely on. The findings and analysis presented here are solely according to Indigenous worldviews. I do not tend to compare or validate the findings with other Western science findings or Western scientific methodologies because IK in itself is complementary to scientific and Western knowledge (Riedlinger & Berkes, 2001). Validating and extracting the IK is a form of colonial research. Comparing two different knowledge systems to validate IK with Western science, and extracting only those that fit the Western criteria devalues and threatens IK (Nakashima & Rou´ e, 2002). However, I have discussed how these findings are similar or different to other studies conducted in similar settings with IP in the Arctic and Nunavut region. In this research, I have tried to incorporate and follow recommendations and suggestions of different Indigenous methodologies and models in all the phases from pre-research discussions, research design, data collection, report finalization, report and data sharing, and data ownership. I have discussed this in different headings based on the five priority areas of the National Inuit Strategy on Research.

Priority 1 of advancing Inuit governance in research, was addressed through prioritizing the concerns of the Chesterfield community in the research. I visited the community and met the community members, and officials of Hamlet, and HTO before developing the research proposal to collect their priorities, concerns, and suggestions on the research design. We conducted an Open House to discuss the research and build relationships. The research is based on their knowledge and observations. Community research concerns were discussed before the development of proposals and were incorporated into the research design. The interview questions were finalized in coordination with Barnie Aggark, Senior Executive Director at the Sapujiyiit Society, at the time. The research was coordinated with the two Inuit-led organizations from the start: the Aqigiq Hunters Trappers Organization and Sapujiyiit Society.

Priority 2 of enhancing the ethical conduct of the research, was addressed through consideration of protocols and guidelines for conducting ethical research. The research as a part of the GENICE II project was reviewed and approved by the Research Ethics Board of the University of Manitoba on 28th March 2023 with Protocol Number: HE2022-0385. This approval was in accordance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2). Next, I completed a course on Research Ethics based on the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2: CORE 2022) on 9th July 2022. For the priority related to Inuit-specific ethical concerns, the GENICE II project got approval from the Nunavut Research Institute on 18th April 2023 with license number 0301523N-M. Written consent was taken from all the participants of the interviews and workshops for their consent to participate in the research, record the interviews, share their knowledge through the report, and directly quote their names in the report.

Priority 3 of aligning funding with Inuit research priorities focuses on partnering with Inuit governance in placing funding, prioritizing funding for Inuit worldview and methodologies, and prioritizing funding on the Inuit-related geography, culture, and settlement areas (Inuit Tapiriit Kanatami, 2018). This was done through the GENICE II project. The project's objectives, programs, and activities were designed through coordination and consultation with the Inuit communities, Inuit-led organizations, and the meaningful involvement of community members.

Priority 4 “ensures Inuit access, ownership, and control over data and information” (Inuit Tapiriit Kanatami, 2018, p. 3). The Chesterfield community has ownership and access to the data generated from this research. The data will be handed over to the Aqigiq Hunters Trappers Organization. Based on the consent given by the interview participants, a copy of the transcribed interviews is given to the interviewees, recorded interviews will be given to the HTO archive.

Priority 5 encompasses the capacity building of Inuit in the research. This is about investing in human and infrastructure resources to lead and take action in the research (Inuit Tapiriit Kanatami, 2018). During the research, a local youth, Larry Jr Ittinuar, worked as an Inuit researcher and I worked with him designing interview questions and

conducting and facilitating the interviews. Members of the Sapujiyiit Society, Jason Ippiak and Simon Aggark were involved in interview participant selection, facilitating and live translating interviews into English. Next, Philippa Aggark was involved in live translating the interviews into English. Members of the Sapujiyiit Society were involved and trained for sampling and other activities of the GENICE II project.

Table: Table 1. 1 Priorities areas of National Inuit Strategy on Research and my research works in meeting the priorities

SN	National Inuit Strategy on Research Priority Areas	My Approach
1	Advance Inuit governance in research	- Prioritized concerns of the community - Research concerns discussed before and during the research and incorporated into research design - Conducted an Open House to discuss the research and build relationships - The research is based on the IQ - Discussed Interview questions with the Sapujiyiit Society - Coordinated with the HTO and the Sapujiyiit Society from the initial phase of the research
2	Enhance the ethical conduct of research	- Considered protocols and guidelines for ethical research - Approved by the Research Ethics Board - Completed course on TCPS 2: CORE 2022 - Approved by Nunavut Research Institute - Written consent for interview, workshop, record the interviews, share their knowledge through the report, and directly quote their names in the report
3	Align funding with Inuit research priorities	Ensured the community's involvement in designing the GENICE II project and its activities
4	Ensure Inuit access, ownership, and control over data and information	- The community will have ownership and access to the data - Data will be handed over to the HTO archive
5	Build capacity in Inuit Nunangat research	- Worked with a local youth as an Inuit researcher - The members of the Sapujiyiit Society involved in interview participant selection, facilitating and live translating interviews into English - Members of the society trained for sampling and other activities of the GENICE II project.

1.6.5 Methods

I visited *Igluligaarjuk* four times during my research time. The first visit was a year before I started my research. With my supervisor, we met members from the community and HTO and officials of Hamlet of Chesterfield Inlet and learned community's concerns,

discussed their research priorities, and talked about the research design. On the second visit, we conducted an Open House in the community, met community members, conducted the first workshop, built relationships, and discussed the research and potential time and participants of the interview. On the third visit, I interviewed Inuit knowledge holders and on the third visit, I did member checking and conducted the second workshop.

Table 1. 2 Date and task of my visit to Igluligaarjuk

Date	**Task**
19th to 21st July 2022	Met community members for initial consultation
2nd to 5th May 2023	Conducted Open House and first workshop
27th June to 15th July 2023	Conducted interviews and shared the first community report (progress and future activities)
8th to 14th March 2024	Interview Member checking and second workshop. Presented the results and got feedback
August 2024	Give back results in the form of a community report and thesis.

1.6.5.1 Interviews

Semi-structured interviews were used to interview IQ holders, where the questions were loosely structured and open-ended, and the respondents were allowed to answer in their own way (Alsaawi, 2014; Easwaramoorthy & Zarinpoush, 2006). Further questions were asked to elaborate more about the topic.

Interview participants were selected in consultation with the community members, officials of the Municipality of Chesterfield Inlet, HTO, and Sapujiyiit Society. Members of Sapujiyiit Society, Simon Sammurtok, and Jason Ippiak, and the interpreter of the research, Philippa Aggark helped to identify the other knowledge holders who were willing and available in the town to share their knowledge with us. We selected knowledge holders aged thirty and over who could have a lot of experience and observation on the change in *Igluligaarjuk* and tried to maintain gender balance in interviewees.

Table 1. 3 Interview participants and the date of their interview

S N	Name of Interviewee	Gender	Age	Date of Interview	Date of Member Checking
1	Harry Aggark	Male	72	29th June 2023	11th March 2024
2	Louis Autut	Male	87	30th June 2023	10th March 2024
3	Jennifer Sammurtok	Female	54	2nd July 2023	10th March 2024
4	Andre Tautu	Male	80	3rd July 2023	10th March 2024
5	Elizabeth Tautu	Female	76	3rd July 2023	10th March 2024
6	Leo Minialik	Male	76	4th July 2023	11th March 2024
7	Jimmy Krako	Male	53	4th July 2023	(not able to complete)
8	Jacinthe Amarok	Female	70	4th July 2023	10th March 2024
9	Casimir Kriterdluk	Male	79	5th July 2023	11th March 2024
10	Mark Amarok	Male	64	6th July 2023	10th March 2024
11	Larry Ittinuar	Male	53	6th July 2023	10th March 2024
12	Carl Amarok	Male	51	7th July 2023	Unable to reach
13	Jason Ippiak	Male	44	8th July 2023	12th March 2024
14	Philippa Aggark	Female	63	11th July 2023	9th March 2024
15	Simionie Sammurtok	Male	64	12th March 2024	22nd August 2024

An Inuit youth researcher Larry Jr Ittinuar and interpreters Philippa Aggark and Jason Ippiak from Chesterfield Inlet were hired to facilitate and conduct the interview in the Inuktitut. In June and July of 2023, Interviews were conducted with fifteen IQ holders (n=15), and the interviewees were selected purposively through the recommendation from the interpreter, HTO, and Sapujiyiit Society. Interviews were live translated and recorded. The interviews were recorded with consent and were transcribed later. The Inuit youth researcher reviewed the interview transcripts and assisted with the interpretation of some of the knowledge that was shared. A second validation (member checking) interview was conducted with participants in March 2024, along with an interpreter, to verify their transcripts and quote interpretation.

1.6.5.2 Co-Development Workshops

Two workshops were carried out in May 2023 and March 2024 to generate knowledge on such changes and indicators and validate the findings from the interview. Eleven and eight community members, including the representatives from the Hamlet office, the Aqigiq HTO Coordinator, and the Sapujiyiit Society attended the first and second workshops. Participants of the workshops were invited through consultation with the community which included members from the Aqigiq HTO, community members, Hamlet of Chesterfield Inlet, and the Sapujiyiit Society. Both workshops were organized by the GENICE II project where I got the opportunity to learn and discuss my research questions with the participants. In the second workshop, I presented my initial findings from the interviews and got feedback and suggestions from the participants.

1.6.6 Data analysis

Coding is a crucial step in analyzing qualitative data (Wong, 2008). NVivo software was used to code and analyze the qualitative data from the interview. The transcribed interview was uploaded to NVivo where thematic analysis of the data was conducted. First, themes and codes were identified through the deductive method where codes were predetermined based on the review of literature and research objectives. However, as the data were analyzed, an inductive approach was adopted where new codes were generated based on the interview data.

1.6.7 Data storage

The recorded interviews were uploaded to a password-protected Microsoft OneDrive file. A different sub-folder for each participant was created to upload the recordings. The transcribed interviews and scanned copies of signed consent forms were later uploaded to the same folders. The original files in the recorder were permanently deleted. The physical hardcopy of the consent forms filled in during the interviews were given to the University. All the data and files will be made accessible to the Aqigiq Hunters Trappers Organization Archives.

1.7 Overview of thesis

This thesis is divided into four chapters. Chapter I is about the overall background, literature review, and methodology. Chapter II focuses on the Inuit perspectives on the observed ecological changes and knowledge indicators used by the Inuit to monitor the changes in *Igluligaarjuk* and the challenges of knowledge integration during CBM in relation to *Igluligaarjuk*. Chapter III deals with the community's perspective on the cumulative impacts of ecological changes, shipping, and mining on social and ecological systems. Chapter IV includes the overall conclusion.

IP with their knowledge have been monitoring ecological changes for ages (McGregor et al., 2020). IK uses a holistic approach where ecosystem and social aspects are parts of a single system that cannot be separated (Nadasdy, 1999). So, it is essential to connect ecological changes, anthropogenic stressors, and social implications on the community. Indigenous-led CBM programs have the potential to support cumulative impact monitoring, knowledge preservation, and transmission to younger generations, and sustainably manage the environment through the promotion of Indigenous governance and self-determination (Reed et al., 2020)

In Chapter II and Chapter III, I am looking into community knowledge on monitoring and how Inuit-led CBM could be crucial in long-term sustainable management and monitoring of stressors like climate change, mining, and shipping and their impacts on social and ecological impacts. IQ and CBM are common threads that run through both chapters.

Chapter II

IQ indicators used in monitoring for ecological changes in *Igluligaarjuk* (Chesterfield Inlet)

Abstract

With the increasing temperatures due to anthropogenic climate change, ecosystem components in the Arctic are undergoing rapid changes. Indigenous people have been monitoring and adapting to the changes. Indigenous Knowledge is based on the close observation of the ecosystem, experience, and traditional activities related to the use of the resources. Community-based monitoring (CBM) programs co-develop indicators, and recognize, use, and document the knowledge system that is necessary for the sustainable management of the ecosystem. Such programs can help to mitigate and adapt to the increasing changes in the Arctic. This study aims to document the changes observed and to understand what and how indicators are used by the Inuit in monitoring such changes. For this, a community-based qualitative research approach was used in partnership with the Inuit of *Igluligaarjuk*. Based on fifteen interviews and two workshops with the hunters, harvesters, Elders, and community members, we found out that the degrading health of caribou and polar bears, decline in the abundance of seal and polar bears, decrease in ice thickness, early ice melting, late freezing, rapid growth of plants, and decreased yield of cloudberries are the major changes observed by the Inuit knowledge holders. Indicators like the condition and pattern of ice are used to determine the overall changes in sea ice. Likewise, color, taste, and cleanliness are used to determine the status of drinking water. Likewise, indicators like the color of the liver, amount of fat, presence of fluid under the skin, and movement are used to determine caribou's health. Increasing patterns of such changes are serious concerns of the *Igluligaarjuk* community. Finally, we discuss the challenges and implications of engaging IQ in CBM.

Keywords: Arctic, Community-based monitoring, Indigenous Knowledge, Inuit Qaujimajatuqangit, environmental changes, indicators.

2.1 Introduction

Indigenous communities in the Arctic are experiencing the direct impacts of climate change and resource development on their economics, traditions, harvests, and travel and safety (Van Luijk et al., 2022). The situation is already serious now and is likely to be worse in the near future (Labbé et al., 2017). Arctic Indigenous communities have been monitoring environmental changes and problems through their knowledge, experience, and observation. Indigenous Knowledge (IK) is the "unique, traditional, local knowledge existing within and developed around the specific conditions of women and men Indigenous to a particular geographic area" (Grenier, 1998, p. 1). It is not just knowledge of bio-physical resources (Latulippe, 2015) but the complete set of ideas, skills, knowledge, and observations gained by the Inuit passed from generation to generation (Henri & et al., 2020). IK contains detailed information about the flora, fauna, resources, environment, and entire ecosystem (Hey et al, 2000). IK and their skills help create a holistic picture of "the environment on a continuous time scale" (Berkes et al., 2007, p. 158).

IK based on ecological and social indicators gives a larger perspective and idea of resource conditions (Berkes & Berkes, 2009). IP use these indicators to interpret the changes and predict their impacts. Conditions of the ecosystem are analyzed to determine the change in the population of animals and other components of the ecosystem like sea ice (MacDonald et al., 1997).

While Indigenous People (IP) have always monitored their environments, CBM programs involving IP and their knowledge are growing in number globally (Danielsen, 2020; Kouril et al., 2016), more in the Arctic and Sub-Arctic (Johnson et al., 2016; Kouril et al., 2016). More focus and interest have been given to Indigenous-led monitoring in the Arctic region, mainly in response to environmental change but also due to issues about the impacts of infrastructure and resource development like mining on natural and social systems (Johnson et al., 2016; Wilson et al., 2018). According to Whitelaw and others (2003), the motivations for the increase in CBM are; reduction in the number of government activities and programs on monitoring; insufficient data and information for decision-making and solving complex environmental issues; recognition of right holders,

stakeholders, and local people's contribution to the sustainable management of resources; increased interest and concern of the community members in protecting and managing their resources.

Many of the CBM programs have mainly focused on the collection of Western scientific instrumental observations to assess ecosystem quality (Conrad & Hilchey, 2011), with a primary focus on wildlife population and health monitoring, while others concentrate on sea ice, land, weather, plants, and animals in Arctic and Subarctic regions (Kouril et al., 2016). Given that the ecosystem is rapidly changing, it is crucial to document and acknowledge IK to manage such changes and to prevent further worsening of the environment. Monitoring such unprecedented changes in the ecosystem and social structure is necessary for managing them sustainably (Berkes et al., 2007).

This community-based qualitative research, conducted in partnership with the Inuit of *Igluligaarjuk,* engages with the possibility of using IQ indicators in CBM. First, I examine the ecological and physical changes observed in and around *Igluligaarjuk* from the community's perspective. The changes were mostly focused on the ice, weather and climate, vegetation, animals, and water. Second, I document community knowledge and indicators the locals use to monitor the environmental components, analyze their conditions, and determine changes in them. Third, I discuss the challenges and implications of engaging IK in CBM.

2.2 Literature Review: Indigenous Knowledge Indicators and Community-Based Monitoring

Indigenous people have been able to manage the complexity of the ecosystem through IK refined through hundreds of generations, learning from mistakes, and continual practice of using the resources (Berkes & Berkes, 2009). Engagement of IP in environmental monitoring creates the possibility to use different indicators than the engagement of outsider groups, including external researchers, government, and non-government organizations. IP have been using IK "indicators or the signs or symbols used to understand and communicate about changes" in the ecosystem (Parlee et al., 2005, p.

168). Indicators present insight into the patterns, existing status, and future direction, which assist in making decisions. Ecological indicators are used or co-developed to monitor changes, assess the impact on the ecosystem, or measure the status of environmental components Phillips (2003). They are used to routinely observe and document the patterns of changes in the ecosystem, which could be used to prevent threats and risks in the future. They are crucial in managing resources (Dale & Beyeler, 2001).

IK indicators may include things like body condition, “species abundance and distribution, quality of land and water, and cultural landscapes and land features” (Parlee et al., 2005, p. 168). IP use ecological indicators like caribou body condition, socio-ecological indicators like hunting success, and social indicators like IK of seasonal cycles in the community (Berkes et al., 2007; Thompson et al., 2020). IK based on ecological and social indicators might not be easily quantified, but it gives a larger perspective and idea of resource conditions (Berkes & Berkes, 2009).

Studies show that there are various reasons for developing indicators ranging from documentation, comparison, prediction, identification, and exploration to validation of knowledge and research findings (Table 2.1). For instance, in a study in the Baker Lake watershed in Nunavut, Nesbitt and others (2018) found that Inuit Elders and hunters used ecological indicators to determine the health of the water bodies. They used organoleptic and physiochemical indicators like water taste, saltiness, smell, and temperature to determine if the water could be used for drinking or other uses. In collaborative research conducted by external researchers, the government, local community, and other stakeholders in Kuujjuaraapik, Nunavik, Henri and others (2020) found that the Inuit used the presence of Arctic Terns as an indicator to determine the change in weather and season and to find the seal and fishing areas. Filling the data gap and limitations that the scientific approach cannot provide are the common reasons for using community-based indicators (Wilson et al., 2023).

Table 2. 1 Examples of CBM Programs involving Indigenous Knowledge Indicators.

Authors	Description of Indicator	Involvement of IP	Methods
(Stenekes et al., 2020)	Collaborative research with Kátł'odeeche First Nation used ecological indicators to monitor the aquatic health and fishing livelihood of the community	KFN of the Northwest Territories	Community-based participatory research approach with semi-structured interviews
(Ovitz et al., 2023)	Researchers studied how indicators are used by the community in determining the health of beluga and fish.	Inuvialuit knowledge holders	Interview with knowledge holders and residents of Kendall Island
(Ostertag et al., 2018)	As a part of Fish and Marine Mammal CBM, researchers co-developed the indicators for monitoring beluga health	Inuvialuit from Inuvik, Paulatuk, and Tuktoyaktuk	Knowledge was documented through surveys, interviews, and focus group meetings
(DeRoy et al., 2021)	Researchers used indicators to predict the occurrence of culturally modified trees	Indigenous researchers from Kitasoo/Xai'xais First Nation	Multi-criteria evaluation modeling framework
(Gearheard et al., 2010)	Researchers compared Inuit Knowledge of wind patterns with data from the weather station	Inuit from Clyde River, Nunavut	Weather data were collected from weather stations and qualitative data were collected from interviews
(Nesbitt et al., 2018)	Findings from the use of cultural indicators were compared with those from Western scientific indicators to find riparian health	Inuit Elders from Baker Lake, Nunavut	Interviews and site visit
(Henri & et al., 2020)	Researchers and Inuit developed indicators for measuring Arctic tern abundance. Inuit used the occurrence of Arctic Terns to understand the ecosystem's condition	Inuit from Kuujjuaraapik, Nunavik (northern Quebec)	Field research and Interviews
(Parlee et al., 2005)	Denesoline of Laustsel K'e Dene First Nation has been using it to access the ecological health and interlink species with land	Denesoline of Laustsel K'e Dene First Nation	Interviews and workshop
(Gagnon et al., 2020)	Inuit use the amount of fat content as an indicator of caribou health	Indigenous Knowledge holders from different communities in Alaska, Yukon, and Northwest Territories	Field research and interviews

Several methods and approaches are used worldwide to identify or co-develop IK indicators. Interviews (Adanu et al., 2021; Henri & et al., 2020.; Nesbitt et al., 2018), focus group discussions (Adanu et al., 2021), surveys, workshops (Henri & et al., 2020), and observations are often used by the researchers to co-develop them. A collaborative approach between the community and other parties, including researchers, government, or project, is adopted for the co-development. Western scientific models and frameworks are often used for such to combine IK indicators with Western scientific indicators. For instance, DeRoy and others (2021) used a multi-criteria evaluation modeling framework to assess cultural and biophysical factors in predicting the occurrence of culturally modified trees. On analyzing 71 programs related to CBM, Thompson and others (2020) found that most of the programs (45%) used interviews as a data collection method, while 42% used field monitoring, 21% used workshops or focus group discussion, 14% used participatory field visits, and 11% used surveys or questionnaires. Likewise, on analyzing articles related to CBM in the Arctic, Wilson and others (2023) found that interviews, focus group discussions, and workshops are mostly used to develop and document indicators (Wilson et al., 2023).

Indigenous communities have diverse knowledge systems and use various indicators in monitoring. These indicators are based on their observation, experience, and their connection with the specific components of the environment. This knowledge they possess is detailed and place-based gained through live experience (Ovitz et al., 2023). Indicators are based on the culture and values passed down through generations (Berkes et al., 2007).

Studies on Arctic communities are mostly focused on the study of IK in relation to particular components like water quality (Sardarli, 2013), *Siku* (sea ice) (Eicken, 2010), climate change (Riedlinger & Berkes, 2001), or particular species like Arctic Char (Henri & et al., 2020), caribou (Gagnon et al., 2020), salmon (Reid et al., 2022), or Arctic Terns (Henri & et al., 2020). Next, the studies are on integrating Western science and IK to examine specific aspects. For instance, Mantyka-Pringle and others (2017) linked science and local knowledge to find the pressure on ecosystem health. These studies are mostly centered around documenting, exploring, or using indicators related to the specific

components of the ecosystem. However, a holistic approach of documenting all the IK indicators used by the specific Indigenous community of a particular place to monitor the change in the multiple components of an ecosystem is less common. This is important for the recording baseline and monitoring of the micro-ecosystem which could be crucial in regional management. This helps in managing the resources over the long term to mitigate, manage, and adapt to the changes.

Against this backdrop, this study, using a community-based qualitative research approach with interviews and workshops as the data collection tool, this research aimed to examine the changes *Igluligaarjuk* has gone through as compared to the past. Next, it aimed to understand and document their knowledge and indicators used in monitoring the changes. Finally, this paper discusses the challenges and implications of engaging IK in CBM.

2.3 Materials and Methods

2.3.1 Research Setting

Chesterfield Inlet is called *Igluligaarjuk* in Inuktitut, which means “Place with a few Thule Houses.” The Inlet (63°20’N and 90°40'W) lies on the west coast of Hudson Bay, about 100 km north of Rankin Inlet (Municipality of Chesterfield Inlet, 2017). The Inlet is characterized by tundra vegetation with “birch, willow, northern Labrador tea, *Dryas spp,* and *Vaccinium spp*.” (Wahab et al., 2009, p. 3). The average “annual temperature is -11 °C, with a mean summer temperature of 4.5 °C, and a mean winter temperature of -26 °C, and mean annual precipitation is 200-300 mm” (Wahab et al., 2009, p. 3). The Inlet is home to the Inuit. According to Nunavut Planning Commission, the Inlet is 1550 km north of Winnipeg. The total population of the Inlet in 2016 was 437 (Statistics Canada, 2016), with 85% Inuit.

During the early 1900s, Chesterfield Inlet was a center for the fur-pelt trade for the Hudson Bay Company. Until the 1950s, it was a center for an administration looking North of Churchill. Residential schools started during the early 1950s and closed in 1969 (Municipality of Chesterfield Inlet, 2017). In 1993, the Inuit signed the Nunavut Land Claims Agreement (NLCA) with the Government of Canada and Northwest Territories,

creating a new Inuit land, Nunavut. Nunavut has a consensus governance system with no political parties for governance (Tootoo, 2012). Members of the Legislative Assembly select Speakers of the House, Premier, and Cabinet Ministers. The Municipal of Chesterfield Inlet is one of the 25 municipalities in Nunavut. The hamlet of Chesterfield Inlet governs and administers the municipality.

The Aqigiq Hunters and Trappers Organization (HTO) and KIA (Kivalliq Inuit Association) are the designated Inuit Organizations in the Kivalliq region under the NLCA. The HTO comes under the Nunavut Wildlife Management Board and the Nunavut Inuit Wildlife Secretariat. The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society) is an Inuit-led Non-Governmental Organization working in *Igluligaarjuk*, Coral Harbor, and Naujaat, Nunavut, Canada, among other things, is working on developing long-term monitoring of the change in the climate, animals, water, and other resources of the Foxe Basin Kivalliq North area. It also aims to monitor shipping and mining and their impacts on the region (Newell, 2023).

2.3.2 Methodology

This project used a community-based qualitative research approach to address the research questions. We used interviews and workshops as the primary data collection tools. We have incorporated and followed the recommendations from the ScIQ research framework, and before, during, and after the research work (Pedersen et al., 2020b) where applicable and possible. We have also followed recommendations and guiding principles developed by Ljubicic et al. (2022) following Qaggiq Model in Uqšuqtuuq where applicable and possible. We started meeting community members a year before the interview began to talk about research, meet, and develop a relationship. We conducted an open house meeting with the community to get to know them more and discuss the research and priority areas. We worked closely with the Hunters and Trappers Organization (HTO) of *Igluligaarjuk*, community members, Hamlet of Chesterfield Inlet, and Foxe Basin Kivalliq North Sapujiyiit-Guardians of the Sea Society (Sapujiyiit Society) from designing interview questions, selection of participants, data collection, analysis, report preparation, and publication. We worked in coordination with the

community in all phases of the research including designing the research, participant selection and conducting interviews and workshops, and report preparation.

We used semi-structured interviews to interview Inuit knowledge holders, where the questions were loosely structured and open-ended, and the respondents were allowed to answer in their own way (Alsaawi, 2014; Easwaramoorthy & Zarinpoush, 2006). The questions were open-ended, and further questions were asked to elaborate more about the topic. We used an age limit of more than thirty years for the interviewee. The interviewees were finalized after discussion with the community. A validation (member checking) interview was conducted with participants to verify their transcripts and quote interpretation. The interview was conducted with 15 Inuit (n=15). An Inuit youth researcher from *Igluligaarjuk* was hired to facilitate and conduct the interview in the Inuktitut. Interviews were live translated and recorded. The interviews were recorded with consent and were transcribed later. Next, two workshops were carried out to generate knowledge on such changes and indicators and validate the findings from the interview. Participants of the workshops were invited through consultation with the community which included members from the Aqigiq HTO, community members, Hamlet of Chesterfield Inlet, and the Sapujiyiit Society.

The raw data were analyzed based on the research questions and objectives of the study. The interview in Inuktitut was live translated first into English. For that, a local Inuit person was hired. Such raw data from the interview and workshop were transcribed with Otter.ai and thoroughly rechecked before analyzing with the NVivo software. In NVivo, themes based on the research objectives were categorized. Each interview was read, and data were coded according to the theme which was later analyzed to draw final results. All the data, results, and the final report of the research will be shared directly with the individual participants and with the community through HTO and Sapujiyiit Society.

2.4 Results

2.4.1 Changes Observed in *Igluligaarjuk*

2.4.1.1 Changes in Animals' health and abundance

Changes in the abundance and health of *Nattiq* (seals), *Tuktu* (caribou), and *Nanuq* (polar bears) are the major concerns of the *Igluligaarjuk* community. In addition to these animals, hunters and harvesters find sick fish and birds sometimes. Hunters have observed unusual fluid on *Tuktu*'s joints, meat, skin, and hoofs and unusual colors in the liver. The stories they have heard from their ancestors mention that having fluid in the *Tuktu's* body is a normal process, but hunters are worried about the growing number of such animals.

Describing how he finds unhealthy *Tuktu*, a hunter, Larry Ittinuar, said:

> *Yeah, you could tell the difference. The health of the caribou is different today. You know, we'll see sick caribou, and we won't take it cause it's sick. The liver and stuff. There's like pus on their meat and stuff like that. So, if their joints are green, and so we know not to take that. And we'll cut it up though and leave it. So that's the difference we're seeing today. In the past, we've rarely only seen anything like that.*

The community shared a positive response to the abundance of the *Tuktu*. Nine out of 15 interviewees have noticed either an increase or the constant abundance of *Tuktu*, including the increase in the abundance of calves. The herd is bigger these days which could be noticed from hunters' cabins. Some think that every year the herd size changes, they are scarce some years and are abundantly found some years. It is a normal process to fluctuate every year.

> [Philippa Aggark]- *"Caribou, I've seen lots of caribou. From our cabin, you can see when they're migrating, you can watch them. There seem to be more this year than last year, more coming in, there's still more coming from Rankin."*

Likewise, two participants also shared that many unhealthy and skinny *Nanuq* are found these days. They are moving further away from *Igluligaarjuk*, mostly towards the north because of a lack of food, no ice, and destroyed habitat. Many times, old and skinny

Nanuq come closer to the community, and they are shut down because of safety issues. However, the other two hunters had a different view. One of them said that its population has been increasing ever since polar bear management was introduced in the region. According to him many Elders and hunters from circumpolar think that *Nanuq* abundance has increased. Next said that the *Nanuq* are healthier than before and are found more abundantly than before. Skinny *Nanuq* that are seen around the human settlement tend to be older bears, and it is a normal natural process to be so and is not because of climate change. Sharing the change in the *Nanuq*'s health, Larry Ittinuar said:

> *The polar bear is no different. It's always been there, and it's always gonna be there. They're more polar bears today than they were just 20 years ago. 20 years ago, I could go out with my family and pitch a tent and sleep in the tent and not worry about polar bears. But now we're seeing polar bears come. Fall time, where we can travel 50 miles and count 30 Polar bears.*

The decline in the abundance of *Nattiq* is one of the major changes in *Igluligaarjuk*. Eight interviewees said that there is a decrease in the number of *Nattiq* in the Inlet, whereas one of them said more *Nattiq* are seen these days. The reasons behind the decrease in the *Nattiq* are the delayed freezing and early melting of the ice. Another reason is the rise in the temperature because of which they are moving further north in colder places. Along with *Nattiq*, *Qinalugaq* (belugas) are also in a declining trend. Hunters hardly hunt *Qinalugaq* on their Inlet. Disturbance and noise pollution from shipping are some of the main reasons behind the decline.

> [Harry Aggark]- *"We used to have more seals down here, in front of the harbor. We are getting less seals now because it's taking longer to freeze. I guess they just moved somewhere else further north I guess."*

Two interviewees shared that new non-native species are growing in seawater. They have noticed new species of shrimps and bioluminescent organisms in the seawater around the *Igluligaarjuk*.

2.4.1.2 Change in *Siku* (Sea ice)

The community in *Igluligaarjuk* has observed a significant change in the *Siku*. Alterations in the ice thickness, changes in snowfall amount and timing, changes in the rate of melting, and changes in freezing and melting time are other observed changes in *Igluligaarjuk*. A participant shared that the *Siku* in the Inlet used to be almost 6 ft thick but these days, it's around 5ft and less. Ice does not freeze thicker than before because of warmer temperatures.

Next, these days the ice starts melting sooner and starts breaking faster. The rate of melting has also increased. Rapid melting and breaking are making the ice thinner. A few years ago, the ice melting time between the Inlet and the sea was different. The Inlet used to have ice for more extended periods, even when *Siku* started breaking up in the sea. However, this has changed now; ice in the inlet starts breaking as early as it breaks up in the sea. Describing the condition of ice, Louis Autut shared:

> *Ice is not as thick. This time of the year, we were able to walk on lakes with no broken ice. You would feel safe to walk on the ice, but now it just melts a lot earlier than before. And in the winter, there's a lot less snow. Back when I used to be a hunter when I was younger, I could travel anywhere without hitting any rocks, but now, when I travel, there are rocks that still pop out. There's not as much snow and ice as before.*

Three of the interviewees think that every year it is different with the *Siku*. One of the interviewees thinks that ice levels are thicker and more compact these days than before. They said ice level depends on the amount of snowfall, blizzard, and weather temperature. As these parameters keep on changing, the ice thickness and freezing and melting times change every year.

2.4.1.3 Changes in the *Tasiq* (Lake) and *Kuuk* (River)

The next change that *Igluligaarjuk* has gone through is in the *Tasiq*. The level of *Imaq* (water) in the *Tasiq* around *Igluligaarjuk* is getting shallower and has decreased

noticeably. Many small *Tasiq* and puddles are drying up faster. The *Imaq* marks on the *Tasiq*'s rocks is higher than the present level of *Imaq*.

The same is true with the *Kuuk* as well. The level has decreased in the *Kuuk*. The speed of flow in the *Kuuk* has also decreased. Crossing the *Kuuk* used to be hard in the old days, but now, it is easy to do so because of the low *Imaq* level. Leo Minialik shared how water levels have changed in the *Kuuk*:

> *The water level is going lower, and the rivers aren't flowing as much as they used to. I have seen a lot of changes when the river is not as high as it should be. At the end of August or something like that, you have to go up to the rim up to the lakes. And the rivers aren't flowing as much as before.*

2.4.1.4 Rainfall

Rainfall has also decreased in *Igluligaarjuk*. Four of the interviewees shared that they have noticed less rainfall these days than in previous years. One of them said it's increasing, while four said there is no change in the rainfall pattern.

> [Andre Tautu]- *"I think we used to have more rain when I was very young, but we don't get that much anymore. Not much training anymore."*

2.4.1.5 Decrease in snowfall

Two interviewees shared that there is a decrease in snowfall in the winter. Less snowfall occurred in the last two years. Ice fishing is much easier these days because there is less snow above the ice to shovel out. Sharing the changes in the snowfall Jason Ippiak said:

> *When I was between that age, like 10 to 15, like younger boys, we were always told to shovel where they're going to drill holes. The depth of the snow used to be about three to four feet sometimes five feet high. So we used to dig down right to the ice. But now like last early May and April I went fishing, but it's been this has been like this probably for the past 5/10 years that you don't even have to shovel.*

2.4.1.6 Water quality

Almost all the interviewees said that the quality of drinking *Imaq* is good and fresh. They have not noticed anything unusual in the *Imaq*. The community gets drinking *Imaq* from *Puirsu* (First Lake), *Akulliq* (Second Lake), and *Amaruqtalik* (Third Lake). Since they think that Lake's *Imaq* is fresh and clean, they have been drinking *Imaq* directly from the *Tasiq* though the municipality has a supply of purified *Imaq* to all the households. The preference for drinking water directly from *Tasiq* is because of its good taste. Interviewees shared that they don't drink tap water because of the smell of chlorine.

> [Harry Aggark]- *"Never really noticed the changes in the color of the water. We still have fresh water."*
> [Philippa Aggark]- *"I think they're still clean. The lakes that we go get water from are still okay."*

2.4.1.7 Climate change/ warmer temperatures

Nine of the IQ holders said that there is a change in the weather, temperature, and climate. The air and sea in *Igluligaarjuk* are getting warmer, and there is a shortened winter and longer summer. Participants shared their experiences on how cold it used to be when they were younger and how this has changed now.

> [Louis Autut]- *"The temperatures is a lot warmer and hotter than years before. I think that in the future it will get hotter and there there'll be a bigger risk of a fire starting anywhere around the house or land."*

However, one of the hunters had a different view on climate change. According to him, the changes observed do not have much to do with global warming. Change in the climate is a natural process that occurs in a natural cycle. Some years are dry, and some years are wetter. Some years, it's hotter; some years, it's colder. *Imaq* in the *Tasiq* rises up when it rains and goes down when it doesn't. Nature fluctuates, and change happens but comes back again. Considering the views of the interviewees, the observed changes in *Igluligaarjuk* are caused by both climate change and natural fluctuations. Explaining how natural fluctuations work, Larry Ittinuar shared:

So last year, it was a little bit drier. So, everybody said, oh, its global warming and stuff. But you know, the following year, it's going to be deeper and wetter. Like this year already, we have a lot of water raining constantly, so we're seeing higher levels in the lakes and the rivers. That's what we see, through decades of hunting and stuff.

2.4.1.8 Change in the *Nuna* (Land)

One of the changes observed in *Igluligaarjuk* land is the increase in dryness. Many small ponds and ditches have dried, and the amount of water has decreased in the soil. Because of this, plants on the ground die easily.

2.4.1.9 Change in vegetation.

Except in the winter season, the community has found changes in vegetation growth. Six of the participants have noticed a faster rate of growth in both height and coverage. Five have not noticed any new plant species, while one has noticed many non-native plants growing around *Igluligaarjuk*. An elderly participant shared that he has noticed more moss and grass growing around the houses.

[Jacinthe Amarok]- *"They're growing faster, like the berries, like ...I think this year it's gonna be like middle of July or the end of July. Before they used to grow like in August, the berries, the end of August. Now it's only earlier."*

Some of the berry pickers said that there was a decrease in *Akpik* (cloudberry) yield, which they think might be because of less rainfall. However, some of them said it is increasing because it is hotter these days.

2.4.2 Indicators used in monitoring the changes

2.4.2.1 Observation as Indicators

IQ indicators of the changes in the socio-ecological system in the *Igluligaarjuk* are based on the observation, knowledge, understanding, and experience of the community. Their

life, including livelihood, culture, tradition, food, and lifestyle, is based on the natural resources and surroundings they live in, because of which they have a deep connection with nature. They have close observation of how their surroundings are like and what changes they have gone through while they are out on the land, hunting or fishing.

With close observation and comparison between the present and the past, they develop a pattern of how the environment would be over time. Based on the study of the pattern, they determine whether the changes seen are problematic or a natural cycle. Jennifer Sammurtok explained how they observe and determine weather patterns:

> *.....the way the environment is, we kinda know how the pattern is.....Indicators or signs that we look out for, you know, it's just observing yearly. Observing yearly, always have an eye out for the seasons of the year to see if it was like that last year, compare it to this year, or if it was like that two years ago, compare it to this year.*

2.4.2.2 From the stories from the past

Stories from the past, which are passed down through the generations, are one reference the community takes to determine the changes. The stories their seniors and ancestors shared with them are used to compare the present with the past, and also to predict how would the future be. Remembering the stories his father told him about the health of the *Tuktu*, Jimmy Krako explained the relation between caribou and snowpack on the tundra:

> *Caribou tend to eat on the tundra, whatever they eat. If the snowpack is not too hard for them to break, they will have enough food. But if it's too hard, some of them can't, like can't go all the way down to the ground. And that's when they're more skinnier. This is from what I heard from my late father. Cause he used to tell us stories about the old days. And I do remember some of them, but not all of them.*

2.4.2.3 Observation through the ages

Observation of nature starts in childhood. Inuit knowledge from the parents and community is shared, starting at a young age. Children are taken out on the land for hunting and fishing with their parents and other Elders. They observe and get involved in

the traditional practices to gain knowledge of the surroundings, which continues as they get older.

2.4.2.4 Indicators for *Tuktu*

Hunters and harvesters in *Igluligaarjuk* use IQ, indicators, and observations in hunting and managing the *Tuktu* populations. They use many references to determine which one among a herd to hunt and which not to, the time and place for hunting, determine their health and estimate their population, and to know the biology and life cycle of *Tuktu*.

Tuktu body condition indicator

In *Tuktu*, hunters observe their movement and outer appearance, like fur, skin, antler, hoof muscle, and fat, to determine health. They see if there are any unusual things inside the body, like fluid, white pus, sores, or blisters on the joints, bones, and muscles, which are signs of unhealthy *Tuktu*.

> *A hunter should know when they're skinning deer, for example, caribou when you skin it, they notice the strange condition of the meat, or it could have white pus or white spot on the meat.* [Harry Aggark]

They see the livers. The reddish or almost red-colored pores in the *Tuktu* are considered healthy whereas the greenish or bluish liver indicates that it is sick. They see the color texture under the skin and ribs, in the joints, muscles, and organs. The unusual colors, like greenish joints, indicate sick animals. Unusual greenish fluid in the shoulder indicates unhealthy *Tuktu*.

Next, they see how fat or skinny the animal is. *Tuktu* with more fat reserves are considered healthy. But it also depends upon the seasons, it is normal to be skinner when they change their winter fur, and when females are with the calves.

Body movement

Hunters also observe the movement and level of activeness in the *Tuktu* to determine their health. *Tuktu* with stiff movement and are inactive are some determining factors that there is something wrong.

If you see a caribou that's not really active, slow, you can tell that there's something wrong with the caribou. Maybe something is wrong with joints, watery or. You can always tell. [Philippa Aggark]

2.4.2.5 Indicators for preference to hunt

Fat reserve in the body, amount of muscles, timing and seasons, and health of *Tuktu* are the determining factors for hunting preference. Most of the hunters shared that they prefer bull for hunting. It is because bulls are fat and muscular most of the time. The bull with big, curved, and palmated antlers is chosen first. They are considered healthy and fattier. After bulls, they prefer females with no calves as they have more fat reserves than those with calves. On the question, "Which *Tuktu* would you prefer to hunt?" the answers some of the hunters gave were,

[Mark Amarok]- "Depends, but bull caribou most."
[Larry Ittinuar]- "I start hunting it when they are more fat and healthier."
[Carl Amarok]- "I go for the big one. The one with the fat."
[Jennifer Sammurtok]- "A lot of times, it's a bull caribou that we go for because it has the most healthy, like the biggest meat with the big *Tunnuq*, the fat."
[Casimir Kriterdluk]- "They usually look for a bull, a bull caribou, or a female with no calf."

2.4.2.6 Knowledge of timing for hunting *Tuktu*

Hunters usually do not hunt *Tuktu* throughout the year. They wait for the time when the *Tuktu* gets fat and healthy. Bulls are thinner, and their meat does not taste good during winter and fall, so hunters prefer to hunt females with no calves during this period. Many hunters have different preferences varying from season to season throughout the year. They know in which season the bull gets more fat, and which season the cow gets more fat and is healthy. They also know at what season their meat is tastier. Relating the season of hunting, a hunter, Jason Ippiak, said:

> *It depends. In the summer, you could catch either male or female, but in the fall time, like from September to November, you hunt the bulls. After November, we start hunting the females. And then I would say maybe in January or February, you start hunting either the males or females, but most prefer the females. And by springtime, like April, May, June, people prefer hunting the bulls.*

Preference also depends upon their respect and knowledge in managing the population. Inuit tradition is respecting and causing less harm to animals. Hunters said that they don't hunt from the first herd because doing so might disturb the entire herd, including the following herd causing them to change their migration route or return back. So, they hunt the one from the last herd.

2.4.2.7 Knowledge of egg picking

Some of the egg harvesters shared their knowledge of duck and bird eggs' condition based on the number of eggs in the nest. According to one harvester, for *Mitiqs* (Eider duck), four eggs in a nest indicate that the embryos have started to develop inside the eggs. When there are two or three, those are good to harvest. For *Pittiulaaq* (Mallard duck), if there are two, it means there's going to be a little embryo in there already.

> [Larry Ittinuar- *"There's, when there's four in the nests, we won't take it. But if there's three and two, one, we'll take it because they're incubating already."*

The next harvester shared a different approach. According to her, for *Mitiq* and geese, if there are six eggs in a nest, that indicates embryos have started to grow, whereas if there are three or four, they are good to be harvested.

2.4.2.8 Ice Indicators

The changes in the ice are determined by the thickness of ice, softness of snow, level of salt in ice, easiness to drill, rate of melting and freezing, and timing of melting and freezing. These indicators are based on the experience during fishing, harvesting, and other activities related to *Siku*. It is also based on the incidents and stories of the past and comparing them to the present. The occurrence, presence, and availability of animals, the

state and condition of the ecosystem, and timing are taken as a reference to monitor the changes. Jennifer Sammurtok described how easy it is to drill *Siku* today than in past years:

> *I noticed that when we do ice fishing, the thickness of the ice is easier to drill right through than years before when they had to use an extension, double extensions, and then chisel to get to the water. But now, use just an extension or two extensions, and just drill.*

She further added:

> *The ice does not form as soon as before when I was younger. It used to form like in October. Because I have seen my uncle capture a polar bear on the sea ice in this inlet in October. But right now, it's like late November or the beginning of December, it just starts forming sea ice now.* [Jennifer Sammurtok]

2.4.2.9 Snowfall as an indicator for Ice thickness

The community shared that there is usually a negative correlation between the amount of snowfall and the thickness of the ice. The snow insulates the ice, causing it to be thin, which means high snowfall decreases ice thickness, and less snowfall increases the thickness. However, this natural pattern has changed in recent years and varies from different places and times. One of the participants shared that the lake ice is thicker these days because there is less snow cover over the ice:

> *The less snow we get, the Ice should be thicker; the more snow we have, the thinner the ice is. The less snow we have on the ice, it should be thicker, but this doesn't seem to be happening nowadays. It seems like the ice thickness, especially where the strong currents are, the ice is always thinner, much thinner than the different areas. That's why it seemed to break up faster in the springtime.* [Harry Aggark]

2.4.2.10 *Imaq* (water) quality indicators

Participants did not share a specific indicator they use to detect the quality of *Imaq* but they frequently used terms like color, good water, drinkable water, tasty water, and presence of minerals, contamination, and bugs in the water while describing the status of the water.

Table 2. 2 Changes observed in Igluligaarjuk, and indicators used in monitoring the changes.

SN	Ecosystem components/ function and Indicators	No of the interviews referred to the changes	Common observations	Illustrative Observations (direct quotes from the interviewees).
	Animals			
1	**Abundance**	9	The number of *Tuktu* has either increased or has not changed much but has not decreased.	"Before way back when I was young, we hardly used to see caribou but now the herd are coming this way. We see the herd. We never used to see the herd before, but we can see them now. Like a lot of them."
2	**Body condition**			
	Movement, behavior, and activeness	3	Many sick *Tuktu* are found these days. Mostly fluids and pus on the joints, skins, and hoofs are found.	"Sick caribou have problems in moving and they are inactive."
	Fluid, pus, and sores in the body	6		... caribou when you skin it, it could have white pus or white spot on the meat.
	Color of liver	4		"If the liver is too blue, then there's something wrong. The pores should be a nice brownish color, almost red."
	Color of organs, joints, muscles, and ribs	4		"(Sick caribou has) like something different inside the skin on the ribs or outside the ribs and there's a lot of fluid on the shoulder and like it's green."
	Amount of fat in the body	5		"I go for the big one. The one with the fat."
	Size and shape of antler	2		"When you see a bull *Tuktu* with big antlers and when you see a *Tuktu* with antlers are close to each other like that, you can tell that the *Tuktu* is healthy and fat."
3	**Hunting preference**			
	Size and amount of fat reserve	5	Hunters prefer healthy and fat bulls or cows with no calves.	"I start hunting it when they are more fat"
	Seasons and timing	3		"In the fall when they start rutting the females, we hunt the big females without calves."
	Male/ Female	4		"A lot of times, it's a bull *Tuktu* that we go for."
	Size and shape of antler	2		"…. if you see this kind of *Tuktu* how big it is, how big the antlers are, that's a healthy one. "

SN	Ecosystem components/ function and Indicators	No of the interviews referred to the changes	Common observations	Illustrative Observations (direct quotes from the interviewees).
	Presence of calves with cow	2		"They usually look for a bull, a bull *Tuktu*, or a female with no calf."
4	***Nattiq* (Seal) abundance**	14	The sea population has sharply declined in *Igluligaarjuk*. They have moved away where there is more ice.	"Before we would see 1000s of *Nattiq* up the inlet and that would be like an easy lunch. We should have it for lunch and continue. And today you'll be lucky to see one within 200 miles."
5	**Abundance**	3	less *Nanuq* is observed in the Inlet these days as they have moved to other places. However, its population has increased in the region. More Sick and old bears approach settlement areas.	"The *Nanuq* are going further north."
6	**Body condition**		Skinny, unhealthy, and old *Nanuq* are seen around the settlement.	"I notice that the *Nanuq* are like they're so skinny now cause Ice is gone too soon."
7	*Siku* thickness	13	Ice is much thinner these days.	"The ice is not getting as thick as it used to be. It used to be over six feet thick, but it's only about five feet or something."
8	*Siku* breakup	10	Ice now breaks earlier than before.	"Normally ice used to break up at the beginning of July during mid-1960s but this year it breaks up about two and half weeks earlier. That was in the middle of June this month."
9	*Siku* Freezing time	9	Ice freezes later than it used to before.	"I think the weather is warmer and it takes longer time for the Ice to freeze up in the fall now. Like we used to be able to cross the Chesterfield inlet in the beginning or middle of November in 1960S. Right now, we are waiting until almost January. That's about three months later."
10	Rate of ice melting	2	Ice and snow melt rapidly. Snow melts within a few days.	"And then this year, the snow melted really fast. Like in an instant, in the month of June. It was more like the month of July we would have. That's how fast the snow and ice melted."

SN	Ecosystem components/ function and Indicators	No of the interviews referred to the changes	Common observations	Illustrative Observations (direct quotes from the interviewees).
11	Easiness in drilling/ softness	2		"I noticed when we did the fishing, it was like, the thickness of the ice was easier to drill right through than years before…"
12	**Lake ice thickness**	1	The lake ice thickness has increased.	
13	***Tasiq* level**	6	The level of water in the lakes has decreased, which is much lower than the rim marks of previous years.	
14	***Kuuk* level**	3	The level of water in the rivers has decreased, which is much lower than the rim marks of previous years.	
15	**Temperature**	7	The temperature in *Igluligaarjuk* is getting hotter and warmer	"I have seen changes. When I was younger it used to be very cold. It used to be colder then, but now it's not as cold as before."
16	**Seasonal timing**	3	The winter season is getting shorter and the summer season is getting longer	"I noticed about the climate change. Summer comes earlier now you know the fall is very late."
17	**Rainfall**	9	The frequency of rainfall has either decreased or is the same as before but has not increased.	"On summertime, we barely get any rainfall anymore cause that's why the ground is so dry. That's the only change he has noticed cause we barely get any rain during the summer."
18	**Snowfall**	2	There is less snowfall than before	"I know, the past few years, we hardly had any snow."
19	***Nuna***	3	*Nuna* is getting drier, little ponds and ditches have dried up.	"And as you are walking on the grounds on bushy parts, you can even hear them so dry, too dry and that's one of the changes. The land is kind of too dry."
20	**Vegetation growth rate**	8	Vegetation is growing faster in both height and coverage.	"And what I am starting to notice is there's more like (Nuna) there's more moss and grass growing around the houses."

Table 2. 3 Possible questions for long-term monitoring of the ecosystem

SN	Ecosystem components/ function and Indicators	Possible questions for long-term monitoring
	Animal	
1	**Abundance**	Estimate the population of *Tuktu*, male and female, number of calves, type and size of herds in every season or year. How many are found in different areas? Is there any change in the migration route?
2	**Body condition**	
	Movement, behavior, and activeness	How many *Tuktu* are found to have problems in movement, behavior, and activeness? When and where were such *Tuktu* found?
	Fluid, pus, and sores in the body	How many *Tuktu* are found with fluid, pus, and sores in their body? When and where were such *Tuktu* found?
	Color of liver	Are there any abnormalities in the color and health of the liver?
	Color of organs, joints, muscles, and ribs	Are there any abnormalities in the color and health of organs, joints, muscles, and ribs?
	Amount of fat in the body	Do the *Tuktu* have more or less fat than normal?
	Size and shape of antler	Are there any abnormal shapes and sizes of antlers? How many have such?
3	**Hunting preference**	
	Seasons and timing	Are there any changes in the natural cycles of *Tuktu*? Like, migration, number of herds in that season.
	Male/ Female	Estimate the population of *Tuktu*, male and female, type, and size of herds in every season or year.
	Presence of calves with cow	How many calves are found in the herd?
4	*Nattiq* abundance	Estimate the population of *Nattiq*, male and female including the number of pups in every season or year. How many are found in different areas? Is there any change in the migration route?
5	*Nanuq* abundance	Estimate the population of *Nanuq*, including cubs, male and female in every season or year. How many are found in different areas? Is there any change in the migration route?
6	*Nanuq* body condition	How many *Nanuq* are seen around the settlement? How is their health condition? What might be the reasons for them coming to the community?
7	*Siku* thickness	What is the current thickness of the S*iku* in different areas? How much is the difference from last year? How does it change over the months of the same year?
8	*Siku* breakup	When does it start melting? At different areas?
9	*Siku* Freezing time	When does it start freezing? At different areas?
10	Rate of ice melting	How long does the ice remain before it completely dries up? At different areas?
11	Easiness in drilling/ softness	How easy is it to drill the ice? How many chisels or extensions are needed for drilling?

SN	Ecosystem components/ function and Indicators	Possible questions for long-term monitoring
12	***Tasiq* level**	Are the levels of *Tasiq* declining or increasing?
13	***Kuuk* level**	Are the levels of *Kuuk* declining or increasing? How difficult or easy is it to cross the rivers?
14	**Temperature**	What is the monthly air and sea temperature?
15	**Seasonal timing**	How long is the summer and the winter every year?
16	**Rainfall**	What is the frequency and amount of rainfall?
17	**Snowfall**	What is the frequency and amount of snowfall?
18	***Nuna***	How dry is the *Nuna*? Are plants drying up sooner than normal time? Are ponds, ditches, and streams drying up?
19	**Vegetation growth rate**	How fast is the *Piruqsiat* growing in height? Are they increasing in coverage?

2.5 Discussion and Conclusion

IK is considered critical knowledge for understanding and managing the environment (Peloquin & Berkes, 2009). IP and IK are increasingly being recognized, involved, and used in monitoring the changes in the Arctic and Sub-Arctic regions (Johnson et al., 2016; Kouril et al., 2016) mainly in response to environmental change but also due to issues like the impacts of infrastructure and resource extraction like mining on natural and social systems (Johnson et al., 2016; Wilson et al., 2018).

Through this research, we found out that the changes that *Igluligaarjuk* has noticed are mostly related to animals, *Tasiq*, *Kuuk*, *Siku,* precipitation, temperature, *Nuna*, and vegetation. Degrading health of *Tuktu* and *Nanuq*, decline in the abundance of *Nattiq* and *Nanuq*, decrease in ice thickness, early ice melting, late freezing, rapid growth of plants, and decreased yield of cloudberries are the specific changes observed by the Inuit knowledge holders. The changes observed in *Igluligaarjuk* are similar to the changes observed in other parts of the Arctic studies (Garcia-Soto et al., 2021; Gérin-Lajoie et al., 2018; Ndeloh Etiendem et al., 2020; J. Overland et al., 2019; J. E. Overland et al., 2014;

Tomaselli et al., 2022; Thoman et al., 2023). The change-related findings of the research are similar to other studies by Maelzer (2023) and Newell (2018) in *Igluligaarjuk.*

Our findings on *Nanuq* suggest that due to the loss of *Nattiq* in the inlet and harbor, they have moved away, more toward the north. Their sightings in the settlement area have increased. However, the overall population of *Nanuq* in the region has increased. The same perception from the *Igluligaarjuk* community was reported in the study by Lokken et al. (2019) but in contrast to our findings, other studies, Lunn et al. (2016) and Stapleton et al. (2014) have shown that *Nanuq* abundance has decreased. The increase in the *Nanuq* population was also shown by a study done in the Kimmirut, Pangnirtung, and Iqaluit communities of Nunavut where it increased by 73% since the 1970s in Kimmirut (Tomaselli et al., 2022). Like the sharp decline in the *Nattiq* around the *Igluligaarjuk*, the same study also showed a significant decline of ringed seals in those regions.

Our findings on the population of *Tuktu* are consistent with the study by Lokken et al. (2019). Most participants shared they are either increasing or have not changed. Observation of an increasing pattern in the *Tuktu* population including a calf in the *Igluligaarjuk* is different than the study done in Tłı chǫ region, where the calf population showed a declining pattern (Ekwǫ̀ Nàxoèhdee K'è report, 2022). In contrast to our findings of increasing sightings of sick *Tuktu*, the other difference in this study was also on the health of *Tuktu* where the pattern of good *Tuktu* health was reported.

Taking indicators as a reference, the *Igluligaarjuk* community compares the present condition and status with the past to monitor the changes. Indicators like thickness, melting time, freezing time, rate of melting, and availability of ice and mammals are used in *Igluligaarjuk* to determine the overall changes in *Siku*. The formation of ice, freezing time, and melting time indicate not just the overall condition of ice, it is also the key factor that affects the health and population of animals, fish, and birds associated with it (MacDonald et al., 1997). Likewise, color, taste, and cleanliness are used to determine the status of drinking *Imaq*. Indicators like the color of the liver, amount of fat, presence of fluid under the skin, and movement are used to determine *Tuktu'*s health. These indicators are similar to the indicators documented in "Voices from the Bay" (MacDonald et al., 1997). Indicators are also in line with those used by Tłı chǫ in monitoring the *Tuktu*

health with additional indicators like the length of the tail and number of calves with the cow (Rabesca et al., 2017). The differences and similarities in the status and pattern of the animals and other components of the ecosystem and the knowledge of the community in *Igluligaarjuk* as compared to other places indicate that it is important to focus the study on the particular areas and community. Sometimes it might not be right to generalize the findings from a place to an entire region.

The knowledge that the Inuit of *Igluligaarjuk* has is based on close observation of the ecosystem, experience, and traditional activities related to the resources. While explaining the changes, Elders and hunters oftentimes do not use specific terms for the indicators. As mentioned by Berkes et al. (2007), such observations are general, represent the overall status or changes, and help create a holistic picture "of the environment on a continuous time scale" (Berkes et al., 2007, p. 158). For instance, "we can tell", "we'll know right away if it's not healthy", "we can say by looking at them", and "you can automatically tell that there's something wrong" are the common answers that community members refer to when asked about the indicators. They reach a conclusion based on their long-term observation and their connection with their environment. To validate their observation, analyze the pattern, and predict the possibility of the future, they compare or refer to what their parents and ancestors have told them. Taking pictures and recording the observations will allow them to compare and analyze the findings.

Engaging IK indicators alongside Western scientific knowledge indicators is important for long-term monitoring programs. However, it is crucial to understand the historical and political context of knowledge integration and other problems and challenges that might arise during integration. One of the problems with knowledge integration is rooted in the colonial form of research (Gaudry, 2011). Through the integration paradigm, IK is filtered and extracted to fit Western scientific knowledge requirements in already existing institutions and forms (Nadasdy, 1999; Simpson, 2004). Additionally, knowledge integration involves the disbelief and distrust between the holders of IK and Western scientific knowledge. One hunter during the interview shared how scientists didn't trust them when they said that the abundance of *Tuktu* and *Nanuq* had increased. This type of distrust of the Indigenous community in the study, data, and methodology designed by

outsiders is because of settler colonial governance both historically and in the present (Wilson et al., 2018). The same study also reported how the community samplers had greater trust in the data collected by the community than that by outsiders (Wilson et al., 2018).

Another problem that might come during CBM is the unequal authority of making decisions which results in valuing one knowledge system more than another. For instance, the "Quota system" allocated to the community by the Narwal Management programs in the Arctic was considered ineffective by the Inuit hunters (Armitage, 2005). Despite working on what the Inuit said, the program ignored their knowledge and approaches to determining the whale stock and imposed quotas that limited the hunting practice of the Inuit (Armitage, 2005). The community in *Igluligaarjuk* also shared that they have often voiced to increase the number of quotas for *Nanuq* allowable harvest, however, their voices are not considered while deciding the annual allowable harvest by each community. Other communities in Nunavut like Kimmirut and Pangnirtung, have been raising the same concern of fewer quotas allocated compared to the increasing *Nanuq* population (Tomaselli et al., 2022). Similarly, the *Igluligaarjuk* community shared that their voices are not heard by the shipping and mining companies though they are the ones highly impacted. They indicated that they were excluded from the decision-making process many times. One Elder during the interview shared that they wanted to be in a leading position, not just to participate in the management of shipping. Next, the integration approach has multiple issues of ignoring "friction, antagonism, and power inherent in knowledge co-production" which could provide a base for generating alternative ways of managing environmental problems (Klenk & Meehan, 2015, p. 160).

With in-depth ecosystem knowledge, IP are considered environmental experts. They often have a wider range of knowledge than Western science. The collaborative approach in CBM helps to put Indigenous and Western scientific knowledge together comprehending and filling the gaps of one another and making the work more accurate and inclusive (Arsenault et al., 2019). As IK are adapted and changed with the changes in the ecosystem, engaging them in CBM gives data more accurate and based on different time scales. Since IK is the accumulation of knowledge over many years passing from

generation to generation, it provides the baseline and historical data of the ecosystem conditions that even Western science cannot explore (MacDonald et al., 2009). However, studies suggest that many such collaborative CBM programs in practice frame the community as a stakeholder excluding locals from self-determination and governance (Reed et al., 2020). Environmental governance designed by settler colonizers places IP as stakeholders in asserting self-determination. Based on the Land Claims Agreements between IP and the state, IP have been able to conduct research and be involved in the decision-making process to some extent. However, these agreements are critiqued for limiting full involvement in important phases of decision-making processes and also critiqued for limiting the full practice of Indigenous governance (Wilson et al., 2023).

Indigenous communities are now using their own methods of monitoring with approaches like empowering locals to monitor and develop their own plans, standards, methodologies, and protocols with their leading or equal role in the decision-making process (Arsenault et al., 2019). Indigenous CBM programs are growing to empower Indigenous governance and support self-determination and knowledge transfer to the younger generations. For instance, Indigenous Guardian programs are increasing globally, more in Canada and Australia (Reed et al., 2021) and have broadly supported resource monitoring, knowledge preservation and transfer to the younger generations, and sustainable management of the environment (Reed et al., 2020). However, Reed et al. (2021) suggest that barriers and control from the state government still exist and further critical study and analysis are required to conclude whether they have backed up or barred Indigenous governance. Despite all these challenges of knowledge integration between IK and Western scientific knowledge, there are opportunities and alternatives for better integration. For example, Klenk & Meehan (2015) gives “triangulation, the multiple evidence-based approaches, and scenario building” as alternatives for knowledge integration among different disciplines (Klenk & Meehan, 2015, p. 160). Two-eyed seeing, an approach of seeing through both the Indigenous and Western worldviews combining the strengths they both possess (Reid et al., 2020), is used increasingly as a guiding framework for knowledge integration. However, Western science should not be in a role or intend to validate or legitimate the TK to fit them into the Western system (Nadasdy, 1999). IK is better understood and analyzed only when the

community members are involved in the entire process from research or monitoring to the decision-making step.

CBM programs working with Indigenous communities should analyze the possible challenges that might come during the entire process of monitoring. Programs should be carefully designed, and challenges should be sorted out mutually between the community and the researcher or any outsiders involved in the program. Sapujiyiit Society, the Inuit-led Guardian CBM project in the Kivalliq region, aims to bridge the IQ and Western science to monitor the impacts of climate change and marine health and to facilitate and advocate for Indigenous solutions. This research documents the baseline information of the changes in *Igluligaarjuk,* and IQ indicators in monitoring such changes. It highlights the challenges and implications of knowledge integration. Our research findings are intended to help inform the Sapujiyiit Society, HTO, and other community-based organizations for long-term monitoring programs in the region.

Chapter III

IQ and Community-based Monitoring of Cumulative Impacts in *Igluligaarjuk* (Chesterfield Inlet)

Abstract

The Arctic has undergone rapid changes in the last few decades. The drivers of change are climate change, infrastructure development, shipping, and mining. Shipping is one of the main concerns in *Igluligaarjuk* that has both social and ecological implications for the community. To find out about the impacts in *Igluligaarjuk* and how such impacts are experienced by the community, we used a community-based qualitative research approach. With fifteen interviews and two workshops with the Inuit Qaujimajatuqangit holders (hunters, harvesters, Elders, and other community members), we found that most of the changes observed were related to animal health and abundance, lake, river, sea ice, precipitation, temperature, land, and vegetation. More specifically, shipping has a major impact on seals, polar bears, caribou, and sea ice. Furthermore, oil spills and ballast water from ships have negatively affected marine ecosystems. Changes in *Igluligaarjuk* have cumulative impacts on the community including linked intangible and tangible impacts. Intangible impacts are on food, culture, tradition, and knowledge whereas tangible impacts are on travel and safety, travel cost, hunting, fishing, and harvesting. The observed changes and their consequent impacts could be used as indicators to track and manage social and ecological changes such as those related to climate change and shipping.

Keywords: Community-based monitoring, Inuit Qaujimajatuqangit, Cumulative Impacts, climate change, shipping, mining

3.1 Introduction

The Arctic environment is changing rapidly with high-temperature rise, decrease in ice, and change in the ecology as the result of anthropogenic climate change (Gérin-Lajoie et al., 2018; Ndeloh Etiendem et al., 2020). With the temperature getting warmer, almost four-fold faster than the mean Earth temperature (Rantanen et al., 2022), sea ice in the Arctic has been decreasing gradually over time in surface cover, amount, and thickness (Garcia-Soto et al., 2021; Overland et al., 2014b). The snowfall pattern has been fluctuating with highs in some areas and lows in some areas of the Arctic (Thoman et al., 2023). The same is with the overall precipitation which varies regionally (Walsh et al., 2023).

Climate change impacts on sea ice such as the reduced sea ice thickness, extent, and seasonal duration, have enabled the opening of new shipping routes and marine activities (Downing, 2019; Hovelsrud et al., 2011) as well as longer shipping seasons in the Arctic (Brigham, 2008; Theocharis et al., 2018). Increases in shipping are driven by an increase in mining, and commercial marine activities like tourism, transportation, and fishing (Downing, 2019; Wang & Aporta, 2024a).

Change in the Arctic ecologically and socially affects lives of Indigenous People (IP) socially, culturally, and economically. Climate change and change in the cryosphere combined with the other associated anthropogenic stressors have cascading impacts on the communities that have a high dependency on natural resources, beyond their adaptative capacity in most cases (Hovelsrud et al., 2011). Thus, a significant increase in shipping activities in the Arctic is a growing concern for the communities considering its impacts on the social aspects, economy, and culture (Van Luijk et al., 2022).

The level and severity of the climate change impact varies in different communities because of geographical, social, economic, and political reasons (Prażmowska-Marcinowska, 2023; Sultana, 2022). IP in the Arctic are more severely impacted climate change than people in other regions because of rapid temperature rise, sensitive topography with a large portion covered by ice and sea, and their integral connections and dependency on the ice and natural resources. (Kronk Warner & Abate, 2014; Mantyka-Pringle et al., 2017a; Roosvall & Tegelberg, 2015). Though IP contribute

almost negligible amounts of carbon, the impacts of climate change on them are disproportionate compared to others. (Kronk Warner & Abate, 2014).

There is a growing concern among the communities in Nunavut about the increasing shipping (Carter et al., 2019). Research conducted in Coral Harbour, a community in Kivalliq, reported that increasing sea vessel activities in sensitive areas could impact marine animals' habitats, reproductive activities, and migration patterns. This could also lead to an increased risk of travel accidents, and affect traditional food culture (Carter et al., 2019). Mining and related activities are some of the main reasons behind the increase in shipping in Igluligaarjuk, Nunavut. The *Igluligaarjuk* community has been raising its voice against the impacts of shipping on the marine ecosystem (Kamula et al., 2016). Its growing social and ecological impacts are a concern to the *Igluligaarjuk* community (Maelzer, 2023; Newell & Doubleday, 2020). Kamula et al. (2016) suggests conducting further studies on the impact of shipping and climate change on the *Igluligaarjuk* environment.

Indigenous knowledge (IK) could be crucial in monitoring the impacts of climate change on ecosystems and communities. There are multiple fields where IK could complement scientific knowledge in terms of climate change (Berkes et al., 2007). Community-based monitoring (CBM) is significant in managing and monitoring the impacts of climate change (Lam et al., 2019) as it uses holistic approaches to monitoring both the social and environmental changes and their cumulative impacts on communities (Stenekes et al., 2020).

Through the partnership with Inuit organizations including the Aqigiq Hunters and Trappers Organization (HTO) and The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society), I conducted community-based research in *Igluligaarjuk* to learn about how the community is experiencing a change in their Social-ecological System.

3.2 Review of Literature

3.2.1 The cumulative impact of changes on Indigenous People

Climate change, mining, and shipping combinedly have a cumulative impact on the Indigenous communities of the Arctic. The cumulative impacts are “compounding and incremental impacts that result directly from environmental disturbances (often anthropogenic development projects) that can invoke ecological change” (Proverbs, 2019). The change in cryosphere and climate and anthropogenic activities like resource development, mining, and shipping have cumulative implications on the community and ecosystem (Hovelsrud et al., 2011). Some of these impacts are tangible whereas others are intangible. When external stressors affect certain aspects of their traditional activities, it impacts their culture and livelihood associated with it (Turner et al., 2008).

One of the major impacts is on country food which has implications on the food tradition, nutrition, and economy (Donatuto et al., 2011). Changes in the snow and ice have cascading impacts on the habitat, reproduction, and migration of the animals. There is a decline in the species that IP depend on because of climate change. Traditional harvesting has always been a crucial part of the Arctic economy and culture and has balanced food security, and cost of living. (Arruda & Krutkowski, 2017; Prażmowska-Marcinowska, 2023). Reduction in the primary food source that the community depends on has a negative chain effect on the livelihood and culture associated with it. This results in the exclusion of the cultural activities connected with it (Donatuto et al., 2011; Turner et al., 2008). The impact on traditional harvesting also affects the economy at the individual and community levels. As Turner et al (2008) note, “[l]ocally produced food is often part of a larger subsistence economy, its loss can greatly intensify poverty by forcing people into greater reliance on external market-based products” (Turner et al., 2008).

Traditional activities related to land, hunting, harvesting, fishing, and traveling have integral connections with the IP. It is not just the source of food and living but something they are spiritually and emotionally connected to. It provides relief from stress (Cunsolo Willox et al., 2013a). Harvesting traditional foods is “more than just a mode of subsistence, it is a way of life drastically different from one determined by cash economy and store-bought ready meals as the source of nutrition” (Arruda & Krutkowski, 2017, p.

278). Hunting and fishing activities promote social ties and relations within the family and among the community members. With the decline of such activities because of fewer animals, the social composition and relations are weakened (Prażmowska-Marcinowska, 2023).

The inability to engage in traditional practices such as harvesting affects the knowledge associated with it (Prażmowska-Marcinowska, 2023). IK systems consist of intangible components like language, belief systems, values, norms, and worldviews, and tangible components like physical structures, monuments, land, and animals (Orlove et al., 2022). The knowledge of hunting, and processing meat might be disturbed because of animal decline. This disrupts the flow and transfer of knowledge from Elder knowledge holders to the younger generation (Prażmowska-Marcinowska, 2023). It refers to the understanding of the customary foods and techniques for survival that their predecessors possessed (Turner et al., 2008). For example, because of unpredictable weather conditions, and changes in the snow and ice, the practice of making Igloos and the knowledge associated with it are affected (Prażmowska-Marcinowska, 2023). Next, when people are deprived of the resources they have been using for thousands of years, their knowledge and ability to manage such resources also reduces, making them lose more of their traditional lifestyle and practices (Donatuto et al., 2011; Turner et al., 2008).

The landscapes which IP consider their homeland connect nature with humans and their cultural identity (Orlove et al., 2022). IP have a much closer connection with land than other Western communities have (Arruda & Krutkowski, 2017). Land for Inuit is a collective term for land, sea, lakes, or rivers. Their knowledge, culture, livelihood, experiences, and survival are related to the land. It is a medium to connect to their family, community, and nature (Reed et al., 2021). Describing the importance of land, a hunter said, "…it's a way of life for us to be out on the land and to do things and to feel, you know, that you are part of Mother Nature. It's just the same as bathing every day. It feels good" (Cunsolo Willox et al., 2013b, p. 262). The impact on the landscape, plants, and animals is the impact on its culture, knowledge, and spiritual importance (Orlove et al., 2022).

The extraction of resources like hydrocarbons and minerals in the Arctic has impacted the Arctic ecosystem and subsistence economy of the IP (Arruda & Krutkowski, 2017). Consequently, the physical changes that resource development brings have a social impact. It changes living styles, economy, livelihood, and cash jobs. The increasing trend of extraction and infrastructure has impacted them both at the individual and community level (Arruda & Krutkowski, 2017). Despite the serious impacts climate change has on multiple dimensions of tangible and intangible cultural and social values of the IP, impacts on Indigenous culture and values that are intangible in nature are less studied and assessed throughout the world (Orlove et al., 2022; Simpson et al., 2022).

3.2.2 Impact of Mining

Mining activities and associated infrastructure development are the drivers of development of economy in the Arctic (Tolvanen et al., 2019). However, though exploration and mines provide jobs to few locals, it has a long-lasting environmental impact on the area, disrupting local ecosystems (Bernauer, 2010; Dana & Anderson, 2014). Land and marine animals are affected (Bowman, 2011). For example, Caribou (*Tuktu*) tend to avoid mines and industrial areas. Infrastructure like roads, machines, and excess human activities around mines disturb *Tuktu* migration routes and might result in herd fragmentation (Herrmann et al., 2014).

Mining in Nunavut had severe impacts on the health of the Inuit and the environment. For example, the release of dust into the atmosphere, wastes on the land and water, and disturbance to the *Tuktu* herds (Rodon & Lévesque, 2015). Mining also has an impact on traditional harvesting and affects food security (Rodon & Lévesque, 2015) which are integral parts of the Inuit's culture, well-being, livelihood, and economy (Bernauer, 2010).

3.2.3 Impact of Shipping

In addition to the intense pressure from climate change and mining, the rapid expansion of Arctic shipping has imposed serious threats to the Arctic ecosystem (Huntington et al.,

2015). Introduction of non-native species into the sea through waste and ballast water, breaking of ice along the routes of shipping, high traffic, disturbance, and noise pollution, chemical pollution through oil discharged from vessels, destruction of ice habitats of marine mammals, and emission of carbons into the atmosphere are the major threats of shipping to the ecosystem (Vincent et al., 2023). Ice breaking, and wakes from ships impose risk for travel. Ice broken by the ships once might easily break again while traveling through snowmobiles and wakes from ships may cause an imbalance in the small boats that the communities use increasing the risk of accidents (Van Luijk et al., 2022). Additionally, Hunting, fishing, and harvesting which are an integral part of Inuit culture are impacted by shipping (Van Luijk et al., 2022).

Marine resources are culturally, socially, nutritionally, and economically important for IP (Raymond-Yakoubian, 2018). For example, culturally and traditionally, they are important to carry out the activities of processing, preserving, harvesting, and sharing food, and the continuity and preservation of knowledge associated with it. Socially, they are important since sharing food strengthens community members' social relations and knowledge transfer to younger generations. Nutritionally, marine food is important for health. Being involved in harvesting activities keeps them physically and mentally healthy. Marine foods contribute a large share of the total food the community consumes, maintaining the livelihood and economy of the community (Raymond-Yakoubian, 2018). The impact of changes on Arctic communities is extreme because of their high dependence on natural resources, residence in a sensitive geographical location, and inadequate capacity and resources to cope with the changes (Ell-Kanayuk & Aporta, 2023). Hence, the impacts of stresses like climate change and mining on the community and environment are more severe than in other parts of the world (Tolvanen et al., 2019).

3.3 Materials and Methods

3.3.1 Research Setting

Chesterfield Inlet is called *Igluligaarjuk* in Inuktitut, which means “Place with a few Thule Houses.” The Inlet (63°20’N and 90°40'W) lies on the west coast of Hudson Bay, about 100 km north of Rankin Inlet (Municipality of Chesterfield Inlet, 2017). The Inlet is characterized by tundra vegetation with “birch, willow, northern Labrador tea, *Dryas spp,* and *Vaccinium spp*” (Wahab et al., 2009, p. 3). The average “annual temperature is -11 °C, with a mean summer temperature of 4.5 °C, and a mean winter temperature of -26. °C, and mean annual precipitation of 200-300 mm” (Wahab et al., 2009, p. 3). The Inlet is home to the Inuit. According to Nunavut Planning Commission, the Inlet is 1550 km north of Winnipeg. The total population of the Inlet in 2016 was 437 (Statistics Canada, 2016), with 85% Inuit.

During the early 1900s, Chesterfield was a center for the fur-pelt trade for the Hudson Bay Company. Until the 1950s, it was a center for an administration looking North of Churchill. Residential schools started during the early 1950s and closed in 1969 (Municipality of Chesterfield Inlet, 2017). In 1993, the Inuit signed the Nunavut Land Claim Agreement (NLCA) with the Government of Canada and Northwest Territories, creating a new Inuit land, Nunavut. Nunavut has a consensus governance system with no political parties for governance (Tootoo, 2012). Members of the Legislative Assembly select Speakers of the House, Premier, and Cabinet Ministers. The Municipal of Chesterfield Inlet is one of the 25 municipalities in Nunavut. The hamlet of Chesterfield Inlet governs and administers the municipality.

The Aqigiq Hunters and Trappers Organization (HTO) and KIA (Kivalliq Inuit Association) are the designated Inuit Organizations in the Kivalliq region under the NLCA. The HTO comes under the Nunavut Wildlife Management Board and the Nunavut Inuit Wildlife Secretariat. The Foxe Basin Kivalliq North Sapujiyiit/Guardians of the Sea Society (Sapujiyiit Society) is an Inuit-led Non-Governmental Organization working in Chesterfield Inet, Coral Harbor, and Naujaat, Nunavut, Canada, among other things, is working on developing long-term monitoring of the change in the climate,

animals, water, and other resources of the Foxe Basin Kivalliq North area. It also aims to monitor shipping and mining and their impacts on the region (Newell, 2023).

3.3.2 Methodology

This project used a community-based qualitative research approach to address the research questions. We used interviews and workshops as the primary data collection tools. We have incorporated and followed the recommendations from the ScIQ research framework and before, during, and after the research work (Pedersen et al., 2020b) where applicable and possible. We have also followed recommendations and guiding principles developed by Ljubicic et al. (2022) following Qaggiq Model in Uqšuqtuuq where applicable and possible. We started meeting community members a year before the interview began to talk about the research, meet, and develop a relationship. We conducted an Open House meeting with the community to get to know them more and discuss the research and priority areas. We worked closely with the HTO of *Igluligaarjuk*, community members, Hamlet of Chesterfield Inlet, and Sapujiyiit Society from designing interview questions, selection of participants, data collection, analysis, report preparation, and publication. We worked in coordination with the community in all phases of the research including designing the research, participant selection and conducting interviews and workshops, and report preparation.

We used semi-structured interviews to interview Inuit knowledge holders, where the questions were loosely structured and open-ended, and the respondents were allowed to answer in their way (Alsaawi, 2014; Easwaramoorthy & Zarinpoush, 2006). The questions were open-ended, and further questions were asked to elaborate more about the topic. We used an age limit of more than thirty years for the interviewee. The interviewees were finalized after discussion with the community. A validation (member checking) interview was conducted with participants to verify their transcripts and quote interpretation. The interview was conducted with fifteen IQ holders (n=15). An Inuit youth researcher from *Igluligaarjuk* was hired to facilitate and conduct the interview in the Inuktitut. Interviews were live translated and recorded. The interviews were recorded with consent and were transcribed later. Next, two workshops were carried out to

generate knowledge on such changes and indicators and validate the findings from the interview. Participants of the workshops were invited through consultation with the community which included members from the Aqigiq HTO, community members, Hamlet of Chesterfield Inlet, and the Sapujiyiit Society.

The raw data were analyzed based on the research questions and objectives of the study. The interview in Inuktitut was live translated first into English. For that, a local Inuit person was hired. The raw data from the interviews and workshops were transcribed with Otter.ai and thoroughly rechecked before analyzing with the software NVivo. In NVivo, themes based on the research objectives were categorized. Each interview was coded according to the theme which was later analyzed to reveal the results. All the data, results, and the final report of the research will be shared directly with the individual participants and with the community through HTO, Sapujiyiit Society.

3.4 Results

3.4.1 Impact of temperature rise and climate change on the *Siku* (Sea Ice)

The major impacts of temperature rise and change in climate are observed on the *Siku*. This impact has cascading effects on sea mammals like *Nattiq* (seals) and *Nanuq* (polar bears). The significant change that *Igluligaarjuk* has experienced is the *Siku*. Alterations in the ice thickness, changes in snowfall amount and timing, changes in the rate of melting, and changes in freezing and melting time are other observed changes in *Igluligaarjuk.* An interviewee shared that the *Siku* in the Inlet used to be almost 6 ft thick but these days, it is reduced to around 5ft or less. Ice does not freeze thicker than before because of warmer temperatures.

Next, these days, the ice starts melting sooner and starts breaking faster. The rate of melting has also increased. Rapid melting and breaking are making the ice thinner. A few years ago, the ice melting time between the Inlet and the sea was different. The Inlet used to have ice for more extended periods, even when *Siku* started breaking up in the sea. However, this has changed now; ice in the inlet starts breaking as early as it breaks up in the sea. Louis Autut recalled his observation:

Ice is not as thick. This time of the year, we were able to walk on lakes with no broken ice. You would feel safe to walk on the ice, but now it just melts a lot earlier than before. And in the winter, there's a lot less snow. Back when I used to be a hunter when I was younger, I could travel anywhere without hitting any rocks, but now, when I travel, there are rocks that still pop out. There's not as much snow and ice as before.

3.4.2 Impact of Climate Change on *Tasiq* (Lake) and *Kuuk* (River)

Climate change has resulted in the decrease of water levels in *Tasiq* and *Kuuk* in *Igluligaarjuk.* The level of water is getting shallower and has decreased noticeably. Many small *Tasiq* and puddles are drying up faster. The *Imaq* marks on the *Tasiq*'s rocks is higher than the present level of *Imaq*.

The same is true with the *Kuuk* as well. The level has decreased in the *Kuuk*. The speed of flow in the *Kuuk* has also decreased. Crossing the *Kuuk* used to be hard in the old days, but now, it is easy to do so because of the low *Imaq* level.

The water level is going lower, and the rivers aren't flowing as much as they used to. I have seen a lot of changes when the river is not as high as it should be. At the end of August or something like that, you have to go up to the rim up to the lakes. And the rivers aren't flowing as much as before. [Leo Minialik]

3.4.3 Impact on *Nattiq*

Siku and snow are the habitats of *Nattiq*. It is where they reproduce and nurture their pups. Thin ice, less snow, and early ice breakup have severely impacted the *Nattiq*, leading them to move further north and to other places with suitable habitats. The major change in *Igluligaarjuk* is that there is a sharp decline in the number of *Nattiq* in springtime. Eight interviewees said that there is a decrease in the number of *Nattiq* in the Inlet, whereas one of them said more *Nattiq* are seen these days. The reasons behind the decrease in the *Nattiq* are the delayed freezing and early melting of the ice. Another

reason is the rise in the temperature because of which they are moving further north in colder places.

> [Casimir Kriterduluk]- *"The ice was breaking up when the edge flow was close by, there used to be a lot of seals on the ice."*
>
> [Harry Aggark]- *"We used to have more seals down here, in front of the harbor. We are getting less seals now because it's taking longer to freeze. I guess they just moved somewhere else further north I guess."*

One of the interviewees said that ice in different areas used to break at different times/months and *Nattiq* used to move from one icy area to another area within *Igluligaarjuk* to escape the early break-up of ice. However, these days, ice melts around the same time in all the areas so *Nattiq* moves away from *Igluligaarjuk*.

> *When the ice would break up down here, the inlets would still have ice. So the seals would be there in the inlet. But now when the ice break starts breaking down there even the inlets start breaking up too. So that's the difference. That's why the seals aren't hanging around.* [Philippa Aggark]

3.4.4 Impact on *Nanuq*

Siku is also the habitat for *Nanuq*. Thin ice, less snow, and early ice breakup lead to their habitat destruction. On the other hand, they prey on the *Nattiq* and their pups as their food, and they move along where the *Nattiq* and their prey move. They need ice for hunting. The decline of *Siku* in *Igluligaarjuk* has affected *Nanuq* in multiple ways from habitat destruction to lack of prey, to difficulty in hunting. Mark Amarok explained the impact of declined *Siku* on *Nanuq*:

> *There is no more ice for them (polar bears) to hunt. That's where the young pups are like seal pups. And right now there is no more ice and most of the polar bears like showing up very skinny only. Last year it was like that too. Destroyed that polar bear because it was skinny.*

The Igluligaarjuk community has different observations of *Nanuq* in the *Igluligaarjuk* region and the Kivalliq region. The *Nanuq*'s abundance in the Kivalliq region has increased whereas its abundance in *Igluligaarjuk* has decreased. However, old and skinny bears are increasingly sighted around the community in *Igluligaarjuk*.

Two hunters said that its population has been increasing ever since *Nanuq* management was introduced in the region. Hunters find them abundantly when they travel a few miles away from the Inlet.

The next two interviewees said that *Nanuq* are moving further away from *Igluligaarjuk*, mostly towards the north because of a lack of food, no ice, and a destroyed habitat. One of the reasons behind the increase in the sighting of unhealthy *Nanuq* is the lesser number of *Nattiq* on which they prey.

However, three of the interviewees said that many times, old, starving, and skinny *Nanuq* come closer to the community. Two of them said that tourism in Churchill, Manitoba also has a certain role in pushing them north toward human settlement. They are used to human-given easy foods in Churchill. When they get older, they are released to the Kivalliq region where they move towards settlement in search of food. They are often found near dumping sites searching for food.

3.4.5 Impacts on *Qinalugaq* (beluga)

Qinalugaq are also in a declining trend. Two interviewees shared that their sightings have sharply decreased. Hunters hardly hunt *Qinalugaq* on their Inlet these days. Two herds of *Qinalugaq*, one coming from the Baffin basin and the next coming from Churchill, that used to come to *Igluligaarjuk* have now changed their migration route and do not appear in *Igluligaarjuk* anymore. Disturbance and noise pollution from shipping are some of the main reasons behind the decline and change in their route.

> [Andre Tautu]- *"...for the last three years belugas have changed (route)…. They used to, lot of herd used to come here every summer. For some very strange reason, this have changed. There was hardly any beluga last year. They usually used to come here in the bay, lots of them."*

3.4.6 Impacts on the Vegetation and Berries

Three interviewees said that there was a decrease in berry production, mainly cloudberries. Two said berries are growing more, while one of the interviewees said there is no difference in the berries. The decrease in the berry yield is because of dryness and less precipitation.

> [Philippa Aggark]- *"Maybe because of no much rain a few years ago that berries and the cloudberries haven't been growing much."*

3.4.7 Impact on Land

Temperature rise, decrease in precipitation, and climate change have also affected land in *Igluligaarjuk*. The land is getting drier, the grass dies earlier than before, and small water bodies are getting drier.

> [Mark Amarok]- *"I think the land is getting dry like there's hardly any water now, it used to be like little ponds and puddles like they are dry now."*

3.4.8 Impacts of Forest Fire

With the increase in forest fires in the south, birds and animals have moved towards *Igluligaarjuk* and even further north. New species of insects like bumble and small jacket bees, small birds like blue jays, and animals like grizzly bears have been spotted by hunters. Larry Ittinuar recalled his observation on the sightings of new animals and birds because of forest fire:

> *This year, we noticed some new birds but that's from the forest fire. The forest fire had pushed the animals. Each year we will notice if there's forest fire in the west or in the south of us, we get different types of animals coming out into our area anyways, like moose or grizzly bear or like you said the birds. We'll see different types of birds come around.*

However, hunters think that these animals would move back to their original habitat once the conditions are normal in the south. He further added,

"But not long after, they'll be gone anyway. So, it's just when the forest fires are around, that's when we see them come up."

3.4.9 Social Impact

3.4.9.1 Impact on Harvesting

Changes in *Igluligaarjuk* have impacted the community's hunting and harvesting of animals, fish, and birds. They are mostly impacting ice fishing and hunting. The early ice break has shortened the Char fishing season. Crossing the Inlet for char fishing is difficult these days. Three interviewees said that they hardly do char fishing these days because ice is getting much thinner and is more dangerous. Two interviewees said that the same is true with seals, and walrus hunting and egg picking. *Nattiq* hunting time has shortened due to the early break of ice in the Inlet. These days it is not safe to be on *Siku* for seal hunting. Jacinthe Amarok expressed how the declined *Siku* has impacted harvesting:

> *"I know the fishing season is a lot shorter now because we have a hard time going across the Inlet to get chars. We harvest char, dry it and we have to really rush like to gather some fish for the winter."*
>
> [Jeniffer Sammurtok]- *"Because normally in June, we would still be able to just drive on the sea ice go seal hunting, go egg picking like on the shoreline drive with the ski-doo, the snowmobile. But this year, we couldn't because it melted so fast."*

3.4.9.2 Impact on Culture

Inuit take the ecosystem as an integral part of their life. Hunting, harvesting, and fishing are not only their source of survival but also their culture and tradition. Every component of the ecosystem from land to water to ice to plants, to air is important for the Inuit. One of the interviewees said that land is important because it not only provides life to humans

but also to animals. The next interviewee said that their environment has been well preserved by their ancestors and they want their younger generations to continue living in such an environment. It is their culture to respect nature, keep it clean, and harvest only what is needed. However, this culture and its connection with nature is impacted because of changes observed, mainly by a decline in *Nattiq* abundance, and changes in the *Siku* around *Igluligaarjuk*.

> [Jason Ippiak]- *"Because it's part of our culture. This is what we all Inuit up north grew up doing…its just the part of our lifestyle. We need our traditional food and it's important that we take care of the land and the water."*

3.4.9.3 Impacts on the Traditional Food Culture

The impact on the traditional food culture is caused by the reduced availability of animals around *Igluligaarjuk* for hunting and the growing practice of consuming non-local foods. As the number of stores and non-local food products have increased, younger generations are used to having food from the stores. However, the Elders who lived their whole lives with the traditional foods are now concerned by the growing store food culture. They are more worried about their less access to such traditional food and growing practice preferring store food to traditional ones. Likewise, hunting and fishing practices have somehow decreased in the younger generation as they have options to buy food. A decrease in harvest means a decrease in the supply of traditional foods needed for daily consumption.

Next, sea animals like *Nattiq*, *Qinalugaq*, and walruses which are the major traditional foods for Inuit are less found around *Igluligaarjuk* these days. The effort in hunting and harvesting sea mammals these days is more than before. They must travel miles further than before, which is not possible for the elderly, and they should solely depend on the younger generations to share their food. Leo Minialik explained the importance of traditional foods for the Elders:

> *But being an Elder, we have to have traditional food for us to eat every day. As I was growing up, the only food we ate was traditional. There were no stores out*

here, and that's what they're used to. The stores have what the younger generation could eat but the Elders would like to have traditional food every day.

Another Elder, Casimir Kriterdluk, said that hinting might have been less these days:

"Back then, it was the only surviving to do some hunting by dog team, and they used to do a lot of that just to survive, but now they have these fast machines that they can go and come back right away. It seems to be less hunting now."

Next, traditional foods that come from hunting, fishing, and harvesting are the staple food for the community. The community has been surviving with this. One of the interviewees said that ninety percent of their food comes from *Tuktu*, *Nanuq*, whales, walruses, *Nattiq*, and fish. In particular, *Tuktu , Nattiq* and fish are important parts of their food. However, a decline in the abundance of sea mammals and fish is a concern of the community:

They provide us food to live to get through because you know if we just try and live off the store, we wouldn't survive. Too expensive so the animals up north that we hunt they're very important to us. We harvest them right through the four seasons. Winter, spring, summer, fall. [Jeniffer Sammurtok]

3.4.9.4 Impact on Travel Safety

Five interviewees shared that these days, it is riskier to travel around *Igluligaarjuk* during wintertime. Ice is thinner and snow melts faster which leads to accidents. Locals have not been able to travel by snow machines because of this. Many accidents around *Igluligaarjuk* have occurred while traveling through the ice.

[Mark Amarok]- *"In June, we used to have snow that we used to travel by machine but the ice is like it's very dangerous now to travel."*
[Leo Minialik]- *"Because of the late freezing, it's more dangerous during summer cause, I mean, spring when the snow starts melting the ice starts melting too from the top and from the bottom."*

3.4.9.5 Impacts on the Knowledge Transfer

One of the important aspects of Inuit culture is the transfer of knowledge and observation to the younger generation. This process has helped them live with nature for thousands of years. Their knowledge is associated with their connection with nature and is related to survival, hunting, harvesting, weather prediction, monitoring of changes, and resource management. Younger generations learn such knowledge through experience, learning from their parents, and observing and being involved in traditional activities.

> [Jennifer Sammurtok]- *"We don't teach them by telling them they have to be involved with what we're doing. It's a tradition, passed down…we involve them with the stuff we're doing hunting, harvesting, harvesting, and how to prepare the food."*

When any component of their ecosystem is disturbed or there is any imbalance in the ecosystem, the knowledge associated with it is also affected. For instance, the knowledge of *Nattiq* hunting and meat processing is preserved and transferred until there are *Nattiq* available in the place. Knowledge related to survival, hunting, and fishing on ice is associated with the condition of ice. One of the interviewees said there is already a gap in knowledge transmission to the younger generation about survival skills on the ice. For instance, many youths in *Igluligaarjuk* don't know how to build igloos:

> *There's a lot of changes that before back then. And there's probably young people that don't even know how to build Igloos and that's very dangerous for them. Like when they go out on the land, something breaks, their machine breaks, and they don't know how to make an Igloo that's not a surviving thing.* [Leo Minialik].

3.4.10 Shipping and Mining and their Impacts

Shipping along the Inlet of *Igluligaarjuk* started increasing after mining started in Baker Lake. All the ships and tankers going up the Lake must cross the *Igluligaarjuk* narrow causing heavy traffic in the Inlet. One of the interviewees said that every couple of days, there's a ship going up to Baker Lake. These ships have multiple impacts on the ecosystem of *Igluligaarjuk*.

[Harry Aggark]- *"When the shipping started increasing because of the mining, Baker Lake, there are lot more ship going in and out to Chesterfield Inlet."*

[Jennifer Sammurtok]- *"A lot of ship traffic back and forth to Baker, this is the route for the Baker Lake mine. So we're gonna see a lot of ships coming through. Some of them will be anchored like, weeks at a time out here."*

3.4.10.1 Impacts on Animals

One of the major impacts of shipping is its negative effect on the sea and land mammals. *Nattiq* is the most affected among them. Ship produces loud noise, and travels through the habitat of *Nattiq*. One of the interviewees said that hunters could hear the ships going through from 15 to 20 miles inland. The next interviewee said that sea animals and fishes can hear even a small sound underwater, and they tend to stay away from that and move on somewhere else. Disturbance and noise from the heavy ship traffic and the decline in the *Siku* have forced them to move away to a quieter place. Not just *Nattiq*, other mammals like walrus, and *Tuktu* are impacted by the shipping.

[Harry Aggark]- *"People started saying that because of the ship, seals are declining. Yeah, they are declining that used to hang around close to the harbor. But all they did is move out somewhere more quiet."*

Explaining how mining has impacted animals, Andre Tautu shared:

There's a lot of changes ever since the mining company started. All those ships going back and forth drive away the seal, the walrus, and even caribou because it makes a lot of noise pollution and also the low-flying helicopters or frequent airplanes that change the environment.

Shipping and mining have highly impacted *Tuktu* in *Igluligaarjuk*. *Tuktu*'s route used to be at the shoreline around the Inlet. Now, they have changed their route away from the shorelines because of the noise and disturbance from the ships. Hunters have been noticing them moving further inland. Describing the impacts of shipping on *Tuktu*, Jason Ippiak shared an incident of how *Tuktu* turned back and changed their route inland when a ship passed a few miles away from them:

> *I could say that every September we used to go up towards Baker Lake or fall for a caribou hunt. They used to walk along the shore and you could be able to catch some caribou but now the past few years you have to walk like five miles inland for the caribou most times.*

Next, two interviewees said that helicopters from the mining companies disturb *Tuktu*. When the *Tuktu* herd moves towards the mining sites, miners use helicopters flying low to distract the *Tuktu* and force them to change the route:

> *When there's some big migration in the past few years and up to now. People were observing the mine choppers flying low, trying to distract them from going through the mine area. Yeah, so that's what we're seeing, as a hunter, we see the choppers flying low, and back and forth, and they're trying to distract the caribou from coming through.* [Larry Ittinuar]

3.4.10.2 Oil spills and Ballast water

Ballast water and oil spills from ships are one of the major concerns of the *Igluligaarjuk* community. There are incidents of oil spills in the inlet of Baker Lake and Rankin Inlet (Punter, 2021; Rogers, 2017) . Next, ballast water from the ships is dumped in the *Igluligaarjuk* and the harbor. This has increased algal growth on the sand and rocks. This has also impacted the nutrient cycle in the seawater. Larry Ittinuar shared an incident where a ship anchored for three days in *Igluligaarjuk* Bay dumped ballast water for hours through a 12-inch pipe and again dumped for another three days at the next stop.

> *And they're dumping their ballast water and everything else. There was fuel spills up the Inlet, right in our bay. But what changes we're seeing is in our sand, our beaches, and on the rock, there's a lot of algae growing on the rocks and stuff. Now, where in the past it wasn't as much but today there's a lot more and the sand used to be white and today, it's black, dark color.*

Interviewees shared that the ballast water from ships has also introduced non-native species into the seawater. Two interviewees shared that there is a growth of new non-native species of shrimps and bioluminescent organisms in the seawater around the *Igluligaarjuk*.

Table 3. 1 Stressors and their impacts on the social and ecological systems

SN	Stressors	Impacts
1	Temperature rise and climate change	**Ecological impacts**
		Change in *Siku*- decreased ice thickness, early and rapid melting, late freezing
		Decreased water level in *Tasiq* and *Kuuk.*
		Small ditches and puddles are drying up faster
		Decreased cloudberry production
		Lands are drier, small water bodies dry sooner
2	Change in ice and snow	*Nattiq* - habitat destroyed, decreased population, moved further north
		Nanuq getting closer to settlement
		Decreased *Qinalugaq* abundance
3	Forest fire in the south	Non-native animals moving towards *Igluligaarjuk* and even further north
		New species like bumble and jacket bees, blue jays, grizzly bears spotted
4	Shipping	Disturbed marine animals
		Tuktu migration route changed from shoreline to inland
		Impacts on *Siku*
		Release of ballast water and oil spill
		Introduction of non-native species
5	Climate and other ecological changes	**Social impacts**
		Decreased hunting and harvesting
		Shortened fishing season
		Decreased access to traditional food
		Impacts on food sharing culture
		Impact on food security
		The culture of hunting, fishing, and harvest is impacted by the change in the number, health, and migration route of animals and the change in the *Siku*
		Lands, water, and animals they are connected have changed
		Impacts on the knowledge associated with those that have undergone changes
		Impacts on the traditional use of animals (For example, the use of *Nattiq's* skin)
		Increased risk in travel and safety

3.4.11 Community-Based Monitoring of Cumulative Impacts

To address the changes and their impacts experienced in *Igluligaarjuk*, interviewees said that formal and long-term monitoring is needed. CBM would help keep records of the present conditions of the ecosystem. It monitors the current conditions of the ice, water, freezing and melting time, blizzards, snow, and weather and monitors how they change over time. One interviewee said that such monitoring would be more beneficial for the younger generation to compare the environment in the past. The monitoring program should be for a long period of 5 or 10 years to compare the changes.

> [Jennifer Sammurtok]- *"I'd like to have some kind of documentation for the community, like to have it reported for communities like not just for one year or two years, it has to take 5/10 years to completely monitor the season of changes."*

Monitoring is also essential to predict the danger and avoid them. It is important for the hunters to know the conditions of *Siku* before they travel.

> [Philippa Aggark]- *"It would help the hunters like the dangers of the sea ice. And our younger people will need to know the dangers or just for their protection."*

The community of *Igluligaarjuk* wants to monitor long-term changes in the environment. For example, the *Tasiq* where they drink water from, the land where they hunt, the animals they hunt, and the inlet where they spend their time fishing and hunting are the areas. Monitoring sites are selected for two reasons. First, their long observation of changes occurring in that area, for example, *Siku* in the inlet. Next, current concerns or predictions for how the condition would be in the future. For example, present concerns about the quality of drinking water sources:

> *Do some monitoring work at our freshwater for the community. There are three lakes; in spring runoff, the water flows through those three lakes, and the first lake is where we get water resupply. That should be monitored to see water conditions not changing over time.* [Harry Aggark]

Shipping is one of the major concerns of the community. Many of them want long-term monitoring of the shipping around the *Igluligaarjuk* and its impact on the *Siku* and animals. Next, they want char and other fish in lakes and seas to be monitored. The other

areas the community wants to be monitored are the health and abundance of *Tuktu*, *Nattiq*, and mussels, and the depth of *Tasiq* and *Kuuk* around Chester.

> [Philippa Aggark]- *"We need to get someone to come to Chester and get rid of all the dead weeds because it's stinking up the sea because of all the rotten seaweed that's been pushed up towards the land."*
>
> [Jennifer Sammurtok]- *"I noticed a lot of these lakes surrounding the community, they're getting shallower. And it would be nice to monitor them."*

Elders have a different view on the monitoring of animals and fish. They want the monitoring of *Tasiq*, ice, and other ecosystem components but oppose the monitoring of the animals. Based on their experience with tagging the animals in the past, they don't want anyone to tag their animals and fish. They think tagging or putting collars on the animals infects them, and they suffer a lot.

> [Leo Minialik]- *"When white people come out up here to do some tagging on any animal, they do a tagging on walrus by shooting them and putting something on the dart. Saltwater punch that little thing and will probably start to infect and get infected."*
>
> [Casimir Kriterdluk]- *"As long as they're not monitoring the animals we eat, if they monitor around, I don't mind. I wouldn't want animals to be tagged."*

They don't just want direct collaring; they also don't want any monitoring that could potentially affect animals. Jimmy Krako explained how monitoring devices disturb sea animals:

> *And there's some of these researchers or scientists, they tend to put some kind of monitoring thing in the water, on the sea, in the sea, and they make a noise and fish, walrus or whales, seal they can hear that but we can't. If they hear that, they tend to stay away from that and move on somewhere else. Relocate.* [Jimmy Krako]

One of the Elders, Andre Tautu, shared that taking the baseline data of everything about *Igluligaarjuk* would be important for tracking the impacts of shipping and other infrastructure developments in the long run:

> *Whatever the baseline data should be done for Chesterfield Inlet because it will be affected by the hydro coming out of Manitoba. So it's important for us to keep it from getting polluted even track the shipping company, particularly all tankers that are going up the Baker Lake…*

3.5 Discussion and Conclusion

Igluligaarjuk has undergone numerous changes in the last few years, from *Siku*, animals, and *Tasiq* to *Kuuk*. Climate change, mining, and shipping are three major, interlinked drivers of change that have cumulative impacts on the social and ecological of the community. Such impacts could be tangible or intangible. Climate change has affected the Arctic communities through the direct impact on the ecosystem and community and indirect impact by enabling increased shipping. The community has also been disproportionately affected by climate change though they have limited carbon emissions relative to the rest of the world. Shipping in *Igluligaarjuk* is associated with the mining in Baker Lake, Nunavut. The decline in the abundance of *Nattiq* and *Nanuq*, change in *Tuktu* migration route, introduction of non-native species into the sea, decrease in ice thickness, early ice melting, late ice freezing, rapid growth of plants, and decreased yield of cloudberries are the ecological impacts. Decreased hunting, fishing, and harvests, increased risk in travel and safety, and impacts on traditional food, animal skin sewing, and knowledge transfer are the social impacts on the community.

Though there are no mines located right in *Igluligaarjuk*, mines at Baker Lake and Rankin Inlet have long-lasting implications for the ecosystem and community of *Igluligaarjuk* for several reasons. First, mines in the Kivalliq region directly impact the animals they harvest. Mines are constructed on the *Tuktu*'s habitat which intersects their migration route and calving ground, and alter their behavior as they are not used to the human-made infrastructure (Carter et al., 2019). Next, they increase mine-related vessel

traffic along the narrow Inlet of *Igluligaarjuk* disturbing and forcing animals to move away (Lightfoot, 2020). *Igluligaarjuk* is located within a sensitive ecological area. *Igluligaarjuk* is a narrow inlet, passage to Baker Lake. All the vessels going to Baker Lake have to transit through the Inlet. ships are anchored sometimes for a week to transfer goods to smaller ships before moving to Baker Lake (Lightfoot, 2020). The most observed impacts shown by this research are the sharp decline in *Nattiq*, the change in the *Tuktu* route from shorelines to further inland, and the introduction of non-native species through ballast and wastewater. Shipping has forced marine mammals to move away from the Inlet and hunters now have to travel further costing them more (Lightfoot, 2020).

The community of *Igluligaarjuk* is worried that these cumulative impacts on their social, ecological, economic, cultural, and traditional aspects will continue and will be worse in the near future as the climate continues to change drastically. All these aspects are interconnected and slight disturbance on one has cascading impacts on the other. For example, climate change has altered *Siku* composition, because of which there are fewer *Nattiq* around *Igluligaarjuk*. This means less access to traditional foods, and nutrition and impacts on knowledge associated with it. Lack of access to country food means the community must buy food from stores which further affects the household economy. Climate change has dual impacts on Indigenous communities with direct impacts on the socioecological system and also supporting the increase in maritime activities by declining *Siku* in the Arctic (Dawson et al., 2020).

Communities in the Kivalliq region have been raising their voice about the impact of mines and shipping. Community members in Baker Lake, where mines have a major role in shipping traffic in *Igluligaarjuk* have often opposed the exploration of mines concerning the disturbance of exploration activities on the *Tuktu*, mining sites being on the *Tuktu* calving grounds, and contamination of water from the liquid wastes from the mines (Dana & Anderson, 2014). *Igluligaarjuk* community members have been raising concerns about the possible impact of increased shipping on marine ecosystems since the initial phase of the Meadowbank mine (Lightfoot, 2020). Despite the enduring impacts on the ecosystem and community, *Igluligaarjuk* has often been ignored in the studies and

assessments about the impact of mining. Mining-related studies, primarily about the impacts on the ecosystem and community, are focused either on Baker Lake or Rankin Inlet (Maelzer, 2023).

Next, Impact Benefit Agreements, signed between the project and IP within the impact area of the project, are compulsory agreements based on the NLCA that ensure benefits from the project to the communities and equal decision-making authority between the community and the project (Hitch, 2006; Hummel, 2019). However, the decision power in mining and mineral extraction projects resides mainly on project authorities (Hitch, 2006). The case is the same with the *Igluligaarjuk* community as shared by the research participants. Despite the high impacts of mining-associated shipping and their voice against it, their concerns are not considered in decision-making. Nor do they have benefits from the mining projects.

Arctic shipping has brought both challenges and opportunities for the Inuit (Ell-Kanayuk & Aporta, 2023). Economic and social development and employment for the locals are the opportunities that come along whereas impact on the marine ecosystem, subsistence harvesting, and traditions are the challenges (Wang & Aporta, 2024b). As shipping activities could pose potential risks to the Indigenous communities, "adaptive capacity of Inuit coastal communities become central issues" (Aporta et al., 2024, p. 129). A balance between economic development and benefits for the community, and safeguarding of the ecosystem should be sought (Ell-Kanayuk & Aporta, 2023) for the sustainable management of shipping impacts. Mines have been a source of funds for the development of many communities. For example, royalties from Raglan Mine are distributed to communities from Makivik, Kangiqsujuaq, and Salluit and an annual referendum is carried out to decide how the money would be divided among the three communities (Rodon & Lévesque, 2015). This money is often used for infrastructure development. However, the case is different for *Igluligaarjuk*. They are ignored for help and funds they have been asking for from Meadowbank Mine in Baker Lake. The community has raised a voice against the limited benefits they get from the mine (CBC News, 2015). The community shared they would only fund Baker Lake and Rankin Inlet. A community member from *Igluligaarjuk* shared,

> *"We've been trying to get some help from mining company like get a baseball (facility) and gym or something like that. They never really come. They only want to help Baker Lake and Rankin"* [Harry Aggark].

The Igluligaarjuk community is not against the economic development that mines bring (Maelzer, 2023). However, they want their voice to be heard and be involved in decision-making processes that could help manage the social and ecological impacts while also hoping to get economic benefits and jobs for locals in the mine.

Inuit have a strong and clear statement that "the marine areas of the Canadian Arctic, including the shipping corridors, must be considered as part of the Inuit homeland" (Ell-Kanayuk & Aporta, 2023, p. 33) and they want to be in a position to decide and regulate the policies for Arctic shipping (Ell-Kanayuk & Aporta, 2023). Community's involvement in the decision-making process in Nunavut has increased after the Land Claims Agreement (Koke, 2009). And there have also been initiatives in recent times in Canada that have clearly recognized Inuit self-determination. The Northern Low Impact Shipping Corridors project is one of the examples, that aims to minimize the impact of shipping on the Arctic ecosystem and community through direct involvement in IP in decision-making and co-management (Lalonde & Bankes, 2023). However, the Inuit at *Igluligaarjuk* still struggle to exercise their Indigenous rights fully.

The community has been advocating and raising their concerns about the impacts of shipping, and suggestions and plans to manage the changes observed in *Igluligaarjuk* through different platforms. For example at the Northern Lights conference (Lightfoot, 2020), the Nunavut Impact Review Board (Newell, 2020), Preliminary hearings of Meadowbank Gold Mine (CBC News, 2013), and the Public hearing of the Nunavut Land Use Plan (WWF, 2016). Despite their continuous voice at governmental and non-governmental organizations, mining companies, universities, and researchers, their concerns are not heard or considered when making decisions (Newell, 2020). The *Igluligaarjuk* community came up by themselves to initiate an Inuit-led CBM program that could monitor impacts in the Kivalliq region. For long-term CBM, at their leadership, organizations like HTO and Sapujiyiit Society are working now at the ground level.

The tangible and intangible impacts are interrelated. For example, in *Igluligaarjuk*, the decrease in the abundance of *Nattiq* because of declined *Siku* is a tangible impact whereas the loss of the knowledge associated is an intangible impact. Monitoring the cumulative impacts for the long term should simultaneously monitor all the tangible and intangible impacts. Sometimes setting criteria and indicators for identifying and monitoring the cumulative impacts, basically the intangible impacts, for the long term could be challenging in the initial phase. An interviewee of a study by Middleton (2020) shared the difficulty of expressing or sharing the intangible impacts like disappointment, "….it's so hard to put tangible figures to it because I don't know how you explain that, the disappointment" (Middleton, 2020, p. 18). Many of such impacts cannot be monitored within a short period (Middleton, 2020). This challenge often comes when the community shares the impacts with outsiders like researchers or governments and when communities are not involved during data analysis and preparation of the final report. However, leading or involving in the study from the beginning of the research, research design, interview questions, analysis, report preparation, decision-making steps, and implementation minimizes the challenge.

There are common concerns regarding the impacts of shipping at the regional level. However, the local and area-based impacts are related to the social, cultural, economic, and ecological aspects of the particular place (Doucette & Mansfield, 2024). For impactful and sustainable management and monitoring, it is necessary to understand the area-based social and historical context of the shipping impacts on the particular area (Doucette & Mansfield, 2024). Local IP are the ones who have a detailed understanding of these contexts so, area-based Inuit-led CBM would be crucial in long-term monitoring and management. CBM on the other hand is significant in managing and monitoring the impacts of climate change (Lam et al., 2019), supporting adaptation and resiliency, and promoting Indigenous self-determination (Mercer et al., 2023). So it is important to "document Inuit and local knowledge for policy discussions around Arctic shipping" (Dawson et al., 2020, p. 1).

Chapter IV

4 Conclusion

The objective of this research was to find answers to how has *Igluligaarjuk* (Chesterfield Inlet) changed ecologically and how that has impacted the community. Four specific objectives were to; examine the ecological and physical changes observed in and around *Igluligaarjuk*; document the IQ and indicators used by the community to monitor the changes; identify the challenges of incorporating IQ with CBM; and analyze the cumulative impacts of changes along with shipping on the community. Each of these are discussed in detail below.

The first objective was to examine the ecological changes observed and experienced by the community in *Igluligaarjuk*. Findings from this research showed that the major changes that research participants have noticed are changes in the sea ice- early melting, late freezing, early ice breakup, and declined thickness, decline in the abundance of seals, polar getting closer to the settlement, changed caribou route, and decrease in the water level of lake and river. This research was able to identify the most visible changes to understand the holistic overview of the ecosystem based on the perception of the research participants. However, while I focused on the overall major changes, I might have missed other important changes that community members who did not participate in this research might have noticed.

The second objective was to document the IQ and indicators used by the community to monitor the changes. The IQ indicators used by the *Igluligaarjuk* community are based on their knowledge, observations, and experience which are passed down through the generations. Such indicators are used to determine the changes in animals, water, ice, vegetation, and other components of the ecosystem. For example, hunters observe the color of organs, the amount of fat, and the types of fluids to determine the health of the caribou. Fat reserve in the body, amount of muscle, timing and seasons, and health of animals are the determining factors for hunting preference. Thickness of ice, softness of snow, level of salt in ice, easiness to drill, rate of melting and freezing, and timing of melting and freezing are looked at to determine the change in the sea ice. The findings helped me understand the overall condition of changes and impacts. However,

considering the depth and details knowledge that the Inuit have of every component of the ecosystem they are related to, I was unable to develop an in-depth focus on each of the subjects raised. More specifically, my findings on indicators of determining animal health were focused more on Caribou but further details are needed on the indicators related to seals, polar bears, and fish.

The third objective was to identify the challenges and problems of incorporating IQ with CBM. The challenges identified in this research are based on the literature review. Major problems of knowledge integration between IK and Western science lie in the continuity of colonial research in various forms (Yua et al., 2022). Despite progress in improving research practices with Indigenous communities (Ryder et al., 2020), extraction of knowledge, and selection of inappropriate research subjects different from communities' priorities, are still practiced (McGregor et al., 2018). Other challenges are denial of Indigenous worldviews (Whyte, 2018), imbalance in the power relation between the community and researchers (Simpson, 2004; Thompson et al., 2020), and lack of community involvement in decision-making (Murphy, 2019). In *Igluligaarjuk*, denial of the community's observation of changes, for example, the abundance of polar bears, and less access to decision-making, for example, in making decisions regarding the management of shipping and their impacts.

To address such issues, I have used Indigenous methodologies and have tried to implement Inuit research methods and recommendations from the initial research phase. Recommendations from ScIQ (Pedersen et al., 2020b) and the National Inuit Strategy on Research Priority Areas (Inuit Tapiriit Kanatami, 2018) were taken as guidelines for my methodology. The initial meeting with the community members, the Open House, and the visit to the lands helped me design my research based on their priorities and concerns. Visiting lands with Guardians helped me understand their views of and connection with lands. To respect their worldviews, this research was solely based on their knowledge and experience without validation or comparison with Western science. Indigenous methodologies require a long-term participatory approach, being involved in their traditional activities, and learning from them. While I completed four visits to the Chesterfield Inlet, because of my time constraints as a master's student, I was unable to

spend more time in the community. Additionally, meeting priority 4 of the National Inuit Strategy of aligning funds with Inuit priorities, resides on the project's funder. My research was a part of the GENICE II project, and I was in no position to discuss and decide about the funds with the community.

The last objective was to analyze the cumulative impacts of changes along with shipping on the community. Increasing shipping activities, mostly because of mining in Baker Lake, and impacts on the marine ecosystem and land animals are the pressing concerns of the *Igluligaarjuk* community (Kamula et al., 2016). There is growing concern about travel safety because of early ice breaks and unpredictable weather (Healey et al., 2011). All of such changes have cumulative impacts on the community including social, cultural, spiritual, and economic impacts (Cunsolo Willox et al., 2013a; Orlove et al., 2022). For example, this research showed that such changes have socially and culturally affected through the impacts on traditional food, traditional use of animal products, disturbing the emotional connection with the land, and increasing the risk during travel. Further, economic impacts are through the impacts on food security and decreased harvest that have increased dependency on the store food. As community members have to travel further than before to hunt, and harvest, travel costs for hunting have increased. Shipping, driven by mining in Baker Lake, which the research participants indicated had little economic benefits on the community except a few jobs offered to the locals, nor the other benefits from it shared with them, has huge negative impacts on their lives. These impacts could be severe for the Inuit community in the near future as the temperature continues to rise, sea ice continues to change (Labbé et al., 2017), and shipping continues to increase (Barber et al., 2009).

The Inuit of *Igluligaarjuk* have been monitoring their lands since time immemorial. Their ability to monitor and manage resources, their knowledge of the ecosystem, animals, and lands, and their worldviews are crucial in the sustainable management of the causes and impacts of changes. IK is place-based and developed through their connection with the land they are related (Ovitz et al., 2023). Knowledge and experience of *Igluligaarjuk* might be different than the community of almost 100 km far from Rankin Inlet and 283 km from Baker Lake. The same is true with the impacts experienced by them from

ecological changes and shipping. *Igluligaarjuk* is a sensitive area in terms of its location at the narrow inlet used for shipping to Baker Lake as well as the impacts it is facing from climate change, shipping, and mining (Healey et al., 2011; Kamula et al., 2016; Maelzer, 2023; Newell & Doubleday, 2020). Participants during workshops shared how policies and programs are designed focusing only on Rankin Inlet and Baker Lake, Nunavut. It is therefore crucial to center their knowledge and experience while dealing with problems, formulating policies, and planning activities. IK and the impacts documented by this research might help as baseline information and references for this. The indicators and the possible questions for monitoring the changes as pointed out in Chapter II might be useful in designing the long-term monitoring in *Igluligaarjuk*.

As shared by the research participants, the community wants to be in a decision-making position in designing, funding, and implementing programs and policies related to monitoring and managing their lands and resources, including shipping around the lands. Their involvement in decision-making processes is key to respecting Inuit self-determination. The involvement of the Inuit is the determining factor of the intent of the monitoring program. It significantly affects the selection of indicators, the process and steps used, and the result of the program. Their leadership in monitoring; ensures the consideration of environmental and sociocultural components as the indicators; and strengthens Indigenous governance (Thompson et al., 2020). Indigenous-led or collaborative research projects (Sapujiyiit Society and Aqigiq HTO in *Igluligaarjuk*) are crucial in formulating coping strategies and planning adaptation in response to negative changes observed in the ecosystem (Falardeau et al., 2022).

4.1 Future Directions in Research and Practice

This research has documented Inuit knowledge or IQ of changes and cumulative impacts which might be useful for the baseline information for CBM. However, intangible social impacts of ecological changes and other stressors like shipping need to be studied in detail. For example, community members shared that they were worried about the rapid changes and some elders shared how frustrated they were because of increasing shipping traffic in the Inlet. Consequently, future research needs to focus on such intangible

impacts on the community. Next, the bigger step of developing the entire process and using both ecological and social indicators in the monitoring framework are to be worked on. Future related projects could develop and implement a plan including a checklist for field data collection, and a framework for long-term monitoring.

Interviewees from the community of *Igluligaarjuk* attributed the changes observed in the sea ice, seawater, and marine ecology to various causes like climate change, shipping, and mining. The next step is the continual measurement and monitoring of these parameters and finding their correlation with climate change, shipping, and whatever possible reasons come up. Findings from such monitoring should be used to guide policies and implementation of programs to manage and adapt to the changes. Next, I also recommend a detailed study of the economic aspects of ecological and social changes. During informal talks with the *Igluligaarjuk* community members, they shared how traveling further than before for hunting has increased travel expenses, including gas. It is important to understand the economic contribution of the ecosystem and the economic cost of the changes to come up with an effective plan to manage the stressors. The inclusion of IK in monitoring should be intensified, but only in ways that support Indigenous self-determination. CBM should be driven by the community's interests (Johnson et al., 2015). It could be based on collaborative or Indigenous-led studies, but it should be beneficial and ensure contributions to the community's well-being (McGregor et al., 2018).

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Appendices

Appendix A – Nunavut Scientific Research License

Nunavut Research Institute / ᓄᓇᕗᑦ ᖃᐅᔨᓴᖅᑐᓕᕆᔨᒃᑯᑦ
Box 1720, Iqaluit, NU X0A 0H0 phone:(867) 979-7279 fax: (867) 979-7109 e-mail: mosha.cote@arcticcollege.ca

SCIENTIFIC RESEARCH LICENSE

LICENSE NUMBER 03 015 23N-M

ISSUED TO: Nicole Wilson
Centre for Earth Observation Science
University of Manitoba
522 Wallace, 125 Dysart Road
Winnipeg, MB
R3T 2M6 Canada

TEAM MEMBERS: J.Sinclair,E.Collins,G.Hostetler,Suresh B.K.,S.Danial, C.Brazeau, 1 TBD

TITLE: GENICE II : Reimagining Monitored Natural Attenuation as an Oil Spill Response Tool in the Arctic

OBJECTIVES OF RESEARCH:
GENICE II is a large scale-scale project which looks at how spilled oil gets broken down by microorganisms in arctic water, and how knowledge on this process can be integrated into decision-making around spill prevention and response. The objective of this component of the project (activity 2 & 3) is to co-develop Community Based Monitoring and Policy Analysis related to oil spills to support Inuit self-determination. We willl conduct the research between January 2023 to December 2026. At a minimum, it will involve annual trips to the Kivalliq Region of Nunavut . We have partnered with Chesterfield Inlet,NU with support from the Aqigiq HTO and the Hamlet Office. Additional communities may be added as we develop partnerships. Trip lengths will range from three to two weeks, depending on the research activity.

DATA COLLECTION IN NU:
DATES: January 1,2023 to December 31,2023
LOCATION: Chesterfield Inlet

Scientific Research License 03 015 23N-M expires on December 31,2023
Issued at Iqaluit, NU on April 18,2023

Jamal Shirley
Science Advisor

SCIENTIFIC RESEARCH LICENCE

Appendix B – Ethics Approval and Renewal

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

PROTOCOL APPROVAL

Effective: March 28, 2023 Expiry: March 27, 2024

Principal Investigator: Nicole Joy Wilson
Protocol Number: HE2022-0385
Protocol Title: *GENICE II*

Andrea L Szwajcer, Chair, REB2

Research Ethics Board 2 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2022).

This approval is subject to the following conditions:

i. Approval is granted for the research and purposes described in the protocol only.

ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.

iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.

iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.

v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.

vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*Ethics of Research Involving Humans policies and procedures.

University of Manitoba | Research Ethics and Compliance

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

RENEWAL APPROVAL

Effective: March 22, 2024 New Expiry: March 27, 2025

Principal Investigator:	Nicole Joy Wilson
Co-Principal Investigator(s):	John Sinclair
Protocol Number:	HE2022-0385
Protocol Title:	*GENICE II*

Human Ethics Office as designated by , REB2

Research Ethics Board 2 has reviewed and renewed the above research. The Human Ethics Office is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2022).

This approval is subject to the following conditions:

i. Any changes to this research must be approved by the Human Ethics Office before implementation.

ii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.

iii. This renewal is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.

iv. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.

Appendix C – Recruitment Template for Knowledge Co-Development Workshops (GENICE II Workshop Type 1 - Activity 2.1)

Sample recruitment text to be shared with Inuit partner organizations who will recruit Inuit knowledge holder participants to workshop

The University of Manitoba is holding a workshop as part of a project called GENICE II, which seeks to better understand how spilled oil is broken down by micro-organisms. An important part of this project involves the co-development of Community-Based Monitoring to help better understand impacts of potential oil spills and to inform environmental decision-making processes in the Arctic. An established community monitoring program can help with decision-making and advocacy when environmental events occur.

Workshop will be conducted in Chesterfield Inlet [or other place to be determined later]. The workshop should take about 1-2 days to complete. Workshop will be recorded using note-taking, participatory mapping, and if consented to by all participants including you, some portions may be audio recorded and transcribed. You are also able to withdraw from this research at any time. After the workshop is complete, you will have the opportunity to participate in a voluntary survey to review your experience of the session. You will be offered an honorarium of $300 for each day of the workshop that you attend. The research team will present the workshop findings to the community in the form of a presentation and/or plain language report.

Please contact me if you would like to participate or want more information about the workshop. If you would like to participate in the workshop we will let you know where and when it will take place.

Sincerely,
Suresh B.K
Master's Student
Department of Environment and Geography
University of Manitoba
Phone: xxxxxxx
Email: bks@myumanitoba.ca

Nicole Wilson
Assistant Professor
Canada Research Chair T2 in Arctic Environmental Change and Governance
Department of Environment and Geography
University of Manitoba
Email: Nicole.J.Wilson@umanitoba.ca
Phone: xxxxxxx

Appendix D – Recruitment Template for IQ Interviews (GENICE II Interview Type 1 - Activity 2.1)

Sample telephone recruitment script for Inuit knowledge holder participants

Hello,

My name is [insert name of team member]. I am from the University of Manitoba. I am a member of a large research team undertaking a project called GENICE II, which seeks to better understand how spilled oil is broken down by microorganisms. Our core team members include Nicole J. Wilson, John Sinclair, Eric Collins, and Gary Stern from the University of Manitoba.

An important part of this project involves the co-development of Community-Based Monitoring to help better understand impacts of potential oil spills and to inform environmental decision-making processes in the Arctic. An established community monitoring program can help with decision-making and advocacy when environmental events occur.

You have been identified by the Aqigiq HTO or Hamlet Office in Chesterfield Inlet as an Inuit knowledge holder with valuable insights. We are contacting you to see if you would like to participate in an interview to share your experiences and insights. Interviews will be conducted in community between 27th June to 15th July 2023 or online using Zoom or MS Teams at a time that is convenient for you. Interviews should take about 60 minutes to complete. Interviews will be audio recorded and transcribed, if permitted by you. If you choose to participate, you will only be expected to participate in ways with which you are comfortable. Interviews will be conducted in English with translation support where needed. You are also able to withdraw from this research at any time. You will be offered an honorarium of $200.00. You will be provided with a copy of your interview transcript for review before we begin analysis. When the initial overview of interviews is complete, we will share a summary of the research findings.

If you would like to participate in an interview or to request further information to decide about your participation please contact me at [xxxxxxx] or by email at [bks@myumanitoba.ca].

If you are interested in participating in an interview, please indicate your availability to participate in an in-person interview between [insert dates of community visit] or by virtually outside of these dates.

Suresh B.K
Master's Student
Department of Environment and Geography
University of Manitoba
Phone: xxxxxxx
Email: bks@myumanitoba.ca

Nicole Wilson
Assistant Professor

Canada Research Chair T2 in Arctic Environmental Change and Governance
Department of Environment and Geography
University of Manitoba
Email: Nicole.J.Wilson@umanitoba.ca
Phone: xxxxxxx

Appendix E – Informed Consent (Workshop)

Informed consent - Knowledge Co- Co-Development Workshop (GENICE II Workshop Type 1 - Activity 2.1)

Research Project Title:

GENICE II – Activity 2: Co-developing Community-Based Monitoring

Funder: Genome Canada

Nicole J. Wilson, Assistant Professor, University of Manitoba, Canada

Email: Nicole.J.Wilson@umanitoba.ca

John Sinclair, Professor, University of Manitoba, Canada

Email: john.sinclair@umanitoba.ca

Eric Collins, Assistant Professor, University of Manitoba, Canada

Email: eric.collins@umanitoba.ca

Gary Stern, Associate Professor, University of Manitoba, Canada

Email: gary.stern@umanitoba.ca

Glen Hostetler, Research Associate, University of Manitoba, Canada

Email: glen.hostetler@umanitoba.ca

Syed Danial, Post-Doctoral Fellow, University of Manitoba, Canada

Email: syed.danial@umanitoba.ca

Suresh B.K., Masters Student, University of Manitoba, Canada

Email: bks@myumanitoba.ca

Catharine Brazeau, PhD Student, University of Manitoba, Canada

Email: brazeau1@myumanitoba.ca

Interpreter(s): To be determined.

Inuit researcher: To be determined.

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Summary: My name is Nicole Wilson, and I am inviting you to participate in a research project with the objective of co-developing Community-Based Monitoring intended to monitor environmental change. This research is part of a larger project called GENICE II, which seeks to learn more about how spilled oil gets broken down by microorganisms in the water. At this time, we are having a workshop with Inuit knowledge holders to co-develop Community-Based Monitoring.

This research is approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus.

Procedures: The workshops will be conducted annually for one to two days (8 hours a day). The workshop will be audio recorded, if permitted by the workshop participants. Notes will also be taken during the workshop. Workshops will not be audio recorded unless all participants consent to it. If consent is provided, the workshop will be recorded using a digital audio recorder. Please feel free to ask questions at any time regarding the procedures and goals of the study or your role in this workshop. At the end of each co-development workshop, you will independently complete a survey questionnaire. We expect the survey will take approximately 15-20 minutes to complete. You will have the option to skip any questions you are not comfortable with and can choose to end their participation at any time by closing the survey window. You will be provided with the contact details of the Core Team in the event if you will have any follow-up questions, comments, or concerns.

Debriefing: The results of previous workshops and other research will be presented during subsequent meetings and workshops. If you wish to receive this summary, please provide your email address below.

Data Storage: Hard copies of all data including your contact information, will remain under the strict supervision of the researcher: under lock in their office. Electronic data will be stored on University of Manitoba OneDrive and will only be accessible to the research team members named at the beginning of the consent form. We will not collect identifying information during the workshop and the results will be reported in aggregate without attribution to individuals. Your identifying information will be kept in an encrypted file in the primary researcher's password-secured personal computer and destroyed five years after the completion of the study. Copies of consent forms for those who consent to it and non-identifying records (e.g., written notes) from the workshop will be transferred to Aqigiq HTO using University of Manitoba One Drive for deposit in their archive.

Potential Risks: There are no known or anticipated risks posed to you by participating in this research.

Benefits: You will get an opportunity to contribute insights on oil spills impact that might improve understanding of needed responses. You will have the opportunity to shape a community-based monitoring program to monitor the ongoing health of the marine environment and the potential for natural attention to occur.

Compensation: Workshop participants will receive a $300/day and $200/half day for each full or half day that the workshop take place. You will receive your honoraria for each day before the workshop starts. Participants will retain compensation regardless of whether they choose to withdraw from the study. The honorarium will be provided in cash.

Confidentiality: We cannot guarantee confidentiality in a workshop setting because other workshop participants will be present. However, we ask all participants to respect the privacy of their fellow participants by not repeating what is said during the sessions to others. The workshops will be audio recorded using a portable audio device if all participants consent; otherwise, we will take notes. The audio recording, if available, will be transcribed verbatim by a member of the research team using Otter.ai. Your responses will not be linked to individual participants. Consent forms and other identifying information will be accessible only to members of the research team and will be stored separately from workshop data. Although your information may be used in diverse written documents and presented orally at conferences, it will only be used when combined with others' data, so we will keep your identity confidential by referring to you using a general identifier (e.g., "One Inuit Knowledge holder), depending on the option you select.

There are several options for you to consider if you decide to take part in this workshop. I will read each question to you and you can tell me where to put a check mark on the corresponding line(s):

I grant permission to record using audio: Yes: __ No: ___

I wish to remain confidential and do not wish to be identified in the list of workshop participants: Yes: __ No: ___

I wish to be identified by name in the list of workshop participants: Yes: __ No: ___

I give my permission to include interview recordings and transcripts in the Aqigiq HTO archive:

Yes: __ No: ___

This research project involves local researchers from Chesterfield Inlet as part of the research team. Some data and information from this study may be sent out outside the University of Manitoba to other researchers and organizations including partner Inuit rightsholder organizations. This will facilitate the involvement of our community partners in the research study to build local research capacity and uphold the high standards of Indigenous research protocols. If you have approved the inclusion of your data in the research archives of our partner Inuit Rightsholder organizations (above) your data will be shared. If you have approved the use of your name in association with your research data (above), we will share your name. If you wish to remain confidential outside the research team, we will not include your name. However, despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

Right to Withdraw: Your participation is voluntary, and you can answer only those questions that you are comfortable with. You may withdraw at any time before or during the workshop and as a participant in the research for any reason, by informing PI without explanation or penalty of any sort. Information from the workshop will be aggregated, so it will not be clear who is saying what. For those who wish to withdraw after the workshop has started, it may not be possible to retract or delete individual participant's data. It will not be possible to withdraw after the workshop has been completed.

Questions or Concerns: Contact any of the researchers using the information provided above.

Dissemination: The data may be used to produce a student thesis stored on MSpace, conference presentations and academic publications such as journal publications. The final report will be available by July 2026. If you would like to a copy of the report, please provide an email address (below) so it may be provided to you.

I would like to receive a copy of the report. Yes: ____ No: ____

Email address: _____

Consent: Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

This research has been approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Officer at 204-474-7122 or

HumanEthics@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

_____	_____	_____
Name of Participant	*Signature*	*Date*

For oral consent:

If consent is obtained orally the Consent Form will be dated, and signed by the researcher(s), as below, to indicate that "I read and explained this Consent Form to the participant before receiving the participant's consent, and the participant had knowledge of its contents and appeared to understand it."

_____	_____	_____
Name of Participant	*Signature*	*Date*

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

Appendix F – Informed Consent (IQ Interview) (GENICE II Interview Type 1-Activity 2.1)

Research Project Title:

GENICE II – Activity 2: Co-developing Community-Based Monitoring

Funder: Genome Canada

Nicole J. Wilson, Assistant Professor, University of Manitoba, Canada

Email: Nicole.J.Wilson@umanitoba.ca

John Sinclair, Professor, University of Manitoba, Canada

Email: john.sinclair@umanitoba.ca

Eric Collins, Assistant Professor, University of Manitoba, Canada

Email: eric.collins@umanitoba.ca

Gary Stern, Associate Professor, University of Manitoba, Canada

Email: gary.stern@umanitoba.ca

Glen Hostetler, Research Associate, University of Manitoba, Canada

Email: glen.hostetler@umanitoba.ca

Syed Danial, Post-Doctoral Fellow, University of Manitoba, Canada

Email: syed.danial@umanitoba.ca

Suresh B.K., Masters Student, University of Manitoba, Canada

Email: bks@myumanitoba.ca

Catharine Brazeau, PhD Student, University of Manitoba, Canada

Email: brazeau1@myumanitoba.ca

Interpreter(s): To be determined.

Inuit researcher: To be determined.

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Summary: My name is Nicole Wilson, and I am inviting you to participate in a research project with the objective of co-developing Community-Based Monitoring intended to monitor environmental change. This research is part of a larger project called GENICE II, which seeks to learn more about how spilled oil gets broken down by microorganisms in the water. At this time, I am interviewing Inuit knowledge holders to co-develop Community-Based Monitoring.

This research is approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus.

Procedures: This interview is to be conducted in person within the community or virtually over Zoom or MS Teams. Interviews should take about 40 to 60 minutes to complete. Interviews will be conducted in English or with translation in Inuktitut will be possible where requested. The interpreter will translate English questions into Inuktut and then the participants response will be translated back into English. Interviews may be recorded and transcribed if permitted by the interviewee. Zoom and MS Teams automatically records video and audio. However, only the audio recording will be used in data analysis. If you would prefer audio recording only, please turn off your video. In person interviews will be recorded using Zoom, MS Teams, or a digital audio recorder. Handwritten notes will be taken during the interview in lieu of permission to audio and/or video record. Interviews will be transcribed using Zoom or MS Teams transcription or Otter.ai. Please feel free to ask questions at any time regarding the procedures and goals of the study or your role in this interview.

Debriefing: After your interview has been transcribed, we will contact you to set up a follow-up meeting. During the meeting we will review the transcript with you and ask for help with interpreting specific quotes from the interview. We will then correct the interview based on your feedback. A copy of the interview will then be provided to you for your records. If you consented to it, a copy of the interview the consent form, audio recording and transcript will be deposited in the Aqigiq HTO archive. A summary of the results will be presented to participants in the form of a plain language report and community presentation. An invitation to the presentation and copy of the report will be shared with interested participants prior to finalization.

Data Storage: Hard copies of all data including your contact information, will remain under the strict supervision of the researcher: under lock in their office. Electronic data will be stored on University of Manitoba OneDrive and will only be accessible to the research team members named at the beginning of the consent form. Interpreters will not have access to raw data outside of the interview process. Your identifying information will be kept in an encrypted file in the primary researcher’s password-secured personal computer and destroyed five years after the completion of the study or in July 2031, approximately 5 years after the completion of the study.

Where consented to, your interview audio and transcript will be transferred to Aqigiq HTO using University of Manitoba OneDrive.

Potential Risks: There are no known or anticipated risks posed to you by participating in this research.

Benefits: By participating in this research, you will be supporting the development of community-based monitoring and, possibly, environmental decision-making and governance in your area, particularly as it pertains to spill response. A community-based monitoring program can help communities advocate for themselves on environmental matters since monitoring can illustrate environmental change and impacts.

Compensation: Honoraria will be provided to participants at the rate of $200 for both the initial interview and the subsequent meeting to review the transcript. Participants will receive their honoraria prior to the start of the interview and retain compensation regardless of whether they choose to withdraw from the study. The honorarium will be provided in cash if the interview takes place in person or via e-transfer if it occurs over virtually.

Recordings and transcripts are inherently identifiable so we cannot guarantee anonymity. If you so choose, we can guarantee your confidentiality. To do this we will anonymize your transcript to remove identifying information including your name. Below we provide options if you wish to be linked to your input. Consent forms and other identifying information will be accessible only to members of the research team and will be stored separately from interview data so participants will not be identified based solely on the option chosen. Although your information may be used in diverse written documents and presented orally at conferences, it will only be used when combined with others' data, so we will keep your identity confidential if you choose so. If you consent to being quoted directly, we will refer to you by your name, chosen pseudonym or a general identifier (e.g., "One Inuit Elder"), depending on the option you select.

There are several options for you to consider if you decide to take part in this interview. I will read each question to you, and you can tell me where to put a check mark on the corresponding line(s):

I grant permission to record using audio: Yes: __ No: ___

I wish to remain confidential and do not wish to be quoted directly: Yes: __ No: ___

I wish to remain confidential, but you may refer to me by a pseudonym and quote me directly:

Yes: __ No: ___

The pseudonym I choose for myself is: _____

You may quote me and use my name: Yes: __ No: ___

I wish to be identified using the name: _____

I give my permission to include interview recordings and transcripts in the Aqigiq HTO archive:

Yes: __ No: ___

This research project involves local researchers from Chesterfield Inlet as part of the research team. Some data and information from this study may be sent out outside the University of Manitoba to other researchers and organizations including partner Inuit rightsholder organizations. This will facilitate the involvement of our community partners in the research study to build local research capacity and uphold the high standards of Indigenous research protocols. If you have approved the inclusion of your data in the research archives of our partner Inuit Rightsholder organizations (above) your data will be shared. If you have approved the use of your name in association with your research data (above), we will share your name. If you wish to remain confidential outside the research team, we will not include your name. However, despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

Right to Withdraw: Your participation is voluntary, and you can answer only those questions that you are comfortable with. You may withdraw from the interview and as a participant in the research for any reason, by informing the PI directly at any time without explanation or penalty of any sort. During the interview you can withdraw by telling the interviewer at any time. Should you wish to withdraw after the interview is completed, you can contact any one of the above-listed researchers by phone or by email. Upon withdrawal, all electronic and physical data and records associated with this interview will be destroyed. The deadline to withdraw is [two months after the date of the member checking interview] when the data has been analysed and may not be possible to withdraw your data.

Some data and information from this study may be sent outside of the University of Manitoba to other researchers, organizations, or made publicly available. This is for further analysis, testing, as part of the research study, or a requirement by a granting agency or journal. If you have approved the use of your name in association with your research data, we may share your name. However, if you wish to remain confidential outside of the research team, please let us know. However, despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

Questions or Concerns: Contact any of the above-listed researchers using the information provided above.

Dissemination: Depending on community direction, we may share our findings with your community through a presentation and a report. Research results may be used to produce a student thesis hosted on MSpace, conference presentations and academic publications such as journal articles. One plain-language output will be published for every academic output. We will provide annual updates on the project and the final report will be available by July 2026.

I would like to receive a copy of the report. Yes: __ No: ___

Email address: _____

Consent: Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without

prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

This research has been approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Officer at 204-474-7122 or HumanEthics@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

_____ _____ _____

Name of Participant *Signature* *Date*

For oral consent:

If consent is obtained orally the Consent Form will be dated, and signed by the researcher(s), as below, to indicate that "I read and explained this Consent Form to the participant before receiving the participant's consent, and the participant had knowledge of its contents and appeared to understand it." Oral consent will be audio recorded if you consented to recording, otherwise oral consent will be recorded in my notes.

_____ _____

Name of Participant *Date*

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

Appendix G – Interview Guide

Guiding questions for the interview

Demographic Questions

- What is your name?
- How old are you?
- Gender?
- Can you tell me about yourself?

Inuit Relationships to and Knowledge of Environments

- Why is the environment important to you and your community?
- How do you know if the environment, including land, water, plants, and animals are healthy or not?
- Are you observing any changes in the ecosystems?
- How has it changed in the last five years?
- Have they gotten better or worse?
- Have these changes in the environment affected your decision to engage in harvesting activities (e.g., species not available, danger travel, concerns about contamination preventing harvest, or consumption of country foods)?

Community-Based Monitoring

- Are there any specific components or areas of the ecosystem (water, soil, animals, ice level…) you have been monitoring or you think should be monitored for the long term? Why?
- Are there specific places you think should be monitored?
- Would you be able to show me these locations on a map? (Paper or digital copy of the map to be used to indicate locations).

- How do you monitor these changes in the ecosystem?

- What do you see on these components to detect that it is changing? For instance, to know that there are changes or some problems in a lake, what do you take the reference of?
- What indicators or signs do you look for to monitor ecosystem health?
- What are the *Inuktitut* words or phrases for the indicators or signs you mentioned?
- Can you tell me more about why these indicators or signs are important for understanding change?

- Are there any CBM Programs the community has been involved currently in or in the past?
- What do you think we could learn from these other projects?

Appendix H – Knowledge Co-Development Workshop Guide (GENICE II Workshop Type 1 - Activity 2.1)

Notes on intended use of this guide:

· The guide below will not be presented directly to participants, this is the guide for the facilitator(s) and includes potential prompts and suggested topics that may be used to prime discussion as needed. This is given here to help ethics reviewers better understand the nature of the topics to be explored.

· Following the guide is the text that will be presented to workshop participants, which will be translated into Inuktitut.

· For workshops

  - At the start, participants will be introduced to the thematic and possible focus areas to be explored, and invited to suggest additional topics and/or modifications to my plan

  - If 9 or less participants, workshops will be conducted via whole group discussions

- If 10 or more participants, small groups will be formed for discussion of each of the areas and reporting back to the whole group

- Following reporting of feedback from discussion(s), the whole group will work to group responses and identify priorities

The 1-2 day workshops will be held annually and will include a mix of full group and breakout group discussions. It will follow the discussion items outlined below.

Year 1

- Determining monitoring priorities based on discussions about the impacts of oil spills on marine environments
- Training on genomics-informed monitoring techniques
- Participatory mapping to determine locations for genomics-informed sampling including the reason a site was chosen and exercise to prioritize among the potential sample locations.

Year 2

- Refinement of Inuit Knowledge indicators of marine health (based on Interview Type 1)
- Interpretation of results from prior years genomics-informed monitoring
- Discussion on policy tools and responses to oil spills (Themes from Activity 3)

Year 3

- Interpretation of results from prior years genomics-informed monitoring and implementation of Inuit knowledge indicators
- Discussion and feedback on policy research results (Activity 3)

Year 4

- Interpretation of results from prior years genomics-informed monitoring and implementation of Inuit knowledge indicators
- Determining priorities for future research and action

Inuit perspectives on Potential Marine Oil Spills and Co-Development Community-Based Monitoring:

Thematic and Focus Areas (facilitator guide)

Thematic Area: Concerns about potential spills – Topical foci may include:

- Knowledge and information about shipping and spills – what is known and what would participants like to know
- Perceptions of risk (both likelihood of spills and severity of impacts)
- What could be impacted by spills? E.g.,
    - Geographic area of concern
    - Wildlife and resources
    - Socio-cultural, economic, recreational sites/activities
- What effects could these impacts have on the community, short and long-term?

Thematic Area: Co-development of Genomics-Informed Community-Based Monitoring

- Community priorities for monitoring oil spill impacts and marine health more broadly
- Processes for incorporating Inuit knowledge with natural science approaches to genomics-informed monitoring
- Selecting locations for sampling related to genomics-informed community-based monitoring.

Thematic Area: Desired roles for community in spill preparation and response – Topical foci may include:

- Preparation and planning for spills, e.g.,
    - Knowledge of current plans, capacity, roles
    - Local-level planning, reflecting local interests and priorities
    - Response training
    - Equipment and infrastructure
    - Information sharing or notification regarding nearby shipping
    - Monitoring of shipping, detection of spills
- Response to spills, e.g.,
    - First responders, observers, and/or cooperation with polluter ship-based or Coast Guard response activities
    - Areas of community response
    - Clean-up (wildlife, shorelines, etc.)
- Post-response, e.g.,
    - Monitoring of water, wildlife, habitat, etc.

- Learning from experience and feedback to planning and preparation

Topics for Discussion

1. Concerns about possible spills near your community

a. What information do you have about spills that could happen? What would you like to know?
b. What is the level of risk?
c. What could be impacted by spills?
d. What are some ways these impacts would affect you and your community?

2. Priorities for genomics-informed Community-Based Monitoring

a. What aspects of the marine environment should be monitored? Why?
b. What locations should be monitored? Why?
c. How should Inuit knowledge inform monitoring?
d. Can you think of any potential challenges related to monitoring in your community?
e. How should monitoring data be used?

3. Roles for the community in preparing for and responding to spills

a. Preparation and planning for spills
b. Response to spills
c. Follow-up after a spill