

MASTERARBEIT | MASTER'S THESIS

Titel | Title

Permafrost (Im)mobilities: A Qualitative Analysis on the Impacts of Permafrost-Related Changes on Local Mobilities in Northwest Territories, Canada.

verfasst von | submitted by
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angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of
Master of Science (MSc)

Wien | Vienna, 2024

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:

UA 066 855

Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:

Masterstudium Geography: Global Change and Sustainability

Betreut von | Supervisor:

Univ.-Prof. Dipl.-Geogr. Dr. Patrick Sakdapolrak MA

I. Abstract (Kurzfassung)

English

Anthropogenic climate change is transforming the Arctic, creating complex challenges on both local and global scales. Permafrost as a component of a larger cryosphere and geosphere system acts as a stabilising force in the Arctic, supporting infrastructure, travel routes, livelihoods and culture. However, permafrost degradation is reshaping the region, bringing with it both tangible and intangible challenges for those living and working in the Canadian Arctic. This master's thesis explores the intersection between climate, mobilities and permafrost in the Mackenzie River Delta and Beaufort Sea coast region, within the Inuvialuit Settlement Region and Gwich'in Settlement Area. Rooted in a community-based participatory approach, the research focuses on Indigenous land users and local perspectives. Interviews conducted for the Nunataryuk project, alongside literature insights, emphasise the interrelatedness between permafrost and mobilities, which are identified to be integral to identity, community resilience and cultural connections to the land. The research identifies that the historical contexts of colonisation have influenced community mobility, knowledge and transitions. These changes are further highlighted by material aspects of mobility that shape the way people engage with travel, transport and connections to land conditions. Subsistence harvest and life on the land are shown to be vital for interviewees and life in the Arctic, requiring local and generational knowledge. Perceptions of the future of permafrost-related mobilities are also presented, highlighting place attachment and intangible impacts through eco-anxiety. The findings offer insights into both community and incremental autonomous relocation as adaptation strategies. Through the lenses of climate mobilities and post-colonisation, this research contributes to an understanding of how permafrost interacts with mobilities, offering insights into local perceptions and adaptation processes in response to land changes.

Deutsch

Der vom Menschen verursachte Klimawandel verändert die Arktis und schafft komplexe Herausforderungen sowohl auf lokaler als auch auf globaler Ebene. Permafrost als Bestandteil eines größeren Kryosphären- und Geosphärensystems wirkt in der Arktis als stabilisierende Kraft, die Infrastruktur, Reisewege, Lebensgrundlagen und Kultur unterstützt. Der Rückgang des Permafrosts verändert jedoch die Region und stellt die Menschen, die in der kanadischen Arktis leben und arbeiten, vor materielle und immaterielle Herausforderungen. Diese Masterarbeit untersucht die Überschneidungen zwischen Klima, Mobilität und Permafrost in der Region des Mackenzie River Deltas und der Beaufort Sea Coast, innerhalb der Inuvialuit Settlement Region und der Gwich'in Settlement Area. Die Forschung basiert auf einem gemeinschaftsbasierten partizipativen Ansatz und konzentriert sich auf indigene Landnutzer und lokale Perspektiven. Die im Rahmen des Nunataryuk-Projekts durchgeführten Interviews und die Erkenntnisse aus der Literatur unterstreichen die Wechselbeziehung zwischen Permafrost und Mobilität, die für die Identität, die Widerstandsfähigkeit der Gemeinschaft und die kulturellen Verbindungen zum Land von wesentlicher Bedeutung sind. Die Forschung zeigt, dass die historischen Kontexte der Kolonisierung die Mobilität, das Wissen und die Veränderungen in der Gemeinschaft beeinflusst haben. Diese Veränderungen werden außerdem durch materielle Aspekte der Mobilität aufgezeigt, welche die Art und Weise prägen, wie Menschen sich mit Reisen, Transportmitteln und den Verbindungen zu den Landbedingungen beschäftigen. Subsistenz und das Leben auf dem Land sind für die Befragten und das Leben in der Arktis von entscheidender Bedeutung und erfordern lokales und generationenübergreifendes Wissen. Die Wahrnehmung der Zukunft von Permafrost-bezogenen Mobilitäten wird ebenfalls dargestellt, wobei die Ortsbindung und die immateriellen Auswirkungen durch Klimaangst hervorgehoben werden. Die Ergebnisse bieten Einblicke sowohl in gemeinschaftliche als auch in schrittweise autonome Umsiedlungen als Anpassungsstrategien. Durch den Blickwinkel der Klimamobilität und der Postkolonialisierung trägt diese Forschung zum Verständnis der Wechselwirkung zwischen Permafrost und Mobilitäten bei und bietet Einblicke in lokale Wahrnehmungen und Anpassungsprozesse als Reaktion auf Landveränderungen.

II. Acknowledgements

I'd like to give a special thanks to the communities and individuals in the Northwest Territories who generously shared their time, knowledge, and experiences for this work. As a master's student, I feel incredibly grateful for the chance to learn from those who are experts of their land and culture. Albeit from a distance, their insights have been foundational to my understanding and learning.

Thank you also to the Gwich'in Tribal Council, the Hunters and Trappers Committees and the Inuvialuit Regional Council for facilitating the ongoing collaboration between stakeholders.

This thesis would not have been possible without the support and guidance of Mag. Susanna Gartler and her valued work in the Arctic with the local communities. As an informal co-supervisor and valued mentor, her contributions to my knowledge and this project have been above and beyond. Thank you so much for your guidance and support.

I'm also so grateful to my peers for their input and feedback along the way. It made all the difference in keeping me motivated.

This thesis is a contribution to the Nunataryuk project, supported by the European Union's Horizon 2020 research and innovation programme (grant agreement No. 773421). Therefore, my thanks to everyone involved in making the project possible. Truly, many hands make light work.

Finally, I would like to thank my supervisor, Professor Patrick Sakdapolrak, for his valued expertise and input throughout the various stages of this thesis.

III. Research dissemination

With the guidance of mentors, the results of this thesis have been presented in written and/or verbal form to the contributing community organisations and individuals. In November 2024, a meeting was held with members of the Gwich'in Tribal Council (GTC) to elaborate on the study and results, assuring alignment with community guidelines on research. To enhance transparency and collaborative participation in research, participants were given an opportunity to review and revise their direct quotations before the thesis was submitted. As the thesis includes direct quotations, along with associated names and locations, a draft was sent to the quoted participants for review. Participants were initially contacted via email. If this was unsuccessful, follow-up attempts were made via phone or messenger app. As a result, ten responses to the draft were received during the review process. In the absence of confirmation regarding the use of quotations, the quotes were anonymised. However, since all interviewees indicated on their consent form that they wanted their names to be cited, their names appear in section nine *Interview Information*. If further information is required regarding the quotations, please contact me or Mag. Susanna Gartler.¹

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1. Introduction

The accelerating impacts of climate change in the Arctic are reshaping ecosystems, infrastructure, and livelihoods, with consequences that extend far beyond the region, affecting global environmental systems and human populations. The Intergovernmental Panel on Climate Change (IPCC) emphasises that the stability of polar regions is essential to both the interconnected global climate system and the livelihoods of those who inhabit them (Meredith et al., 2019). International research conducted on the Arctic has unveiled critical insights into the biophysical impacts of climate change, shedding light on the phenomenon of polar amplification (Pearce et al., 2010, p. 158; Rantanen et al., 2022). Polar amplification refers to a fourfold acceleration of warming within the Arctic region, in comparison to non-polar regions (Rantanen et al., 2022). Year-round warming and subsequent thawing of permafrost pose a risk not only to local ecosystems but also to the global environment, as well as to the livelihoods of communities that depend on the solidity of the ground. Permafrost spans over one quarter of the northern hemisphere, and the direct and indirect effects caused by climate change are far-reaching and extend far beyond the Arctic (United Nations News, 2022). The thawing of permafrost and its complex interactions with the environment are creating new challenges and raising critical questions about resilience, adaptation, and interdependencies. Estimates within literature suggest that 3.3 million people are living on permafrost globally and will be impacted by extensive thawing under the Representative Concentration Pathways (RCP) 4.5 scenario (Ramage et al., 2021). The Arctic extends into Norway, Sweden, Finland, Russia, the United States, Canada and Greenland, an autonomous territory of the Kingdom of Denmark. Each of these nations has a complex Arctic history shaped by the environment. In Canada, permafrost covers fifty percent of the ground surface, playing a vital role in the mobility of Arctic populations (Westerveld et al., 2023, p. 84). The social impacts of these transformations particularly on the livelihoods and well-being of local communities have received limited attention, with permafrost's influence on mobility being especially underexplored. Inuk Nobel Prize nominee, Sheila Watt-Cloutier, stated in an address to The Inter-American Commission on Human Rights, "These impacts are destroying our rights to life, health, property and means of subsistence" (Sheila Watt-Cloutier, 2007). In the

Canadian Arctic, historically mobile populations have long relied on the stability of the climate and the ability to be mobile for survival, subsistence, and cultural connection (Sejersen, 2012). However, patterns of Arctic mobility have been previously shaped by waves of colonisation, and modernisation, and now encounter a shift related to climate change (Ayeb-Karlsson et al., 2024). Suliman et al. (2019, p. 304) acknowledge that there is an “intensification of environmental change imposed on Indigenous peoples by colonialism”, underpinning the understanding of how abilities to historically adapt to the Arctic conditions have been altered. Recognising the enduring adaptive strategies of Indigenous communities developed to thrive in Arctic conditions is essential. These strategies serve as a foundation for resilience, enabling communities to navigate and respond proactively to environmental changes today.

This master’s thesis aims to connect local experiences and perceptions from four communities in the Northwest Territories of Canada to broader scholarly discussions on climate-induced mobilities and immobilities. Central to this research is the overarching question: *How do changes in permafrost conditions affect the (im)mobility of local communities in the Northwest Territories, Canada, and what strategies are being employed to adapt to these impacts?* Through qualitative methods, this study employs secondary analysis of interviews with locals, including Indigenous Elders, Indigenous land users and Indigenous and non-Indigenous professionals, within the communities of Inuvik, Aklavik, Fort McPherson and Tuktoyaktuk. In doing so, it explores perceptions of mobility changes related to permafrost thaw. Supported by a literature review, this research seeks to understand the impacts and adaptive strategies emerging at the intersection of permafrost changes and mobility patterns, while grounding these findings within historical contexts.

The literature review section provides a background on permafrost, patterns of mobility and disruption in the Arctic as well as local adaptations. It also addresses Inuit traditional knowledge (Inuit Qaujimajatuqangit) and Gwich'in connection to land which encompass ways of knowing, values, and practices. Additionally, this section includes a discussion of the current knowledge gaps relevant to these themes. This section is followed by the theoretical background, which situates the research within climate (im)mobilities and postcolonial theory as well as establishing an integrated framework to examine mobility,

adaptation and resilience in a colonial context. The methodology outlines the primary data sources and secondary analysis approach, along with ethical considerations and author's positionality. Study site descriptions follow, providing a brief contextual grounding for the findings. The results and discussion sections present the analysis in a thematic structure. The first subsection on the intersections of permafrost thaw and mobility brings together these two concepts. The second subsection, considering the impacts of colonialism, addresses the difficulty in talking about mobility in the Arctic without contextualising it historically. The third subsection, the materiality of mobility, examines the concepts of changing material cultures. These first three subsections provide a foundation for the fourth and fifth subsections. Life on the land and subsistence mobilities addresses the changing nature of cultural practices due to permafrost and resilience. Finally, the relocation and retreat subsection identifies this particular adaptation strategy from an individual and community perspective.

As Suliman et al. (2019, p. 304) highlight, "In light of the challenges of climate change and a legacy of colonialism, it is important to engage with contemporary Indigenous struggles to understand the limits of formal mechanisms of climate change governance, and to envisage alternatives that satisfy the aspirations of Indigenous people in a changing climate." Therefore, a postcolonial and resilience approach emphasises understanding of the historical context, power dynamics, Gwich'in and Inuit Indigenous knowledge (Inuit Qaujimajatuqangit), and the impacts of colonial legacies on the current environmental and social challenges. This research contributes to a larger body of work on how climate change and permafrost thaw related impacts societies and environments.

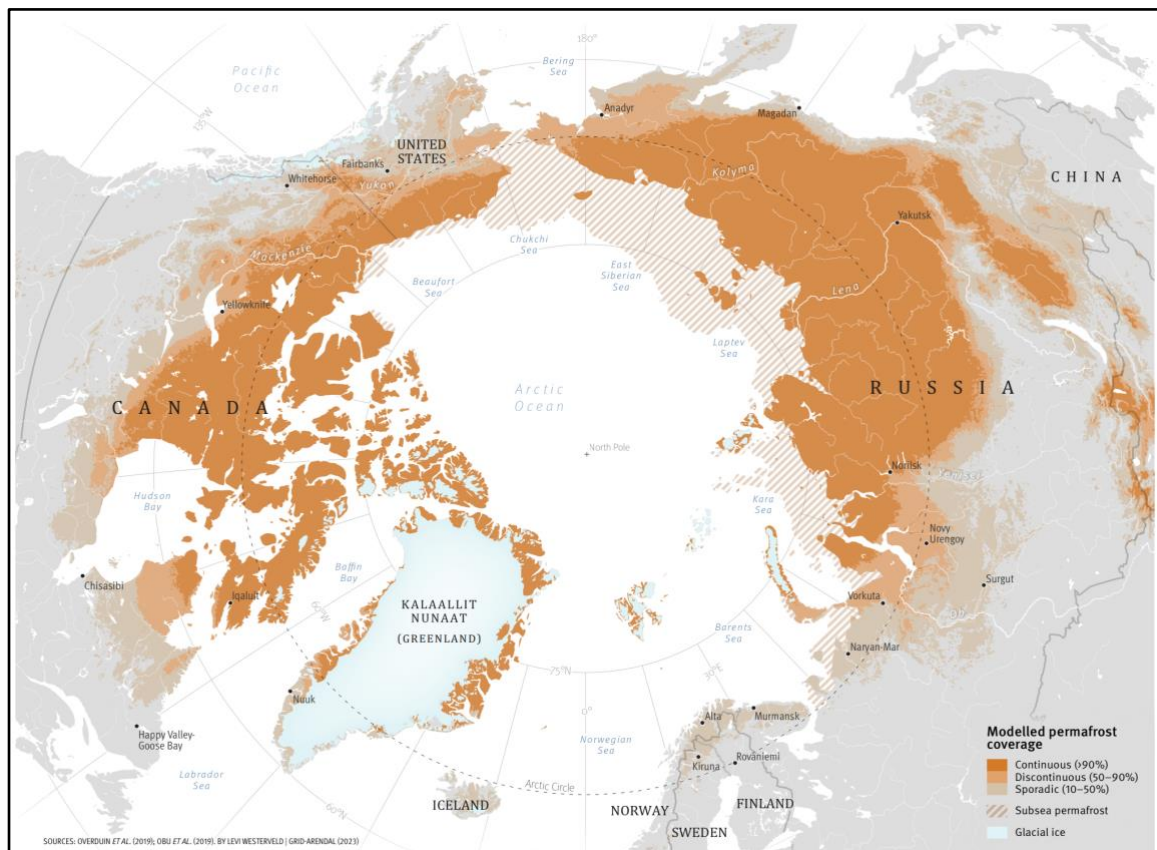
2. Literature Review

2.1. *Permafrost in the Northwest Territories*

Permafrost is a portmanteau of permanent and frost and is understood to be ground that remains at or below zero degrees Celsius for at least two consecutive years. This frozen

ground may consist of soil, rock, ice, or organic material (Westerveld et al., 2023). The four types of permafrost zones are continuous, discontinuous, sporadic and isolated, and are based on the proportion of the permanently frozen ground. The study sites are all located in a zone of continuous permafrost, where permafrost lies beneath ninety percent or more of the surface (Burn & Kokelj, 2009). Permafrost can be found in high latitudes or high altitudes and is found to extend underneath the sea's surface in some instances (Westerveld et al., 2023). Permafrost is globally extensive, covering a total of fourteen to sixteen million square kilometres and amounts to twenty-four percent of the land surface in the Northern Hemisphere (Ramage et al., 2022)(see fig. 1). The uppermost surface layer, the active layer, goes through an annual cyclical thawing and freezing process. Within the study region, the active layer's thickness can differ and the increase in thickness is being researched in relation to the changes in air and land temperature (Burn & Kokelj, 2009).

Figure I. Modelled permafrost coverage. Source: Westerveld et al., 2023.



Mapping and measuring permafrost remain a challenge for researchers and other stakeholders, due to financial and technological constraints (Kokelj et al., 2023). The thickness of the permafrost varies in the study site area and is suggested to range from 500m to less than 100m depending on the deglaciation or glaciation periods (Burn & Kokelj, 2009). Warm ground, shifting channels and the presence of water bodies decrease the thickness of permafrost (Burn & Kokelj, 2009). Physical probing of the ground suggests that the thickness of the active layer is also impacted by “soil characteristics, particularly organic matter content and site wetness” (Burn & Kokelj, 2009, p. 99). The observed large increases in the active layer, or seasonal thaw zone is causing researchers and inhabitants concern (Westerveld et al., 2023). The receding permafrost results in weak and unstable grounds, as the binding agent dissipates (Kokelj et al., 2023).

In the Mackenzie Delta area, conditions of permafrost vary and are influenced by a combination of ecological, geomorphic, and climatic factors (Burn & Kokelj, 2009). Burn & Kokelj (2009, p. 100) indicate that “the most active geomorphic features in the region are due to thawing of ground ice”, leading to landscape changes. It is suggested that permafrost in the Mackenzie River and Beaufort Sea Coast area is comparatively warm (Forbes et al. 2022, p. 927). The degradation of ice-rich permafrost leads to the formation of thermokarst formations, with the potential to rapidly modify landscapes (Kokelj et al., 2023). This can be seen with what Forbes et al. (2022) describe as the “Swiss cheese-like patterns” in the area and the pingo landscapes. Impermeable to water, permafrost can trap water creating a mosaic of lakes and wetlands. However, thawing is resulting in reduced water levels as stored water seeps into the ground. These factors create challenges for the maintenance and development of community and industrial infrastructure (Burn & Kokelj, 2009). However, the rate of warming is not consistent throughout the Arctic, with variability in thawing patterns and their consequences (Westerveld et al., 2023, p.42). Terrestrial and aquatic environments are deeply interlinked with conditions of permafrost and anticipated changes will have far-reaching ecological and societal impacts (Burn & Kokelj, 2009). The thermal and geomorphic changes in permafrost, driven by the amplified warming of the Arctic, are generating increasing interest in both the local and broader impacts that are expected to unfold.

The frozen ground acts as a binding agent amongst rock sediment and soil but is also a large carbon and preserved biomass material storage. The thawing of permafrost raises questions and has induced scientific inquiry into the potential release of large stores of greenhouse gases (Overland et al., 2019). Permafrost is among the earth's largest global reservoirs for carbon dioxide and methane gas, therefore the release of this through thawing will have irreversible global impacts by contributing significantly to climate change (Zimov et al., 2006). Zimov et al. (2006) estimate that approximately 500 Gigatonnes (Gt) of carbon is stored in frozen yedoma, which is ice and organic matter rich permafrost, and another approximately 400 Gt in non-yedoma permafrost. They suggest that the degradation of permafrost and the subsequent contributions to atmospheric carbon have far-reaching consequences. The magnitude, temporality, the extent of permafrost thaw and subsequent impacts remain uncertain and a challenge to be researched. Lake drainage, retrogressive thaw slumps, peat degradation, erosion and weak foundational layering have all been attributed to permafrost thaw leading to environmental and societal consequences (Gartler et al., 2024; Kokelj et al., 2023).

Research emphasises the role of climate change and Arctic amplification as a main driver in the temporality of change (Chi et al., 2024). Permafrost thaw, sea level rise, retreating sea ice and storm frequency are mentioned most frequently as a result of climate change (Chi et al., 2024). Changes in the land and environment and their impact on mobilities are being noticed by Arctic communities and researchers alike. Jungsberg et al.'s (2022) community surveys from Aklavik (Canada), Longyearbyen (Svalbard) and Qeqertarsuaq (Greenland) highlight that the significantly negative and direct impacts of permafrost thaw are felt throughout many Arctic communities. Their research revealed that seventy-four percent of respondents in Aklavik, forty-six percent in Longyearbyen, and twenty-one percent in Qeqertarsuaq indicated 'Yes' to the survey question "Do you think that thawing of the frozen ground causes problems to you?". Looking at permafrost from a social science lens or with an interdisciplinary approach is further needed to highlight the full extent of impacts in an expansive Arctic.

2.2. *Mobility Patterns and Disruptions in the Arctic*

The Arctic is often depicted as remote and sparsely inhabited, yet a closer look shows that Arctic and Subarctic communities are deeply interconnected, shaped by a long history of migration and semi-nomadic cultural traditions. The Arctic extends across Norway, Sweden, Finland, Russia, the United States, Canada, and Greenland, each with its own complex Arctic history. As a result, emerging research on Arctic mobility often varies in its approaches, reflecting the unique political, social, and cultural contexts of these regions. This is captured by Sejersen (2012, p. 190), who describes Arctic mobility as “hyper-mobile and place-polygamous”. Arctic mobility patterns are inherently shaped by a region’s environmental, social, economic and political contexts (Povoroznyuk et al., 2023; Sejersen, 2012), with migration, work, health, leisure, subsistence and cultural practices influencing these movements (Hayfield et al., 2021).

Within literature, mobility as a circular or everyday activity is frequently presented through land-based activities or Indigenous cultural activities such as travelling, subsistence harvesting, hunting, fishing and trapping. These activities and their economic significance vary among Arctic communities, having high importance in the North American Arctic and lesser importance in Greenland (Sejersen, 2012). Distance, technology and the climate further shape how people partake in mobility (Hayfield et al., 2021). Hayfield et al. (2021) refer to these factors as “local mobility cultures” and emphasise the connections to work-related mobility. Here work-related mobility extends beyond paid labour to include subsistence activities, cultural practices and seasonal movements. Indigenous people throughout history have held the required knowledge to be able to live, survive and navigate in the Arctic (Sejersen, 2012). While only approximately nine percent of the four million total Arctic inhabitants are Indigenous, with over seventy-five percent of the population in Greenland and the Canadian Arctic identifying as Indigenous (Wang & Roto, 2019). It is important to note that these statistics can be imprecise as a lack of common definitions of Indigeneity means statistics use regional criteria, which may lead to discrepancies.

Literature that discusses North American Arctic mobility often includes a perspective on Indigenous mobilities (Ayeb-Karlsson et al., 2024; Davis et al., 2022; Watson, 2017). Indigenous traditions of mobility are ancient and hold significance to communities (Whyte et al. 2019, p. 320). This is particularly true for the Gwich'in and Inuvialuit (Krause, 2022a, p. 9). These communities have a deep history of being intrinsically linked through a history of mobility and interconnectedness; it is important to note that social connection within the region extends beyond localities, across country borders and settlement regions. Indigenous mobility in the Mackenzie River Delta and Beaufort Sea coast is shaped by the local environments, including land, water and the changing seasonal weather patterns (Proverbs et al., 2021). Indigenous perspectives on mobility can offer important insights into themes of place attachment, belonging and justice important within the discussion of the Anthropocene (Davis et al., 2022). In discussions of justice and the Anthropocene, the concepts of well-being, non-economic loss and damages are highlighted (Ayeb-Karlsson et al., 2024). Disconnection from land-based practices and mobility is amplified by climate change creating emotional distress, identity loss and a range of insecurities, including food insecurity within Arctic communities (Ayeb-Karlsson et al., 2024).

It is difficult to look at Arctic mobility, especially within the current global context of climate change, without acknowledging the ongoing disruptive processes of colonialism or decolonisation (Sejersen, 2012). Colonisation has played a major role in the shift in mobilities (Davis et al., 2022). Hayfield et al. (2021, p. 147) acknowledge that throughout the Arctic “colonisation imposed sedentary lifestyles on Indigenous Peoples by means of relocation, compulsory schooling and subsequently, wage-earning work”. Literature frequently underscores that with climate change Indigenous cultures continue to be threatened particularly by disconnection from the land (Suliman et al., 2019). Suliman et al. highlight (2019, p. 299) “A prominent concern is that regional risks to land, habitability and livelihoods are unequivocally linked to risks to tradition, culture and identity”. Movement and the ability to be mobile is a significant element that connects communities to subsistence and the ability to survive in these remote areas (Ayeb-Karlsson et al., 2024; Chi et al., 2024). Complete dependency on commercial food systems is financially burdensome for many in this area and the high cost of living is a significant contributor to insecurity (Davis et al., 2022, p. 7). Subsequently, there is some evidence that the drivers

of outmigration are linked to work, education and healthcare (Chi et al., 2024; Hayfield et al., 2021). Colonisation has imposed political, economic and social systems which have undoubtedly transformed the mobility practices.

Literature that discusses mobilities in the Canadian and North American Arctic typically has thematic focuses which are centred around planned relocation (Chi et al., 2024), transportation and development (Povoroznyuk et al., 2023), and mobility as a circular or everyday activity (Ayeb-Karlsson et al., 2024; Davis et al., 2022; Pearce et al., 2010). Often these thematic focuses are interconnected; for example, Povoroznyuk et al. (2023, p. 299) write “Transport infrastructures often tend to encroach on communal lands, endangering the physical and cultural integrity of communities, even causing some residents to leave or relocate”. Suliman et al. (2019, p. 304) suggest that mobility is often positioned as problematic. Furthermore, there is scholarly interest in the technological development in the Arctic and the subsequent reshaping of mobility patterns. Over the past century, significant industrial development, such as hydrocarbon extraction and mineral mining, along with infrastructure projects like highways and international satellite facilities, has taken place across many Arctic states (Cloutier, 2018; Povoroznyuk et al., 2023). There is growing interest among various stakeholders in establishing and enhancing connections to and within the Arctic. As Hayfield et al. (2021) state, developments in technology in the last centuries, along with globalisation, have “transformed mobilities potential”. However, despite these significant modern and globalisation transitions Arctic communities are confronting growing challenges in their daily lives due to climate change, while simultaneously adapting through resilience and innovation (Pearce et al., 2010).

The environment plays a critical role in the stability and accessibility of land and ice-based routes, which are essential for the movement of people, goods, and equipment. The literature recognises that climate change is causing disruptions in mobility (Sejersen, 2012). Travelling on land and ice is made more dangerous and unpredictable (Stern, 2021, p. 4). Many communities depend on permafrost for stable infrastructure, travelling and for subsistence (Westerveld et al., 2023, p. 26). Locals in northern Canada are reporting that permafrost thaw is resulting in safety issues, indicating that hunting and travelling routes are becoming more volatile (Timlin et al., 2022). Povoroznyuk et al. (2023, p. 313) highlight

that permafrost plays a major role in stabilising transport and that permafrost instability has socio-economic impacts. Permafrost is presented by the authors as a “particularity that requires special consideration” (Povoroznyuk et al., 2023). Despite these insights, there remains a gap in understanding the connection between permafrost changes, local mobility, and adaptation strategies with community perspectives, highlighting the need for further research in this area.

2.3. *Local Adaptation*

Technological and infrastructural adaptation responses are predominantly addressed in literature from a macro perspective, emphasising large-scale efforts such as state-led infrastructure development, government funding, and broader community initiatives. Povoroznyuk et al. (2023, p. 311) note that the Canadian government’s support of Arctic mobility infrastructure such as the Inuvik-Tuktoyaktuk highway is largely motivated by supporting economic development, extractive industries and sovereignty through increased connections. The federal government is presented as a significant actor and figure of significant power in the area. The Canadian government can be viewed as an agent of change that contributed politically and financially to the transformation of mobility in the Arctic (Watson, 2017). While the macro perspectives are necessary it is important to also look beyond systems of infrastructure and into localised mobility cultures, to deeply engage with mobility discourse (Hayfield et al., 2021, p. 147). However, Indigenous, individual or micro adaptations and resilience to climate have limited presence in literature, presenting a gap in research. Ayeb-Karlsson et al. (2024) briefly discuss changes in mobility customs through the use of modern technologies, such as snowmobiles and boats. However, they suggest the shift to modern means of transport is also identified to be contributing to a form of harm not only to the environment through air, snow and sound pollution but to individuals and their physical and mental health. Ethnographic studies have identified loss of traditional modes of everyday transport, for example dog sledding, is contributing to a socio-environmental disconnect (Ayeb-Karlsson et al., 2024).

Adaptation can be preventative, anticipatory and responsive which can take place across multiple scales. Migration, or the movement of people in response to environmental

events can occur through evacuations or systematic reduction in development and may be temporary, permanent, internal or international (Marino, 2012, p. 374). As climate-induced threats escalate in areas of the world, relocation emerges as a potential adaptation strategy. According to Bronen (2014, p. 17), relocation of infrastructure and livelihoods may be “the best” adaptation response for those facing climate-induced threats although with an emphasis on the usage of governance frameworks. Relocation at any level, however, demands substantial time and financial resources. For instance, they highlight that the State of Alaska allocated approximately USD\$1.5 million between 1983 to 1989 to manage relocation related to erosion. As climate change begins to make certain areas uninhabitable, Bronen (2014) emphasises the need for a governance framework grounded in human rights that will enable communities to relocate when disaster risk strategies are insufficient. The development of community-planned retreats is occurring in Canada as a result of flooding, erosion, and sea level rise, although it is largely presented as a long-term strategy. Further, there is a strong emphasis on preserving community and individual well-being is identified as essential (Saunders-Hastings et al., 2020). Schweitzer’s (2010) research highlighted the complex histories with Indigenous populations, relocation schemes during colonisation and the current development of planned relocation as a response to climate change. Previous state-sponsored efforts to move populations have employed force and enticement, therefore their research recognised the need to include local perceptions and experience with relocation (Schweitzer, 2010). Grounding research in the experiences and voices of local communities is necessary for a holistic and nuanced understanding of adaptation processes (Ayeb-Karlsson et al., 2024).

According to Ford et al. (2016), effective adaptation requires multiple solutions and perspectives as there is rarely ever a single solution to complex climate challenges. Knowledge and learning play a critical role in building resilience. They highlight that local customs, values and decision-making processes are essential for adaptation in Indigenous communities, requiring reciprocal learning. Mercer and Ovitz (2023) further note that a reciprocal approach is essential, emphasising that knowledge needs to be given back to communities. They suggest that within the Arctic context, there is a recognition of the notion of capacity building to shift to capacity sharing, a two-way exchange of information (Mercer & Ovitz, 2023). Building on previous studies through locally led and community-

based empirical research can provide a diverse range of first-hand capture knowledge and insights. Supporting adaptation to permafrost thaw requires not only the empowerment of locals and community engagement but also the co-production of knowledge (Timlin et al., 2022). In emphasising the role of Indigenous perspectives, Povoroznyuk et al. (2023, p. 321) highlight the value of incorporating Indigenous knowledge, noting that it is “critically important for collaborative research and co-production of knowledge in and about the Arctic”. These approaches highlight the importance of self-determination, push back on top-down approaches in Indigenous climate adaptation as well as recognise knowledge production which is inclusive of divergent ontologies.

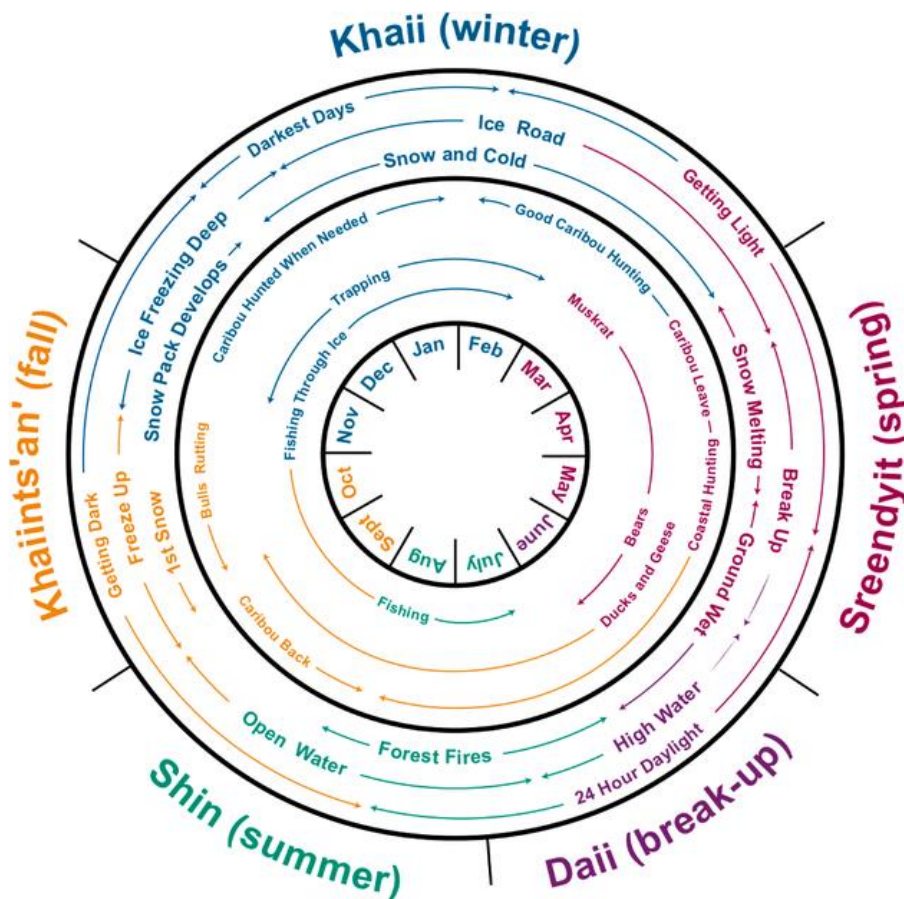
2.4. Inuit Qaujimajatuqangit, *Gwich'in Traditional Knowledge and Connection to the Land*

Inuit Qaujimajatuqangit (IQ) was first translated to ‘Inuit Traditional Knowledge’ in 1998 and as a concept aims to encompass an Indigenous culture including worldviews, languages, societal expectations and perception (Tester & Irniq, 2009). However, the term traditional led to an insinuation that it is in the past or holds less merit in modernity, which is not the case. Instead, described as being in “continuous motion” and passed down from generation to generation, IQ is a testament to the preservation of experience, observation and communication between all facets of Inuit communities (Karetak et al., 2017). The land is a vital aspect of IQ, for example, it is the provider of shelter, food and is a source for maintaining wellbeing (Karetak et al., 2017). Moreover, the land is understood to be alive and thinking (Watts, 2013, p. 21). The health of the land and the physical and mental health of people is understood to be intrinsically linked (Tester & Irniq, 2009, p. 55). Laws of the land, teachings and legends have guided the Inuit within the harsh Arctic environment, however, it is acknowledged that not every Inuk follows these today (Karetak et al., 2017). Mobility in IQ appears in discussions about travelling on the land, hunting and coming from semi-nomadic roots (Karetak et al., 2017).

Mobility also changes seasonally and activities undertaken by land users correlate with the resources available according to the time of year (Fig II). The Gwich'in Seasonal Calendar for example shows in detail the environmental conditions, land use activities,

animal behaviours and the Julian calendar (Proverbs et al., 2021)(Fig. II). Proverbs et al. (2021) address some of the impacts of climate change with a focus on ecosystems, briefly raising concerns about changes in fish migration and observed changes in wind patterns.

Figure II. Gwich'in Seasonal Calendar. Source: Proverbs et al., 2021.



Harmony with the land is fundamental to IQ and Gwich'in traditional knowledge, guiding sustainable practices that maintain balance between people and the land (Proverbs et al., 2021; Tester & Irniq, 2009). Contemporary land practices are evolving and transforming with technologies and infrastructures. While technology like snowmobiles is recognised as essential to modern survival it can be seen to negatively impact the balance when it is given priority over the health of the land (Karetak et al., 2017). The role modern transitions play is to facilitate easier travel, hunting and improving living conditions for others (Karetak et al., 2017). Sustainable practices are integral to traditional knowledge systems and are adapting alongside technology.

Indigenous worldviews are viewed differently on the international stage, where organisations such as the UNFCCC tend to prioritise technocratic approaches to managing climate change (Suliman et al., 2019, p. 303). However, when addressing the adaptation to climate in the Arctic it is necessary to include and work with Indigenous knowledge systems and understanding as incorporating local, place-based knowledge can enhance comprehensive adaptation solutions (Suliman et al., 2019).

2.5. *Gaps in knowledge*

There is a steadily growing body of literature that is drawing out the interconnections between environmental changes, mobilities and the socio-economic impacts within the Canadian Arctic (Sejerson, 2012). As climate change intensifies, researchers from multiple disciplines are paying increased attention to how the Arctic is being affected by the shifting environmental conditions. However, as highlighted in the previous sections, the majority of the Arctic mobility literature does not have a dominant focus on permafrost or specific environmental hazards. This creates a gap in understanding the nuanced connections and relationship between permafrost conditions and mobility. As literature also shows mobility has historically been and continues to play a significant role in life in the Arctic (Sejerson, 2012).

Discourses on adaptation and vulnerability highlight the historical legacies of colonialism and the need for co-developed knowledge approaches that integrate local Indigenous perspectives (Whyte et al., 2019). Therefore, co-developed knowledge approaches that integrate Indigenous perspectives are increasingly seen as essential for addressing research questions. This growing field of research highlights the importance of examining mobility not only through a technical or economic lens but also through a cultural and environmental one to further address the multilayered factors that influence (im)mobility (Boas et al., 2022). Current methods within research vary although there is a tendency towards qualitative data or literature-based research to answer questions about mobility. Thus, more insight into nuanced perspectives and individuals as agents of adaptation

within the context of mobility is needed. Such insights are crucial to understanding how local populations navigate these changes and are able to make decisions about environmental transformations.

3. Theoretical Background

3.1. *Climate (im)mobilities*

Impacts of climate are seen to be so severe that individuals or sometimes entire communities are required to remove themselves from the threats of climate. Discussions about the 'climate refugee' and 'climate migration' are increasingly present in media, policy and research conversations (Diniega, 2024; Everuss, 2023). Boas et al. (2022) emphasise that while it is a compelling and necessary conversation to consider the international and large-scale movement of people, understanding the small scale is equally necessary within the climate migration nexus since the 'climate migrant and refugee narrative' does not reflect reality for most. Their research shows that responses to climate-driven migration as well as individuals' capacities and agency to act, can vary significantly depending on contexts. In response to increasing research and concern with climate change and migration, the climate (im)mobilities nexus attempts to look deeper into the everyday experience and perceptions that influence mobility capabilities (Boas et al., 2022).

The term mobilities attempts to avoid a linearity often found in climate migration theory. It encompasses everyday mobility, power dynamics and interscalar features, to help address the nuances of climate impacts (Everuss, 2023). The turn from the use of climate migration to mobility emerged out of the necessity to cover a wider range of nuanced experiences of movement related to climate and identifying patterns of everyday mobility, 'micro-mobility', to contextualise change (Boas et al., 2022; Zickgraf, 2022). Boas et al. (2022) summarise, "This plurality of mobilities cannot be well captured by the term 'migration', which in discourses of climate change tends to be interpreted as representing

one-off, long-distance and cross-border movements of large groups of people”. Therefore, the concept of mobilities provides a more comprehensive framework for understanding the complex and diverse ways in which climate change affects movement of populations.

According to Blondin’s (2022) research, a nuanced understanding of (im)mobilities can contribute to clarifying the factors and choices that enable or restrict movement. They discuss the ‘mobilities paradigm’ and the importance of considering mobilities at various ‘scales’ and ‘paces’ and how this intertwines with the material aspects that make travelling, movement and migration possible. This expanded view captures mobility systems where infrastructures and transport interact with the environment and should be further considered in mobility decisions and disruptions. Further, exploring how environmental conditions intersect with mobility systems, where people, infrastructures, and elements of daily life become entangled in patterns of mobility and immobility (Blondin, 2022). Examining everyday mobility can reveal critical information about local nuances to climate and adaptation (Diniega, 2024). It is important to consider the historical and existing patterns of mobilities, and the material, social, economic and political conditions in which climate mobilities may occur (Boas et al., 2022). Everyday movement can reveal irregular patterns in mobilities that are impacted by climate (Boas et al., 2022).

The mobilities approach also introduces the idea of a condition of being immobile, which emerged significantly through the idea of trapped populations, where people lack resources to move from climate events (Black et al., 2013; Boas et al., 2022). Scholars acknowledge the challenge of distinguishing between being immobile or being trapped, however, it emphasises the need to consider resource capabilities or social, economic and political means (Black et al., 2013). Zickgraf (2019) asserts that individuals possess different capacities and motivations to migrate from their homelands. Furthermore, it is also important to understand factors that contribute to being immobile beyond the notion of being trapped, albeit an important aspect within the climate migration nexus. Economic factors are influential components of immobility, however, alone are insufficient to explain (im)mobility choices. Considering place attachments, cultural motivation and political factors is also necessary when linking climate and staying. Highlighting the complexity of immobility, the author (2019, p.4) argues “immobility is never monocausal, political factors

do not act alone but rather in conjunction with social, economic, environmental and demographic factors to shape immobility patterns and outcomes”. Additionally, physical constraints, legal constraints or social connections can play a role in capabilities and aspirations or there the lack of (Boas et al., 2022). Zickgraf (2019, p.4) further highlights that “mobility and immobility are not fixed categories”, in that people can change frequently or not between these categories.

A climate (im)mobilities approach takes into account all scales of movement of people as well as encompassing situations where individuals are unable to move. (Im)mobility in this sense are not fixed categories and are non-linear, necessitating deeper insights into nuanced perspectives. Hence, this climate (im)mobilities lens assists in navigating institutional, spatial and infrastructural groundings of mobilities (Blondin, 2022). This approach is necessary in addressing the question of how permafrost conditions impact local mobility. The climate (im)mobility lens offers a holistic framework for understanding the connections between human mobility patterns and environmental change in the context of climate change (Everuss, 2023). Ultimately, understanding the nuanced interactions of factors which include environmental, economic, social, political and personal motivations is essential for comprehensively addressing mobility in the climate change context.

3.2. *Postcolonialism*

There are deep and complex cross-disciplinary engagements with postcolonialism as a theory, condition, method and approach (Chakrabarty, 2012; Gandhi, 1998; Moss, 2003). A pillar of postcolonialism as a theory attempts to grasp the aftermath of complex colonial conditions (Gandhi, 1998). Abrupt and often forceful cultural, social, economic and political occupation of lands and peoples have lasting effects. According to Gandhi (1998) pinpointing the end of colonialism to enter into a postcolonial era is challenging, where an event or establishment of liberation, governing autonomy or independence may not be the immediate end to colonialism. They discuss how the hold colonialism has is far-reaching and long-lasting in societies making the end of colonialism difficult to discern. Moreover,

the residual impacts of colonialism are shown through the example of the psychological hold of colonial power persisting even after a colonial power subsides (Gandhi, 1998). Currently, Canada as an entity is still tied to the English monarchy (Moss, 2003). It is important to acknowledge the discussions regarding Canada's postcolonialism status and whether examples can be drawn from Canada to contribute to the understanding of postcolonialism. As addressed by Moss (2003), there is a difficulty in identifying Canada within postcolonialism as the definition and usage can vary. Furthermore, colonialism also differs for the people within Canada and the modern concepts of globalisation and modernism can at times overlap. Bernauer (2019) notes a discussion surrounding the resource extraction industry in the Canadian Arctic and how the industry has and is feeding into colonial practices. They highlight the dispossession of land, cultural impacts and how the share of wealth from extractive industries is disproportionate. Roy and Hanaček (2023) discuss colonial environmental extraction through the lens of decolonial environmental justice, highlighting the danger of prioritisation of development logic and the need to engage with the voices of communities. Further, they call for methodologies that explore alternatives to Western human-nature relationships. As colonial histories are characterised by exploitation, marginalisation, and cultural disruption, postcolonial theorists call for a "participatory and accountable" approach (Raghuram & Madge, 2006, p. 272).

Moss (2003) discusses Canadian postcolonialism and the benefits of postcolonialism as an approach in research. They suggest that postcolonial approaches in literature can assist in making sense of how knowledge is produced, power relations and residual colonial holds in countries even down to the individual's psyche. Gandhi (1998) states that "Postcolonial theory inevitably commits itself to historical and psychological 'recovery'", whereby acknowledging cultural differences rather than negating them is required. A postcolonial approach in geographical studies also requires "A commitment to take up issues raised by those who are researched, a willingness to engage in constructive dialogue that takes into account the conceptual landscape of those with whom we engage" (Raghuram & Madge, 2006, p. 270). Therefore, with this lens, it is necessary to further incorporate the emergence of dual epistemologies, the importance of the contextualisation of histories and knowing, and going beyond "Eurocentric 'world-picturing'" (Raghuram & Madge, 2006, p. 271). Resilience and adaptation will be discussed through the postcolonial lens rather than

through vulnerability and adaptive capacity framework emphasising a bottom-up and community-based perspective. This approach will assist in exploring power dynamics, resilience and knowledge production (Suliman et al., 2019). The thesis will take into account the legacies of colonialism and their implications for contemporary socio-environmental relations. A postcolonial lens will serve to demonstrate how historical and contemporary political and social dynamics have impacted patterns of (im)mobilities.

3.3. Towards integrating climate (im)mobilities and postcolonialism

Merging a climate (im)mobilities and postcolonial approach acknowledges the historical processes that underpin mobilities and explores the power relations and the maintained inequalities present. It offers a critical lens to examine the permafrost thaw and its impacts on Indigenous communities in the Arctic. This integrated approach serves to examine the climate (im)mobilities nexus with a more focused understanding of historical and contemporary socio-political landscapes. Boas et al. (2022) suggest that “migration under climate change takes many forms that are contextually dependent and are shaped by existing relations of power and inequality”. This is supported by postcolonialism scholar Chakrabarty (2012) who highlights that the impacts of climate change are influenced by existing global inequalities, many stemming from historical conditions and contexts. Integrating climate mobility with an understanding of post-colonialism positions this research within the understanding that emerging climate challenges are exacerbated by social, economic and political conditions rooted in colonialism. This integrated approach provides a lens to analyse climate impacts together with the tools that communities have access to adapt and respond.

Currently, there are limited direct connections that have been made between postcolonial theory and climate mobilities within literature. Whyte et al. (2019) note that Anthropocene discourses should include discussions of colonialism. Although there is an emerging scholarly connection between climate, globalisation and colonial legacies. Chakrabarty (2012) suggests that “postcolonial thinking may need to be stretched to adjust itself to the reality of global warming.” A logical step in understanding how postcolonialism

is at play within the climate mobility nexus. This perspective acknowledges the communities' capacities to adapt and respond to climate mobility issues are not solely the result of environmental factors but are deeply intertwined with legacies of dispossession, marginalisation, and systemic inequities. Examining the intersection of climate mobility and post-colonialism uncovers the internal complexities that influence how local communities in the Northwest Territories experience and respond to permafrost changes. Integrating community insights aims to foster a more holistic and culturally responsive understanding of climate impacts and adaptation strategies.

4. Methodology

The research and thesis are rooted in community-based participatory research principles, emphasising collaboration, reciprocal learning and community engagement (Leeuw et al., 2012). A key aspect of this thesis' methodology is the use of the two-eyed seeing approach, which respects and integrates both Indigenous knowledge systems and Western scientific approaches to enable co-learning and the co-creation of knowledge (Bartlett et al., 2012). Empirical data for this thesis is based on interviews that were conducted by Mag. Susanna Gartler and Prof. Susan Crate between 2022 and 2023 during fieldwork in the Mackenzie River Delta region and Beaufort Sea coast, within the Inuvialuit Settlement Region and Gwich'in Settlement Area. The data was gathered as a part of the *Nunataryuk* Project² which was funded by the European Union's Horizon 2020 research and innovation programme (grant agreement No. 773421) and licensed under number 17168 and AC-REC project Nr. 20190101. The social science component of the Nunataryuk Project aimed to identify the impacts of permafrost thaw on subsistence harvesting and wellbeing, and associated risks, assess adaptation strategies, raise awareness and facilitate the sharing of adaptation strategies. Communicating results with local communities and participants is emphasised in the research agreement with the Gwich'in Tribal Council and therefore extends to this project. This thesis strives to support the objectives of the *Nunataryuk* projects' social science components. This includes identifying impacts, risks

² See: <https://nunataryuk.org/>

and adaptation strategies related to permafrost thaw and with a focus on *Disruptions to Mobility*, one of the five most evident key hazards (Gartler et al., 2024). Mobilities were not the primary focus of the interviews, the topic emerged as a dominant and recurring theme linked to the environment and permafrost, as highlighted by the participants. Land users and professionals interviewed frequently addressed the themes of moving and travelling on the land, relocating permanent housings and how it is difficult to remove these from the environment in the Arctic.

4.1. *Interview Data*

The interview data consists of twenty-nine individual and three focus group semi-structured interviews, amounting to a total of forty-two participants. This thesis focuses on twenty-five Indigenous land users' interviews and is further informed by fifteen Indigenous and non-Indigenous professionals whose work is involved with the communities. Participants were recruited using purposive and snow-ball sampling throughout multiple long term stays in the area. To identify potential participants for this study, initial contact was facilitated through the local Hunters and Trappers Committees. The selection criteria focused on individuals who are active land users and possess extensive knowledge of the local environment as well as professional stakeholders such as representatives from the Housing Department, Infrastructure Department, Town Administration and Hamlet Administration. Participants were chosen based on their availability and expressed interest in the research topic, following standard practices in the field. In total, twenty-six interviewees were males and sixteen females; within this there were fourteen male and eleven female Indigenous land users, ages ranged from twenty to eighty plus. one hour and took place within the communities of Inuvik, Tuktoyaktuk, Fort McPherson and Aklavik. In total, approximately thirty-two and a half hours of interview data was collected.

Questions asked to the participant were centred around the experience of living with permafrost and the changes occurring. Examples of questions include what permafrost means to the participant and if the participants have experienced or noticed any changes in permafrost conditions. Responses varied depending on several factors including their

role within the community, gender and age. With prior informed consent, interviews were collected using handheld recording devices and stored safely by the researchers. Participants were given the option in the consent form to choose anonymity or to have their names included in any subsequent research as well as to opt out of being directly quoted. This approach was adopted in recognition of the historical context in which the voices of certain communities have been marginalised or excluded from scientific research. By offering the opportunity for participants to be named, the study aims to empower individuals to have their contributions recognised and to address past practices that have limited their representation in academic discourse.

The interviews were transcribed as a team effort, this included Mag. Susanna Gartler, Prof. Susan Crate and myself. Each member used different methods of transcribing including *Otter.ai*, *Microsoft Word* online transcribing tool and manual transcribing. One identified limitation of analysing these interviews without participating in them is not being able to get the full context of the interview or interviewee without further clarification with the interviewer. Therefore, understandings occasionally lacked details when physical clarifications were occurring, for example when the interviewee was showing locations on maps. In cases of needing further clarification or context, contact was made with Susanna Gartler for further insight.

4.2. Data Analysis

Given the qualitative nature of the data, a qualitative content analysis (QCA) was undertaken to systematically draw out patterns of experience, perceptions and adaptations to permafrost and mobilities. Since I did not collect the data and the data was shared with me for the purpose of further investigating themes of mobility, this work constitutes a secondary analysis of qualitative data (Ruggiano & Perry, 2019). MaxQDA was used as a technological tool for organisation, coding interviews and categorising data extracts. The organising files, labelled *Aklavik*, *Inuvik*, *Fort McPherson*, and *Tuktoyaktuk*, were established to identify local commonalities or differences. The acronym DQ, *Don't Quote*, was placed next to those who opted out of being referenced directly (n=8), although

their insights have been integrated through interpretation and paraphrasing. Following Schreier's (2014) approach to QCA, deductive codes were established from the literature surrounding the topic to develop content-driven categories. Inductive coding was also utilised when the analysis process began, starting from transcription, creating bottom-up codes. Overall, a circular coding system of inductive and deductive coding was utilised. The dominant themes that began to appear from the coding process have been drawn out and addressed in the results. Table I below shows the final themes, categories and subcategories used, followed by a description of when the code would be applicable. The purpose of this coding tree or coding framework is to make the process replicable and ensure consistent interpretation of interview passages and meanings (Schreier, 2014). This coding scheme was intended to draw out themes that would assist in answering the research question. Approaching analysis with a guiding question can mitigate researcher's "assumptions and expectations" and hence maintain a systematic approach (Schreier, 2014, p. 171). Quotations from those interviewed are an important device for conveying and triangulating the presented themes while also re-presenting participants within the research findings (Baxter & Eyles, 1997, p. 505). Quotes have been slightly modified for readability without altering meaning, for example deleting repetitions and hesitation markers. As a result of the secondary review process described in section III, direct quotes have either been kept anonymous or cited. Therefore, the citations of direct quotes follow two formats. Within the following chapters, quotes are cited using the format '(Interviewee Name_Location)' for individuals who have chosen to be identified. Anonymous quotes are cited using the format '(Interview A, Interview B, Interview C, etc.)', where each letter corresponds to a different interview source. Interviewees who were unable to be contacted during the review process have been anonymised by default. The list of interviewee contributor names, dates and interview locations can be found in section nine Interview Information. The interviews have been referenced using participants' given names in section nine in accordance with the research consent form and community research guidelines. Interviewees who chose to remain anonymous on the consent form and not be directly quoted have not been referenced in the Interview Information. Dates of the interview have been included in the interview information in the case of changed statements in the future. This method is a way of representing the voices concisely, illustrating the impacts of permafrost on mobility. Further, the interview format is an

important tool for maintaining oral histories in the region. The overall methodological approach seeks to achieve a thorough understanding of how insights from local experiences with climate mobility intersect and interact.

Table I. Coding tree utilised on MaxQDA and a description of when the code could be applicable.

Theme	Category	Subcategory	Description of when applicable:
Types of (Im)mobility	Traditional or Cultural	Changes	When changes to cultural mobilities are stated. For example, a common form of travel was dog sledding and is now with snowmobiles.
		Life on the land	When talking about activities that involve being in nature. May not but often involves being away from a permanent residence for a short or extended period of time. May include and is not limited to travelling, hunting, fishing, berry picking or going to cabins.
		Events	When mentioning being mobile for local events. Such as travelling distances for sporting games.
		Subsistence	When talking more specifically about being mobile for purpose subsistence. This can cross over with the 'Life on the Land' category but it focuses more on being mobile for meeting needs for themselves and/ or their family.
	Routine		When addressing daily, weekly or yearly routines. For example, for work or education.

Migration	When addressing current or past migrations to or from the area for the purpose of education, work or health. This may be permanent, circular or temporary.
Relocation	When addressing relocation of houses or whole communities. May be forced or planned.
Immobility	When specifically addressing being unable to be mobile and is not covered in the categories above. For example, the permafrost thaw is making the land soft and unable to be travelled over.
Impacts of Permafrost & Climate Change	As a general category for gauging the frequency of mentioned impacts of climate change and permafrost. Climate change is used here more generally as there may not be any stated link directly to permafrost although it may be still related. For example, mention of warmer air and sea temperatures.
Sinkholes	When discussing sinkholes related to permafrost changes.
Soft Land	When discussing soft land. This may be linked or cross categorised with “thawing”, although remains a separate category as it can relate to
Vegetation growth	When discussing vegetation growth related to permafrost changes.
Slumping	When discussing slumping related to permafrost changes.

	Wind& Storms	When discussing how wind and storms are related to climate changes. Often in combination with erosion.
	Thawing	When discussing thawing related to permafrost changes.
	Erosion	When discussing erosion related to permafrost changes.
	Mudslides & Landslides	When discussing mudslides and landslides related to permafrost changes.
	Perceived & Future Worries	When discussing perceived or future worries related to permafrost changes.
Adaptation [Anticipation]	Education	When addressing how traditional or formal education assists with permafrost impacts. This can include learning from research and researchers. It is not limited to school age learning.
	Infrastructural	When addressing infrastructure changes made to accommodate changes in permafrost.
	Financial Limitations	When discussing the financial limitations that occur with making adaptation choices.
Mitigation [reduction & intervention]	Technological	When discussing the technological mitigation strategies in place currently or that will be implemented in the future.
Colonisation	Healing	When discussing healing associated with the impacts of colonisation.

	Residential schooling	When discussing the residential schools that were used as a tool of force assimilation.
Education	Learning	When discussing learning about the land or environment. In particular from elders, scientists, family or any other community member.
	Teaching	When discussing teaching about the land or environment. For example, to community members, youth or family members.

The results section of this thesis was organised based on the frequency and interconnections identified in the coding tree (table I). Specific themes and categories were merged for a more cohesive results section; for instance, the codes 'life on the land', 'subsistence' and 'routine' while three different ideas frequently appeared together, leading to the results section *Life on the Land and Subsistence Mobilities*. Additionally, the codes 'changes and 'routine' were often linked to discussions about the materialities of mobility. The codes of 'impacts of permafrost' and 'adaptation' informed the results throughout.

4.3. Ethical and Security Considerations

The purpose of completing a secondary analysis of interviews was to further explore questions of mobilities that were present in the interviews (Ruggiano & Perry, 2019). Even though investigating mobilities was not the primary focus of the research in which the interviews were conducted, a secondary analysis through this master thesis was an opportunity to engage more deeply with the information that has been revealed relating to the (im)mobilities, which proved a fruitful avenue of investigation and rich recurring theme in the primary data. Ruggiano and Perry (2019) highlight the debate around the

ethical dilemmas that emerge with qualitative secondary data analysis; to mitigate these concerns in the thesis, an amendment was made on the 10th of October 2023 to the Certificate of Ethic Reviews (AC-REC Nr. 20190101) was made to include me. Further, the usage of material follows the submission to Aurora College and the *1.04 Ethical Conduct for Research Involving Human Subjects*. Interviews were deemed to have a minimal social risk. Prior to being granted access to the interviews for transcribing and analysing, the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2* course and test was completed. The purpose of completing this course was to understand and have guidance around the ethics research involving human participants especially within the Canadian Indigenous context. Recorded interviews and transcripts have been handled in a secure way and with password protection. Any information drawn from interviews and used in this thesis has been carefully managed to ensure the anonymity of participants, who wished to remain unidentified, as well as non-participants within the results. All participants who provided permission to use their names, as indicated in the consent form, are acknowledged in section nine.

4.4. *Author positionality*

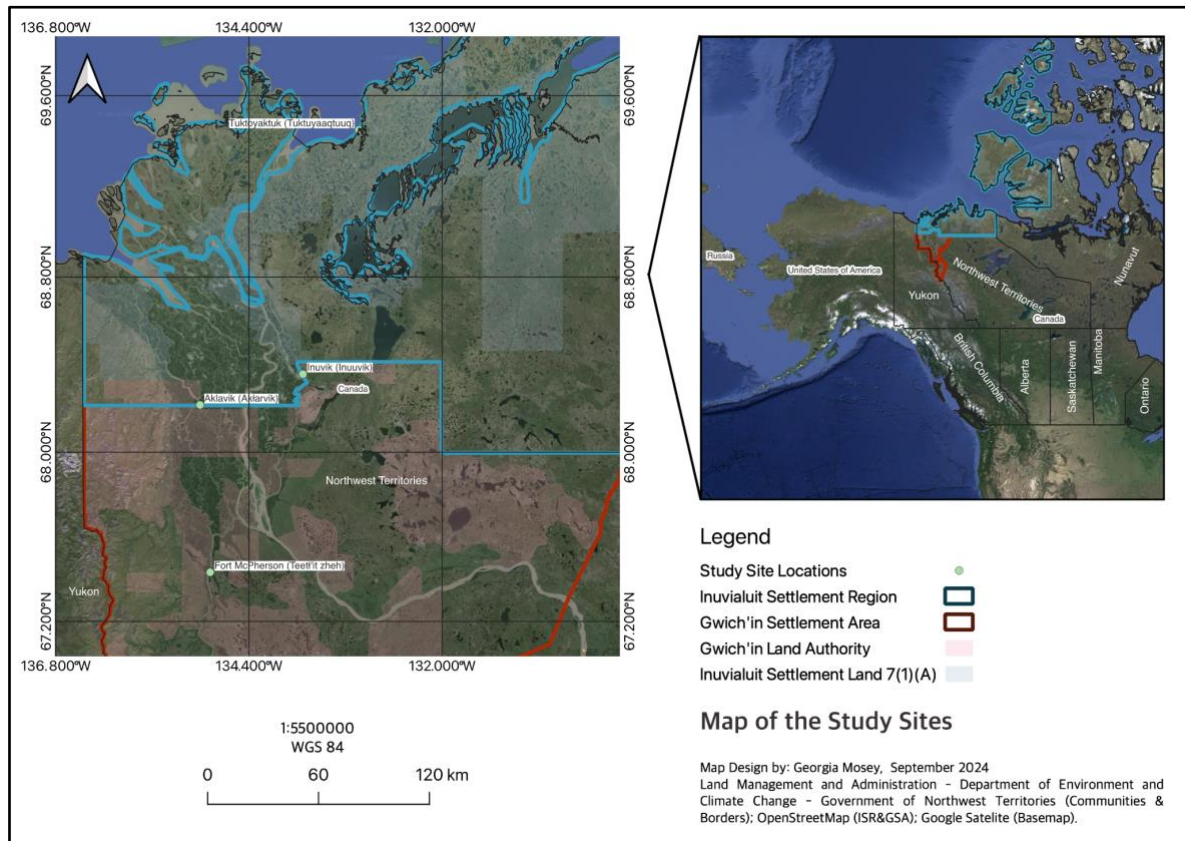
It is necessary to consider, as the author of this thesis, my positionality as a non-Indigenous observer residing in Europe. Qualitative work requires a level of reflexivity and transparency in positionality (Baxter & Eyles, 1997, p. 505). Extensive literature research, guidance from experts working in the field and adherence to local research protocols enhance my understanding, helping to create a clearer and more accurate picture of the issue at hand. To avoid misinterpretation of meanings and strengthen the validity of the findings, this thesis has been revised by Mag. Susanna Gartler, principal investigator of the Nunataryuk social science components in the Northwest Territories. Interpretation of data and themes highlighted in the results have been drawn out using the aforementioned methods and theoretical backgrounds. Following the guidance of postcolonial theory and two-way seeing the data is presented in a way to share the voices and concerns of community members in a respectful and reciprocal manner. Albeit from a distance, this

thesis has been a valued opportunity to learn from those who have a wealth and depth of knowledge about the changing climate within the Arctic.

5. Study Site Description

Described commonly as ‘the North’, the study region is characterised by a history of resilience and adaptation to Arctic environmental conditions, shaped by traditions of mobility, resourcefulness, and interconnectedness among its communities. The four study sites are located in and around the Mackenzie River Delta and the Beaufort Sea coast in Canada, within the forest-tundra transition zone (Burn & Kokelj, 2009). Today, Inuvik and Fort McPherson are located within the Gwich'in Settlement Area, Tuktoyaktuk is within the Inuvialuit Settlement Area and Aklavik is located within both land claim areas. Each community has different contexts and histories that lead to their modern formations. This section briefly introduces the study site for the reader's understanding and to contextualise the research. Figure III shows the location of the communities within the designated settlement and land authority areas. This is significant for understanding the various authorities and stakeholders at play within the area.

Figure III. Map of the Study Sites



5.1. *The Mackenzie River Delta and Beaufort Sea coast*

The Mackenzie River Delta and Beaufort Sea coast are located in the Northwest Territories (NWT) and Yukon. The Mackenzie River Delta spans 13,135 square kilometres to the Canadian western Arctic coast and is according to environmental scientists: “at the forefront of climate exposure on the Arctic coast” (Forbes et al., 2022, p. 931). Meeting the Beaufort Sea Coast on the northern coast, the fluvial system is central for life in the North (Forbes et al., 2022). Fed from the second largest drainage basin in North America, the Mackenzie River is described as playing “a major role in regulating global ocean circulation and Arctic climatic systems and supports a variety of plants and wildlife” (Associated Environmental Consultants Inc. & Integral Ecology Group, 2021). The natural resources of the Mackenzie River Delta and Beaufort Sea coast have played a pivotal role in its history, for both the Inuit and settlers.

The NWT is now a federal territory of Canada that encompasses 1.347 million km² spanning into the Arctic Archipelago and was officially formed in 1870 after the British Empire transferred control of the area to the Canadian Government (Kokelj et al., 2023). Kokelj et al. (2023, p. 888) suggest that the NWT has “much of Canada’s most ice-rich permafrost terrain”. Sparsely populated, the 2021 census indicated that the NWT had 41,070 residents and approximately half lived in the capital of Yellowknife (Government of Canada, 2022b). While English is the most widely spoken and official language, approximately 13.3 percent of the NWT population reported having knowledge of an Indigenous language (Government of Canada, 2022e).

The Gwich’in and Inuvialuit ultimately negotiated self-governance agreements through the Inuvialuit Final Agreement in 1984 and the Gwich’in Comprehensive Land Claim Agreement in 1992. The negotiations of the land agreements took place amid growing pressure for oil and gas development in the Arctic (Fabbi & Wilson, 2021). These agreements are now described as modern treaties that made steps towards land autonomy and enhanced the Indigenous perspective on land use in the Canadian political sphere (Fabbi & Wilson, 2021). The agreements detail legal rights surrounding natural resources and land management for example ensuring access to traditional harvesting. The borders as shown in the study site map were placed according to culture, use and occupancy using a combination of fieldwork interviews and Western mapping tools for guidance (Fabbi & Wilson, 2021). Historically, the redrawing of borders under European ownership impacted various aspects of mobility in the interconnected Arctic. While the borders created administrative boundaries, trans-local connections persisted through marriage, trade, cultural practices and subsistence harvesting (Lyon 2010 p 25). Fabbi and Wilson (2021) argue that these agreements have enabled “the Inuit have built a national presence in Canada” through reclaiming “Inuit Nunangat”, land, water and ice in Inuktitut.

The utilisation of natural resources has enabled Inuit and Gwich’in to live, migrate and travel through the Arctic for millennia, where much of these skills are held in oral histories (Lyon 2010; Inuvialuit Communications Society, 2021). The Inuvialuit are thought to be descendants of the Thule, who migrated from Alaska across the North American Arctic

(Lyons, 2010). Through land-based practices, both Inuvialuit and Gwich'in land users are and have historically been inherently highly mobile. Elder Georgina Masuzumi explained that one reason her father moved to Tuktoyaktuk was for the richness of natural resources and that bush food was plentiful, namely whales, fish, caribou and birds (Inuvialuit Communications Society, 2021). Masuzumi also explains that her forefathers moved with the animals for survival before settling in one place. While the focus of this research is on four unique communities, parallels can be drawn particularly those who live with permafrost outside of this area. Learning and living from the land is a process that has upheld communities in the Arctic. Travelling locally and long distances has been and continues to be in many ways essential for survival, food security and connection (Inuvialuit Communications Society, 2021). Environmental anthropologist Krause (2022, p.9) suggests:

“The increased population density in the settlements has been facilitated by, among other factors, including concerted policies of the Canadian Government, the growing technological capacities for fast travel, including the development of snowmobiles, outboard engines, and the establishment of wintertime ice roads in the delta, which have enabled residents to access a wide area while being based ‘in town’”.

Furthermore, significant environmental, social and economic shifts of change in the study region in recent history are attributed to industrial ebbs and flows, population growth and decrease and colonisation (Krause, 2022).

Nineteenth-century European explorers, missionaries, traders and government officials are attributed to the reshaping of the North American Arctic's economic, social, political and environmental systems (Stern, 2021). Early explorers' interest in this area stemmed from finding trading routes between Europe and Asia. Blocked by the North and South American continents, sailing through the elusive Northwest Passage was pursued by some (Stern, 2021). The sea ice coverage was the largest obstacle in the area, although, with climate change, this area is changing geopolitical debates. The arrival of Europeans also had devastating consequences, including the introduction of diseases by sailors, which led to significant population declines. Major events like the whaling and fur trade boom, gold rush, Cold War military infrastructure construction and hydrocarbon exploration are

attributed to Arctic economic fluctuations (Crate & Nuttall, 2023, p. 173). Trade and interest in the search for new shipping routes connected the Arctic to global empires (Stuhl, 2016). The Hudson Bay Company (HBC) played a central role in the changing of socio-economic systems and capitalising on the Arctic environment. Stuhl (2016, p. 23) states “The fur post was the physical embodiment of outside intervention, a space wherein British traders extracted profits from the Arctic and displaced its natural resources.” Dominating the fur industry, the HBC had sole commerce and trade rights of what was known as Rupert's Land, encompassing parts of current NWT.

The whaling industry further transformed the North American Arctic from the beginning of the 1800s (Stuhl 2016, p. 10). Ravaging the natural environment, the byproducts of whale hunting offered fuel and food to an international market and is another example of taking from the environment to drive economic growth. From the 1880s, the whaling industry met its decline when cheaper fuels, including petroleum, and plastics became more readily available (Stuhl 2016). The industrialisation of the Arctic resources has had lasting and profound impacts. Industry and colonisation changed the region and shifted traditional practices of mobility that spanned across the Arctic. However, the Arctic's physical environment remained a significant hurdle for expansion into the northernmost areas of the North American continent. Stuhl (2016, p. 26) states that “ice remained a force that held in check the economic appetite and geographical expansion of the whaling industry.” Climate change is now altering this reality and interest in the area is increasing.

Stuhl's (2016, p.10) recount of Nellie Cournoyea's, the sixth premier of the NWT, address to the Inuvialuit Regional Corporation highlighted that the reduced land productivity and increasing pressure to move into settlements meant that by the mid-1950's the Inuvialuit “were stuck”. Inuit life hinged on the mobility of the human and non-human world (Stuhl, 2016, p. 10). The establishment of the residential school system had further profound and lasting negative effects on health and Indigenous knowledge. Government and religious institutions intentionally removed children from family and culture. Lyons (2010, p.31) states, “This policy greatly inhibited the mobility of young Inuvialuit families as well as their ability to stay together throughout the year.” The last residential school in Canada was closed in 1997 in the neighbouring territory of Nunavut.

This system has a long-lasting impact and will be further discussed in section 6.2 considering the impact of colonialism.

Today, the economic makeup of the study sites consists largely of a mixed subsistence-based economy and a wage-based economy. The traditional economy is based on subsistence harvesting, and trade of goods and flows into the cash-based system with the sale of goods. Most communities are dependent on a wage-based economy, a turn from the early 20th century. The services industry is a dominant sector in the Northwest Territories with the largest proportion of individuals being employed in public administration, health care, social assistance and education (Government of Northwest Territories, 2024). Within the goods-producing sector, the extractive industries of forestry, fishing, mining and gas as well as the construction industry employ a large proportion of the NWT population (Government of Northwest Territories, 2024). There is high potential for oil and gas in the Beaufort Sea Coast and the Mackenzie River Delta areas (Gwich'in Land Use Planning Board, 2018). Transportation construction projects like the Dempster Highway and the Inuvik to Tuktoyaktuk highway have facilitated connecting and facilitating employment in the area (Povoroznyuk et al., 2023). In 2017, the Inuvik to Tuktoyaktuk Highway established all-weather access to the Arctic Ocean. Subsequently, tourism is a growing industry in the Northwest Territories, where all-season road access allows visitors to venture further into the Arctic (Bird, 2017). Development of infrastructure connection within the region is viewed as important although permafrost and climate pose significant challenges (Povoroznyuk et al., 2023). Each study site community has a different makeup and context shaped by its geographic location, land practices and history.

5.2. *Inuvik (Inuvik)*

Located at 68°N, Inuvik is within the Arctic Circle and is described as the regional centre for the Beaufort Delta region (Anselmi, 2017). Inuvik had a population of 3,001 in the 2021 census, a 4.4 percent decrease from the 2016 census, making it the third-largest community in the Northwest Territories (Government of Northwest Territories, n.d.-c). The establishment of the Inuvik settlement was initiated by the federal government in the

early 1950s as a response to the need to relocate Aklavik due to environmental factors and for administrative purposes. What is now Inuvik best met the requirements for a new settlement site, which needed to include being suitable from economic and social points of view, for the installation of sewage, water, buildings, air access and roads, for navigation preferably on or near to a channel of the delta (Merrill et al., 1960). It was acknowledged at the time that finding a site away from permafrost was not possible and therefore it was understood that “every necessary precaution against disturbing the general permafrost condition will have to be taken” (Merrill et al., 1960). In 1961 Inuvik had a population of 1,248 growing to over double in the following ten years and reaching 3,000 by 1976 (Anselmi, 2017). Many moved into and took up permanent residence in Inuvik for paid work and because of the residential school system (Lyons, 2010, p. 31). To continue a traditional way of life meant that Inuvialuit would have to leave their children in boarding school (Lyons, 2010, p. 33). This is an example of how forcible assimilation changed mobilities and dwellings. Lyons (2010) notes that there was resistance to the government bids and persuasions to move into the town of Inuvik. Today, the non-Indigenous population is larger in Inuvik in comparison to the other study sites, with over thirty-five percent of residents identifying as non-Indigenous (NWT Bureau of Statistics, 2023).

5.3. *Tuktoyaktuk (Tuktuyaaqtuuq)*

Tuktoyaktuk, commonly referred to as “Tuk”, is a coastal community located at 69°N within the Arctic Circle, also formally known as Port Brabant. Tuktoyaktuk throughout history has remained a significant place of gathering and remains as such (Inuvialuit Communications Society, 2021). It had a population of 937 in the 2021 census, a 4.3 percent increase from the previous 2016 census, and approximately 98 percent of the residents are Indigenous (Government of Canada, 2022d; NWT Bureau of Statistics, 2023). The land characteristically has small shrubbery in the spring and summer that is typically covered by snow in winter and no tall trees as it is above the treeline (Burn & Kokelj, 2009). Pingos are a dominant landscape feature that is created by permafrost and exemplify how permafrost shapes the Arctic landscape (Westerveld et al., 2023). Between 2013 and 2022, the average

temperature for the coldest month, February, was -26.6°C, while the average temperature for the warmest month, July, was 11.3°C (*Tuktoyaktuk*, n.d.).

Tuktoyaktuk has been present in the news for extensive coastal erosion and for being one of Canada's first communities in need of relocation due to climate impacts. Forbes et al. (2022) found that the sea level in Tuktoyaktuk, according to the tide gauge record, has risen by 3.5 ± 1.3 mm/year between 1961 and 2006. Sea level rise and storm surges with the compounding impacts of permafrost thaw are a major concern for the community. The planning and reality of retreating from the coast is controversial and has been described as a logistical challenge by the national broadcasting company CBC (CBC News: The National, 2022). Reindeer Point has been established as a retreat community seven kilometres from the main community of Tuktoyaktuk (CBC News: The National, 2022). Many community members are resisting relocation and advocate for preventative action instead and through Canada's Disaster Mitigation and Adaptation Fund in 2023 a CAD\$53 million investment in coastline protection was made. Since then, work has started using quarried rocks from Inuvik (Inuvialuit Regional Corporation, 2024). The youth film "Happening to Us", showing climate impacts from the youths' perspective in Tuktoyaktuk was shown at the COP25 in Spain. Within the short film impacts of permafrost thaw and what it means to the future of Tuk's youth were highlighted (Youth Climate Report, 2019). The youth also show how they are impacted by the warming temperatures, sea level rise and erosion. Furthermore, their film advocates for youth activism and involvement in climate change.

5.4. *Aklavik (Akḷarvik)*

The hamlet of Aklavik is located alongside the Peel Chanel and 113 kilometres from the Beaufort Sea, hence the land and subsistence harvesting are easily accessed from this small community. Between 2013 and 2022, the average temperature for the coldest month, February, was -26.8°C, while the average temperature for the warmest month, July, was 14.4°C. Aklavik is located at 68°N and within the bioclimate subzone E, characterised by larger shrubs (Government of Northwest Territories, n.d.-a; Ramage et al., 2022). The

majority of the Aklavik population participates in hunting, fishing, berry picking and trapping for subsistence, the activity depends on the time of the year (Proverbs et al., 2021). Aklavik is accessible by road during the winter when the town relies on the ice road for the transport of supplies. All-terrain vehicles, Boats and skidoos are mainly used by residents for access to the land and community (Stern, 2021).

Aklavik had a population of 526 in the 2021 census, which was a 9.2 percent decrease from the 2016 census (Government of Canada, 2022a). According to the NWT Bureau of Statistics in 2023 approximately ninety-one percent of the population of Aklavik was Indigenous (NWT Bureau of Statistics, 2023). In 1912, the hamlet of Aklavik was established as a fur trading post (Krause, 2022). The establishment of schools, businesses and hospitals drew in a permanent population and by the 1950s the population was approximately 1500 (Anselmi, 2017; Krause, 2022). As a result of consistent flooding and erosion, the town was relocated east, away from the Richardson Mountains, to Inuvik, however, some residents chose to remain (Anselmi, 2017). The project was initiated by the Canadian Government in 1953 and after a period of scouting for suitable sites, building began in Inuvik in 1956. After a surge in employment to dismantle the town, employment dropped (Anselmi, 2017). The community motto “Never say die” reflects a strong place-attachment and willingness to adapt. In 2021 the hamlet was declared in a state of emergency after a flood. In response, Aklavik resident and deputy mayor Billy Storr said to National news outlet CBC: “We’ll persevere with the flood as long as we have our lifestyle” (CBC News: The National, 2021). Highlighting a deep connection to the land and life on the land where many are determined to adapt to the environmental changes.

5.5. *Fort McPherson (Teet’it zheh)*

Fort McPherson is a riverside community located 67° N within the Arctic Circle and on the Peel River, a tributary of the Mackenzie River. The hamlet was established in 1840 by the HBC and was originally named Peel River Post. Fort McPherson was an important site for trading between the HBC and Inuit and was one of many posts that primarily traded moose and caribou for European goods (Stuhl, 2016, p. 18). The community had a

population of 647 in the 2021 census, a 7.6 percent decrease from the 2016 census (Government of Canada, 2022b). A journalist for the CBC, Alex Brockman, reported that the population decline is a result of out-migration driven by education and job opportunities; particularly in the mining sector following the completion of the ITH construction (Brockman, 2017). The report notes a similar trend in each of the study sites. Fort McPherson has the highest formal unemployment rate in the study site areas of over thirty percent of the labour force, however, subsistence harvesting remains an important aspect of work life (Gwich'in Land Use Planning Board, 2018).

Being below the tree line means that trees like spruce and willow thrive. In the close vicinity of deciduous and transitional forests, which is an important renewable resource of the area (Gwich'in Land Use Planning Board, 2018). Between 2013 and 2022, the average temperature for the coldest month, January, was -26.1°C, while the average temperature for the warmest month, July, was 15.6°C (Government of Northwest Territories, n.d.-b). Located next to the Dempster Highway access to the settlement is less dependent on seasonal access than the other study sites. The Peel River flooding has previously resulted in cutting off access to the airport, water and sewer services (Dulewich, 2023). In 2023 a state of emergency was declared due to the flooding where homes were destroyed and taken with the flood water (Dulewich, 2023).

6. Results and Discussion

This section presents the findings and interpretations of the interview data, focusing on the impact of permafrost thaw on (im)mobilities within the study region, as well as the adaptations that have emerged in response. The results are structured thematically, highlighting key patterns and issues that emerged from the interviews during the analysis process. The types of (im)mobilities that emerged as being affected by permafrost thawing are predominantly related to a) subsistence and life on the land and b) relocation or retreat, related to environmental hazards such as erosion. The following sections will also present the physical, environmental and social conditions that enable or constrain mobility

to understand how people engage in mobility. While there are four study site locations, the findings in this chapter will be examined collectively, through the lens of permafrost thaw and its impact on mobilities. Although permafrost is the focal point, the analysis will at times extend beyond to gain a more comprehensive understanding of the Arctic climate and its environmental interconnectedness. While the majority of the interviewees are Indigenous land users it is also important to highlight the presence and movement of 'southern' and non-Indigenous professionals (skilled migrants not from the Canadian Arctic) into the area who support communities and bring specific skills. As community members expressed the importance of collaboration of Indigenous and Western knowledge, the following Results and Discussion chapter will examine these perspective together, highlighting their interplay and collective contribution to understanding and addressing permafrost thaw related impacts.

6.1. The Intersection of Permafrost and Mobilities

To begin it is important to highlight what permafrost means to those who participated in the interviews and the wider community, how this interacts with themes of mobility, the changes being experienced and how these dynamics are conveyed. All respondents expressed that permafrost held a degree of significance for themselves, the community, the Arctic or all of these. Noel Raymond, an Elder from Tuktoyaktuk pointed out after discussing the increasingly erratic weather patterns: "The permafrost for us is preserving the ground from crumbling, you know and keeping it stable" (Noel Raymond_Tuktoyakuk). Local entrepreneur, Kylik Kisoun further asserts: "The permafrost is a lifeline. The culture, wildlife and landscape would not be the same without it." (Kylik Kisoun_ Inuvik). The interviews created a feeling that permafrost is a powerful force that permeates every aspect of life in the study region.

Quotes such as those above and literature corroborate that permafrost plays a fundamental role both in the physical and the cultural landscapes of the Arctic communities (Ramage et al., 2022). Fast and irregular changes in permafrost conditions are evidently affecting the mobility of the communities of Inuvik, Aklavik, Fort McPherson and Tuktoyaktuk in the Northwest Territories. While these findings primarily concern the

aforementioned communities, many interviewees report analogous experiences in their previous residences throughout the Arctic, including the Yukon and Alaska. The shifting patterns in permafrost conditions are being felt by communities across the circumpolar North, demonstrating the extent of the impacts (Ramage et al., 2022). Similarly to Jungsberg et al.'s (2022) community surveys, the interviewees regularly made connections to the negative impacts of thawing permafrost and softer ground. Further, interviewees confirmed that the warmer temperatures and sporadic weather conditions are rapidly transforming the permafrost and the way the communities are able to live with it. Infrastructure and access to resources are dependent on permafrost as it plays a foundational role in the communities in the Arctic and issues raised in this section are applicable beyond the study areas. Thawing permafrost is disrupting mobilities creating new challenges that lead to both lived or anticipated experiences of (im)mobilities (Gartler et al., 2024). Community members consistently raised concerns about changes that significantly relate to current and future mobility and immobilities.

The interviews reveal that changes in the environment, such as warming and shifts in ground stability, are particularly noticeable to older participants who have observed these changes in local weather patterns over an extended period. Increasing air temperatures are felt by communities within the changing pattern and subsequent shift in the traditional understanding of weather and cultural practices. Older individuals expressed that in the past, during their youth, there were longer periods of significantly colder conditions. To manage the freezing temperatures, keeping active was noted to be essential, through seasonal activities like hunting, and collecting wood and water (see, e.g. the Gwich'in Seasonal Calendar Proverbs et al., 2021). Whyte et al. (2019, p. 323) highlight that seasonal calendars are an important tool for integrating "community norms and responsibilities" and are used to develop harmonising relationships "that act in accordance with (not in reaction to) environmental change." This is further demonstrated through Proverbs et al.'s (2021) Gwich'in Seasonal Calendar, which illustrates the deep ties between seasonality, mobility and the environment. Similar interactions with the seasons can be found in many Indigenous cultures, from Arctic and sub-Arctic communities throughout the North American continent to Micronesia (Whyte et al., 2019, p. 323). Showing the relevance and

importance of moving in harmony with the environment and knowledge of mobility in a seasonal sense extends beyond the Arctic.

Building upon these ideas and concerns raised, Table II highlights the changes in the environment and permafrost mentioned by participants that correlated with the seasonal or monthly changes. The table was created using MAXQDA by overviewing the word frequency tool to draw out data in reference to the months. The 'Characteristics' column highlights typical environmental patterns, 'activities' highlights the patterns in tasks according to the month and patterns in changes are highlighted in the 'Changes' column. This table's purpose is to give an overview of the changing environmental conditions within the Mackenzie Delta and Beaufort Sea Coast region and how this interacts with subsistence and mobility. This table is not comprehensive of the changes in the region, but rather a summary of the participants' observations. Due to the frequent travelling and mobility, the interview data was consolidated, therefore it is important to note not every respondent partook in each activity.

Table II. Overview of activities and changes according to monthly changes

Month	Characteristics	Activities	Changes
January	• Ice too thick for netting	• Trapping • Hunting: Caribou (travel to Richardson Mountains), Polar bear (in Tuk)	• Closed roads • Water Overflow • Decrease in midwinter temperatures by about 10°C • Recorded 3°C air temperature • Recorded one day of 2°C air temperature and rain • Ground not frozen • Flowing water under snow cover
February	• [No data]	• Trapping • Hunting: Caribou, Polar bear (in Tuk)	• More rain • Fewer seals

March	• Still cold • Daylight starts to be longer • Best for travel • Ice Road is still frozen	• Hunting: Caribou, Moose • Trapping: Muskrat • Move to the Delta from the mountains • Move to spring camps	• Warmer temperatures in comparison to Alaska (- 3°C) • Ice road unusually slippery
April	• Slight spring warming	• Move to spring camps (After easter) • Trapping: Muskrats • Community gatherings at Husky Lakes	• Wind Changes • Increased Storms • Winter melt occurring in April, ordinarily May- June • Warmer temperatures
May	• Ice melt • End of May, preparing food	• Community gatherings at Husky Lakes • Whaling • Fishing • Able to travel further along the coast	• Wind changes • Increased Storms • Warmer temperatures
June	• Preparing food • Ice breaks up • No longer using skidoo	• Fishing • Hunting: Seals (Herschel) • Whaling • Set Nets • Drying Fish • Travel by boat	• Slumping and mudslides • Temperature increase • Soft Fish • (summer) high water • No more ocean ice (Tuk) • Used to be able to use dog teams until mid-June • Wind increases (difficulty boating)
July	[no data]	• Fishing Coast: Beluga Whale • Hunting: Bear • Whaling • Drying Fish • Move to Whaling camps (coastal) • Berry picking (End of month) • Shingle Point	• Warmer temperatures • Warm water • Wind increases (difficulty boating) • No longer able to smell the cool air

Summer games			
August	• Freeze • Ice Formation	• Fishing • Hunting • Whaling: Beluga • Drying Fish • Berry Picking	• Spruce rust • (late fall) Excessively muddy rivers • No longer snow in the mountains • Wind increases • Temperature increase (previously - 60°C) • Soft ground
September	• Ice Formation	• Cranberry Picking • Fishing • Start to set nets (End of month)	• Sea ice reduction • Mudslides • Snowfall and rapid melt • Flowers usually die mid-month but do not • 10°C - 15°C warmer
October	• Changes in landscape colours • Preparing food for winter • Difficulty travelling on the land	• Trapping • Set nets •	• Wind increasing • High water levels • Closed roads • Ice Road is not frozen yet • Delay in net setting • Lengthening of boating season • Permafrost thaw more than in previous months because the ground is warm • Ice houses started to drip in previous years
November	• Begin to use snowmobiles to go further • Freezing Period	• Trapping • Hunting: Caribou (Richardson Mountains), Wolverines, Foxes, Seals • Ice Fishing	• Water over roads • Less snowfall • Warmer temperatures • Delay in ice road freezing • Changes to Caribou Patterns because of land changes
December	• Ice too thick for netting	• Trapping • Hunting: Caribou, Polar bear (in	• Delay in ice roads freezing • Instances of Rain

Tuktoyaktuk)	(turning to ice and creating infrastructural problems) ● Underground rivers flowing.
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Table II demonstrates the widespread and year-round changes occurring in the study site region raised in the interviews. The shifting in seasons was noted to cause a range of problems for example unpredictability, changes in resource patterns, difficulty travelling and issues with forecasting the weather conditions. Many shared this concern for the changes, “We're high up in the Arctic where it's supposed to be freezing all the time. And it's not. The Arctic now is absolutely changing” (Elizabeth Gordon_Inuvik). Another interview highlighted the changes in mobility patterns according to seasonal changes: “October it's freezing up, like right now. You can't really do anything. You can't travel. The same thing in June. The ice is breaking up and there's no more snow, you can't skidoo” (Interview E). This table shows how intertwined mobility, agency, livelihoods and the environment are.

Expanding on Table II, interviewees indicated that permafrost thaw is creating geophysical changes that are noticeable to communities, and these are having direct and indirect impacts, such as erosion, slumping, sinkholes, increased vegetation growth, mud and landslides. Individuals directly attribute the changes they were seeing to permafrost: “It's [permafrost] also making the river edges fall off because it's thawing” (Interview A). Those digging into the ground to secure boats or even dig graves notice the changes in the depth of solid ground: “We used to hit ice when we dug into the ground. We used to hit ice about three feet down. You know, now we have to go six feet or more” (Noel Raymond_Tuktoyaktuk). Further inland a similar observation was noted: “I have noticed every time you go, you dig, it's getting deeper and deeper and softer. Next thing we'd be like maybe a foot before you hit permafrost now. It has really thawed” (Interview F). The thawing at times is directly or immediately visible: “Like the melting on the sides [of the river], you could just see a dripping” (Elizabeth Gordon_Inuvik). Elizabeth Gordon continued to explain

her experience with permafrost as a child, being solid and difficult to penetrate, and how it compares to the current state of the ground, which is softer. Annual ground probing on Richards Island, west of Tuktoyaktuk, revealed that between 1983 and 2008, the active layer increased by a mean thaw depth of eight centimetres (Burn & Kokelj, 2009). The impact of thawing is extensive, with reports of land three hundred feet wide and one hundred feet inland, falling in the river due to abrupt riverbank erosion seemingly overnight within the delta area. The speed of transformation in the land is impacting people directly and rapidly:

We went to bed and in the morning, we were having breakfast and my wife said: "I thought your generator was over there." I said: "It was there yesterday. I had it running." And I looked and I said "What, where is my generator" and I walked over. We lost a bank. Maybe about the size of this house. That's how big a bank was and the whole bank just went over. And just disappeared (Interview F).

Another interviewee describes being able to see large cracks and slumps in the ground while flying in a helicopter, describing sections of hillsides collapsing as the land drops. They emphasise the frequency of erosion has increased over the recent summers. These quotes demonstrate the destabilisation of the land due to permafrost degradation. These shifts not only pose risks to infrastructure but also deeply affect the way of life for local residents.

Individuals that interact with permafrost daily explain that moving over the once solid ground is becoming more difficult. Seven interviewees from across the study sites described the land as being sponge-like: "It's like you're walking on a big sponge now" (Interview A). Many described the physical difficulty of moving on the land: "It [the land] is spongy and wet. It is much harder to walk across. It does make an impact just walking across it because it is so spongy that your feet break through. You sink in so far, which did not happen when I was younger" (Samuel McLeod_Aklavik). Two of the interviewees described sinking in the ground as like being in quicksand: "The ground is quicksand at Shingle Point" (Interview B). One continued to explain that they had even had to pull their friend out of the quicksand-like ground. These quotes further demonstrate how the impacts of permafrost are becoming visible and a risk to safety in day-to-day life for those living with it and the exponential change has been witnessed over lifetimes. These experiences intertwine with everyday and 'micro-mobility', which are essential for

understanding the foundations of (im)mobility (Zickgraf, 2022). Many interviewees expressed the need to change routes taken when travelling via the river: “It’s a totally different place now. You gotta go through different routes. There’s a lot of places where the ground has fallen, even along the coastline” (Interview B). Further:

You could see it [permafrost thaw] a lot in our rivers. I’ve been travelling these rivers since I was small, and we used to travel by almost all the rivers down towards the coast and now there’s only one or two that you could make it through with the bigger boat that we use. I mean there are sandbars where there was deep water long ago. (Interview A)

While deltas are dynamic, and this was acknowledged in some interviews, the changes narrated are rapid, less predictable and more dangerous. Unprecedented speed of change is creating uncertainties for land users and is frequently attributed to anthropogenic climate change (Ziegler et al., 2024). These findings confirm Stern’s (2021, p. 4) research that Inuit communities experience across the board difficulties and dangerous conditions when travelling over land and sea. Being mobile is highly valued by Indigenous land users in the study area and access requires extensive multigenerational knowledge of the land, which has gone through rapid transformations (Ayeb-Karlsson et al., 2024). The intersection of permafrost and mobilities illustrates how changes in permafrost influence intergenerational patterns of mobility within communities. The relationship is complex and multifaceted, encompassing various environmental, social, cultural and historical dimensions, as the next section shows.

6.2. *Considering the Impacts of Colonialism*

Throughout the interviews with Indigenous land users, interviewees emphasised the difficulty of discussing the current state of environmental mobility without acknowledging the drastic changes associated with colonialism that individuals and communities have encountered in the last generations and the subsequent impact it had on mobility practices. It is important to recognise that colonialism and colonial policies have disrupted the connection to land and mobility and that climate and environmental change are embedded in this context (Davis et al., 2022, p. 2). The forced shift from a semi-nomadic

and subsistent way of life to settling into villages to participate in paid work and schooling was discussed frequently by older interviewees as to how it has had lasting impacts on the transmission of knowledge. Participants discussed a variety of reasons for their own or their parents' motivations for moving to settlements, some of which included more access to consistent paid labour, health care and education. An interviewee described the change from life on the land to settling: "I learned a lot through my dad, who was always on the land. Until we moved to Inuvik when it was built-up in '60 - '59 ... That's when we, people started moving out from the land and they started getting jobs" (Interview B). This shift reflects broader social and economic changes, where the transition from land-based living was often driven by access to modern amenities and opportunities.

Scholars have noted that many individuals were enticed or forced to relocate to settlements (Schweitzer, 2010). Throughout the circumpolar North, state projects, some attempting to achieve "high modernism", could be seen to be regulating and engineering the mobilities of communities (Schweitzer 2010, p. 31). This raises the historical and current difficulty to discern where the line is between modernisation and colonisation. Whyte et al. (2019, p. 325) assert that "settler colonialism is itself a structure of domination that arranges institutions to undermine Indigenous motion, mobility, and adaptation." In the case of the Kigiqitamiut, an Inupiat community in Alaska, Marino (2012, p.378) argues that over the last hundred years, sedentarisation led to a decrease in the "ease" of mobility and being centred around critical infrastructure resulted in traditional adaptation strategies becoming "less practical". Consequently, the similar shift to sedentarisation has created profound impacts on the culture, health and well-being for the study region. As one interview noted:

Our people are struggling with mental health issues and the consequences of colonisation.

So, there is a large amount of our population that's sitting idle because we've destroyed the mechanism where they can fit in. Three hundred years ago there weren't any idle people. Everyone could find a way to contribute to their community. (Kylik Kisoun_Inuvik)

This reflection highlights the significant loss of community engagement resulting from these changes in community dynamics, where becoming less mobile has created a sense of disconnection.

Ayeb-Karlsson et al.'s (2024, p. 12) findings assert that “ending up trapped and involuntary immobile in town brought up intergenerational traumas from the residential schools and the forced ‘assimilation’”. The impact of the residential school systems was discussed as being long-lasting and widespread by almost all of the interviewees. It is important to note that this was not limited to Canada and the forcible removal of children occurred throughout British colonies, including and was not limited to Canada, the USA and Australia (Feir, 2016). Children were often relocated to schools far from their parents and kept separated for long periods of time (Feir, 2016). Neglect and abuse within the school system, facilitated by religious institutions and the federal government, were rife (Feir, 2016). The interviews show that detaching children from language erased culture and knowledge of adapting to the environment, which is now being identified as vital knowledge for climate change and adaptation (Ford et al., 2016). Further, land skills are life skills in the Arctic (Watt-Cloutier, 2007). Participants who attended residential schools suggest that, at best, learning about cultural land practices became incremental and occurred mostly during short vacation breaks in school. “They [missionaries and federal day schools] disrupted a lot of our traditional ways, you know. They just took us right out of our family and said, ‘Well you have to go to school you know’” (Noel Raymond_Tuktoyuktak). Many of the older participants also described missing opportunities to be out on the land and learning place-based knowledge. Two participants described the difficult process of no longer being able to live off the land due to not being financially viable and the increasing financial pressure to re-enter school with the intention of taking up paid labour. Being taken away from land-based learning was acknowledged in the interviews as having negative and long-lasting impacts.

Many interviewees attributed their learning of the land to their parents, grandparents and the wider community. Where land-based learning or community education plays a major role in learning how to be mobile in the Arctic. Pearce et al. 2010 (p. 168) point out that “traditionally, knowledge and skills were developed and transmitted through on-the-land education”. The previous interviewee’s quotes underscore that opportunities for participants to connect with the land ranged from being limited for some to being more extensive for others. In various ways, the importance of transmitting skills, techniques and knowledge vital for moving on and adapting to the Arctic environment was conveyed

through the interviews, as exemplified by one participant's reflection: "Most of my life was on land. I was very gifted that my grandparents kept me out there, especially during school years. I didn't finish my education, but I had spent a lot of time out on the land, and I am happy for that because I learned everything from my grandparents" (Wanda Pascal_Fort McPherson). Land users confirmed knowledge of the land is an important form of education in itself: "My mother-in-law would always say that she doesn't have a college degree, but she's got a degree in living on the land" (Michelle Gruben_Aklavik). These quotes also demonstrate a shift in knowledge systems within the lifetimes of many participants and community members as well as the complexity and lasting conditions of colonialism (Gandhi, 1998).

Interviewee experiences of the residential schooling system highlight how knowledge flows were affected, as these knowledge systems were altered and disrupted. Whyte et al. (2019, p. 328) suggest that, "given Indigenous intellectual traditions focus on mobility, it is not surprising that a form of oppression and power like (settler) colonialism can be understood to be a disruption to the mobilities of Indigenous peoples." Despite attempts to heal, colonialism can still be felt deeply (Gandhi, 1998). Two respondents stated that: "colonialism is alive and well". Once in reference to a lack of investment in the area and a strained political system and once referencing intergenerational impacts. Both during their interviews referenced the responsibility of large 'Southern' companies to climate change and the impact it is having on removal from culture. Another interview revealed that oil exploration in the study area in the past has led to incomplete cleanup of hazardous waste and contamination of sites remain. The extractive industries are identified to have previously and continue to perpetuate colonial practices of land dispossession, contributing disproportionately to environmental degradation and having an extensive impact on resources essential for subsistence (Bernauer, 2019). The federal government has a substantial interest in the continuation of extractive industries in the North, benefiting from profits and tax revenues despite existing land agreements (Bernauer, 2019). The recognition of colonialism from the federal government has come in different ways. One conversation highlighted the complications with accepting the government's lump sum payment called the Common Experience Payment (CEP). The CEP was one component of the Indian Residential Schools Settlement Agreement (IRSSA), one of the

largest Canadian class action lawsuits, and was granted to anyone who attended residential schools (Feir, 2016). The interviewee viewed the payment as inadequate but despite this feeling highlighted that some chose to use the money for purchasing items such as skidoos. Beyond this conversation, it is unclear what role the present-day federal government plays for the individuals interviewed in the conversation of healing from colonialism or adapting to climate. This disconnect from the land initiated by colonialism is now being further perpetuated by climate change (Chakrabarty, 2012). There are unprecedented parallels between the colonial efforts to remove Arctic people from land-based culture and the forcible nature of climate change and permafrost thaw, including local or even extent to global external exploitation of resources, loss of land and cultural disconnect. Highlighting the need for an ongoing focus on this topic of colonisation.

The interviewees highlighted the lasting impacts of colonialism on mobility and knowledge transmission, particularly through sedentarisation and the residential school system. The legacy of colonialism continues to affect individuals and communities today, particularly in relation to environmental degradation. Community resilience remains strong with many participants drawing on traditional knowledge and adaptive strategies to navigate challenges. This resilience is tied to the material cultures of mobility, where tools, technologies, and infrastructure play a role in mobility and a changing environment.

6.3. *Materiality of Mobility*

The theme of mobility materialities was initially brought forth by Blondin (2022). Throughout the data analysis, it became evident that material culture is indeed an important aspect of partaking in mobility within this regional context. Blondin (2022, p. 3417) states “Until now, the expanding field of research on climate/environmental mobilities has mainly overlooked the material aspects of mobilities including the state of roads and vehicles and the way environmental conditions may distort or destroy them.” This section illustrates how people are moving in the Arctic in a material sense, how this has changed over time and how materiality and technological change interact with the changing physical environment. Changes in how people are able to take part in mobility

and the materiality of moving in the region appeared frequently. In the interviews, the subtheme of materiality within the coding scheme was used when people mentioned past or present mobilities materialities, in other words when referring to transport and infrastructure particularly when it facilitated or was impacted by the permafrost-(im)mobilities nexus. The purpose of this section is to build an understanding of how interviewees indicated they participated in mobility in a material sense, how this has changed in the recent past and the implications of such changes. The analysis revealed that the material culture inadvertently plays a significant role in the conversation surrounding changing permafrost conditions, as vehicle functionality and infrastructure reliability are dependent on the stability of permafrost and impact mobility decisions. Having vehicles was considered by one participant as a means of being “self-sufficient” and similar ideas could be seen throughout interviews. Vehicles also largely facilitate access to land-based practices.

Interviewees pointed out that weather conditions largely dictate the modes of transport utilised and the predictability of weather and route conditions is relied upon for access and livelihoods. During the winter snowmobiles, commonly referred to as Skidoos, are an important tool for commuting to participate in work and education and having access to land-based practices. Interviewees indicated that skidoos could cost between ten and fourteen thousand Canadian dollars and there are further expenses to maintain winter travel. Winter travel is dependent on terrain solidity as well as ice sturdiness where ice roads connect communities and resources. It is clear that climate plays a vital role in critical infrastructure systems such as ice roads, which provide networks for everyday life. During the winter, land users depend on infrastructure systems and environmental predictability to access ice fishing, hunting and trapping. Inuk Nobel prize nominee, Sheila Watt-Cloutier, stated in an address to the Inter-American Commission on Human Rights: “The ice is not only our 'roads' but also our 'supermarket.’” (Sheila Watt-Cloutier, 2007). While the ice roads are not permafrost, the example illustrates the importance and necessity of maintaining frozen terrain. Furthermore, it shows that infrastructure, a road or route in the Arctic can look very different to a more southern build-up area. Interviewees consistently raised that the warmer temperatures and thawing permafrost are reshaping long-standing connection routes: “Climate change is happening here in the North twice as

fast as anywhere else and I mean, there's next to nothing we can do about it, but yet we still have to adapt to it and, you know, live with it, but still every year we're seeing something different with our weather, with our water, with the animals, with the travelling routes. Everything's changing" (Interview A). Another interviewee highlighted: "One place I used to trap, one season the whole side of the mountain came down and just blocked the entire creek system off. There was no water running through there. We used to go up on skidoos and there's nothing but boulders" (Samuel McLeod_Aklavik). Considering that land users are semi-dependent on natural resources for their livelihoods, the thawing permafrost and related impacts are creating a form of forced (im)mobility, as the environment becomes increasingly inaccessible seen in these quotes with boulders blocking paths and changing travelling routes. It is apparent that the aspiration to be mobile is present, however, permafrost and permafrost-related obstacles are becoming major physical inhibitors despite it playing a fundamental role in ground stability. Two interviewees stated that they have lost snowmobiles physically on the land whilst travelling due to the soft ground and being unable to retrieve it. "We're seeing a lot of changes and a few years back, [two names redacted] were just driving in the hills and it just looked normal, and they drove into it and just like quicksand, it just sunk their Skidoos" (Interview A). Land degradation, particularly erosion, is also changing the interactions with mobility materiality. One respondent explained that over a short period of time he lost essential equipment that facilitates being mobile to erosion: "I lost a generator, lost skidoos, a cabin, a whole cabin" (Interview F). Interviewees indicated that there are emerging dangers or safety implications related to permafrost thaw and mobility. As suggested by Blondin (2022) the material aspects of mobility play a role in mobility networks. Losing equipment can have ripple effects and can cause instances of involuntary immobility, exemplifying the fact that material aspects and networks are intertwined and essential for maintaining mobility (Blondin, 2022).

Warmer weather brings a transition to water travel throughout the delta and shorter distance foraging. Travel by boat is widely used by people located in the delta or by the ocean during the warmer months. During the summer, or once the river ice 'break ups', boats are typically used for access throughout the Delta. All land users interviewed asserted that changes in climate and therefore permafrost impacted travel and land

practices: “Over the years the water too is shallow in some places, we’re starting to hit the bottom with our boat. So, we start going through a different route” (Interview B). One interviewee revealed the changing nature of the summer travel:

I always worry about our travelling routes down to the coast. Our travelling routes down to the coast there. In a few years, we probably can't even use the smaller rivers. We'd have to go straight out to the ocean and come back into the smaller rivers from the other side. But I mean that alone there again is a lot more dangerous too because of the winds that we've been getting over the past years is getting stronger and stronger; and we're seeing a lot more flooding down at the coast; and so that worries me that my boy would have to worry about those changes and be harder for him to access the traditional foods. (Interview A)

Another land user highlighted: “I notice the rivers are eroding on the banks, they are getting wider but at the same time they are getting shallower and starting to get a lot of sandbars in places and the river system is changing like the channels” (Samuel McLeod_Aklavik). Ziegler et al.’s (2024) findings confirm that thawing permafrost is resulting in increased sedimentation in the river ways, which in turn affects local ecosystems and has broader cultural implications. As seen in the above quotes, adapting to the changes by using alternative routes is part of the decision-making process, although this is not a simple or straightforward solution as routes continue to change rapidly.

Building on permafrost presents a significant challenge (Povoroznyuk et al., 2023). Many interviewees indicated that permafrost is a foundational element for the community, therefore what is built on the permafrost, including roads, airstrips, community infrastructure and government infrastructure, is impacted by thawing. The changing ground conditions are creating challenges for structural viability: “You build something, you start sinking. It's so different. You know, there's no frost on the bottom. The ground is thawing out a lot all over, no matter where, it's sinking” (Interview B). The interviewee further explains that the size of infrastructure doesn't matter and that it is all impacted. Pilings are an important structural component for building stability and are used to mitigate the movements created by the thaw and freeze of permafrost. One respondent stated, “When I think of permafrost, I think of the pilings.” (Michelle Gruben_Aklavik). Ad freeze steel pilings were also used to create the eight bridges along the recently

constructed Inuvik Tuktoyaktuk Highway (ITH) (Povoroznyuk et al., 2023). Multiple types of piling have been developed in response to increasing structural efficacy, although the rate of change is at times faster than the rate of adaptation. Deciding where to build and adopting the best processes for the building is also a prominent concern within the community. This concern extends to the international government investments within the area like the Inuvik Satellite Station Facility. While environmental changes are ongoing, new investments are being made in terms of mobility infrastructure. The recent construction of the Inuvik Tuktoyaktuk Highway (ITH), finished in 2017 at a cost of approximately CAD\$300 million, created conversations about access, suitability and purpose. Residents highlighted that the highway created welcomed jobs, but the all-season road has had mixed reactions. On one hand, some respondents referred to increased road-related deaths and on the other hand the increased access is welcomed. The CBC reported that a projected social benefit of the ITH was an anticipated CAD\$1.5 million decrease in the cost of living per year, which includes access to food, goods and services (Bird, 2017; Povoroznyuk et al., 2023). However, the promised reductions in food costs did not materialise, bringing into question the future of food security (Mathieu, 2021). Additionally, the report also addressed that the road was considered by the government to facilitate oil and gas exploration and resource development. Povoroznyuk et al. (2023) suggest that the highway conceptualisation was initiated by the Tuktoyaktuk residents and supported by the federal government due to an alignment with respective economic development goals. However, none of the interviewees mentioned the highway in relation to extractive industries. Povoroznyuk et al.'s (2023) research highlight the importance of Indigenous-led governance and project development. It was also suggested that the two-lane gravel highway will need continuous monitoring due to the presence of permafrost in the region, which is being undertaken by the Imaryuk Monitoring Program. These insights reveal a complex picture of infrastructure development within the context of permafrost and the resulting impacts in community mobility.

The material cultures of mobility in Arctic communities have undergone rapid transformations. Older generations recall a time when machines were absent and during the summer fourteen to twenty-foot sail vessels, known as schooners, were commonly used, while dog sleds were essential for winter travel. One participant reflected on the

central role animals once played in daily mobility. Colonisation has played a major role in the shifts in animal usage for mobility (Bell, 2006). One participant highlighted the dog culling that took place by authorities and how this dramatically reduced the use of sledding. However, this is not a focus area in mobilities literature, potentially as it is a contested topic. News articles reveal that the Royal Canadian Mounted Police deny allegations and Inuit activities are still working to present their truth (Bell, 2006). The craftsmanship and knowledge required to build and maintain traditional tools of transportation, such as canoes made from bearded seal skins, also highlight the deep cultural connection to mobility. However, the shift to motorised vehicles, such as snowmobiles, has drastically altered the temporal and spatial dimensions of travel (Krause, 2022b). Mechanised transportation extends the range of travel but also the cost of participating in travel. The construction of permanent roads has further changed interactions with the land, reducing distances and altering perceptions of place, as reflected in the observation: “With the road... everything to Husky Lake. Seems like it's so close now” (Interview E). These shifts illustrate how the transition from traditional to modern transportation methods has reshaped both the physical and cultural landscapes of mobility in Arctic communities. Changes in mobility practices and material culture have been predominantly experienced by older generations, however, the perspectives of the youth on these shifts were not clearly represented in the interviews. One major consequence identified is the loss of traditional Indigenous material cultures. The development of permanent structures such as cabins and houses are a relatively recent change in the area. The older participants reflected on more mobile life on the land facilitated by living in non-permanent housing like tents. These reflections illustrate the transition from a highly mobile existence to one rooted in more permanent forms of housing. It was noted by an interviewee that technological transitions have not fully addressed all the needs associated with modern mobility, in that running-expenses, climate and loss of traditional knowledge are major inhibitors. Two older participants overtly stated the importance of needing to move and rely on the land's resources, especially during the winter, largely for survival in the past. These changes in mobility practices highlight observed transformation of material cultures, which is important for the understanding how people are navigating permafrost-related change.

Historical mobility patterns in the Arctic are key to assessing the current impact of permafrost on travel and access. Recent generations have experienced rapid changes in travel practices, leading to a widespread sense of loss among interviewees. Modes of transport have become more modern, with skidoos, motorised boats, aeroplanes, helicopters, trucks, and cars replacing traditional methods like dog sleds, sail or rowing vessels. Modern vehicles have undoubtedly made travel faster and access to supplies and land-based activities, such as hunting and reaching cabins, more efficient. One interviewee in Tuktoyaktuk illustrated the shift in temporalities, noting that a journey to a whale hunting site that once took three hours now takes as little as twenty to twenty-five minutes. However, the benefits of modern transport have also come with challenges, such as increased fuel consumption, high costs, and environmental pollution. Due to their higher costs, individuals have expressed they ultimately spend less time on the land to afford the equipment that facilitates mobility, such as skidoos. Pearce et al. (2010) further support that the purchasing, maintenance and operation of transport technology in the Northwest Territories is expensive and the price of fuel has a history of dramatic and disproportionate increases. Respondents addressed that the transition has required a shift toward wage-based income. Thus, despite these advances in speed and efficiency to essential resources brought by modern transport, it simultaneously increased reliance on wage-based incomes, introducing new economic and environmental challenges. Emphasising both the benefits and challenges associated with modernisation, alongside growing climate-related obstacles faced by Arctic communities.

Modern mobility materialities and environmental changes are entangled in complex relationships. As highlighted, participants frequently mentioned having to reroute or take detours due to excess water, sediment buildup in rivers, erosion, landslides, and even excessive vegetation growth. A respondent in Aklavik mentioned that they enjoy being mobile using modern vehicles, such as skidoos, trucks, or boats, to travel to their camp or nearby areas. However, they emphasised that their ability to travel is heavily dependent on ice and weather conditions. For example, during the spring, unpredictable variations in ice thickness on the river have taught them to be more cautious and avoid certain trips during that time. These challenges are further linked to food and resource security, safety and well-being (Gartler et al., 2024). Navigating this rapidly changing landscape has

become an urgent challenge for local residents, reinforcing the importance of examining how environmental shifts, materialities and infrastructures interact to create potential barriers or disruptions to mobility for some groups (Blondin, 2022).

6.4. *Life on the Land and Subsistence Mobilities*

Being 'on the land' is frequently referred to as a positive aspect of life in the Arctic and includes activities in nature which are not limited to hunting, trapping, fishing and berry collecting. The categories of life on the land and subsistence were two of the most frequent codes used, appearing as the most important topics. Land also appeared as one of the most frequently used nouns within the MaxQDA analysis, appearing 377 times in all of the documents. The land holds deep significance for the Inuvialuit and Gwich'in, as it is seen as both relational and alive (Krause, 2022b). It can represent not only a physical space but also extend to identity, autonomy, health, and cultural heritage of the people who live on it (Karetak et al., 2017; Watts, 2013). Being able to participate in life on the land plays an important role for all the individuals in the interviews. Particularly in terms of subsistence and to support themselves or their families, permafrost is considered an integral component of the land. As one respondent highlighted, "Permafrost is the land." (Michelle Gruben_Aklavik).

Arctic life on the land is deeply intertwined with the concept of subsistence harvest mobilities, a practice that necessitates both long- and short-term movement across the landscape to secure or supplement essential resources and support survival. The interviewees described subsistence activities ranging from short-distance walking to berry patches or multi-week trips to cabins within the delta. Multilocal connectivity is often essential. For example, some interviewees travel to Herschel Island (Qikiqtaruk) located five kilometres off the Yukon coast for weeks at a time, highlighting the lengths taken for subsistence. One interviewee explained that they travel on average one hundred times from Aklavik to Inuvik per year to gather resources, participate in community life and maintain ties. Such examples of regular travel exemplify the necessity of life on the land and mobility in the Arctic, where access to specific locations is essential for obtaining

resources. As noted in the study site description section the road, infrastructure and resource access within the Arctic communities varies, shaping the need for participation in subsistence harvesting activities. Further, interterritorial and international mobilities also enable individuals to access education, work and health. Some interviewees indicated that migration and subsistence is occurring between Alaska, the Yukon and Northwest Territories, which highlights the interconnectedness of the North American Arctic. Two interviewees mentioned that the establishment of territorial borders has come with challenges that have also necessitated the change of subsistence routines. Within recent literature that addresses the Arctic, subsistence and the ability to travel for long distances are often presented as being at high risk of being impacted by climate change (Sejersen, 2012; Whyte et al., 2019). Sheila Watt-Cloutier highlights that “While Inuit are not an agricultural people, we depend on the bounty of the land for our survival.” (Sheila Watt-Cloutier, 2007). Subsistence fishing, hunting, trapping, wood collecting and berry picking play a vital role in maintaining livelihoods for many, and distance travel is often essential: “I think maybe seventy-five or eighty percent of our food comes from the land” (Michelle Gruben_Aklavik). Ramage et al. (2022) found that food sourced from the land makes up half of the diet for the participants from Aklavik. One interviewee explained: “A lot of people really rely on those kinds of foods, I mean, it's not every day we could sit and eat chicken or steak or pork” (Interview A). In Aklavik, a diet consisting of food from the land is considered essential, with high importance placed on it and frequent consumption as part of daily life (Ramage et al., 2022). Subsistence mobility is vital for many, often requiring travel over long and short distances for varying lengths of time.

Food from the land not only holds a cultural and nutritional value but also offers a financial incentive. The cost was further mentioned by Kylik Kisoun: “That's everything that we need, ten bucks a day, because we catch our own fish, we hunt our own meat, we build our own stuff. So, our costs are really low” (Kylik Kisoun_ Inuvik). Relying on supermarkets is not economically viable for many people in the Arctic (Whyte et al., 2019, p. 327). The cost of groceries is often twice, if not more expensive, than in other more southern parts of Canada, largely attributed to factors such as continuity of access, remoteness, and other logistical challenges (Povoroznyuk et al., 2023). Despite an ongoing trend of withdrawal from a subsistence economy, for many it is still essential (see also Ford et al., 2006). While

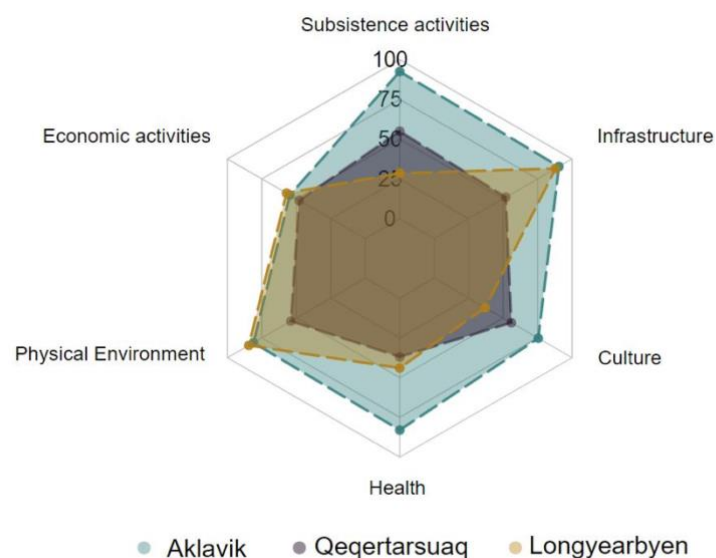
the supermarket may be viewed as a measure of food security, many respondents expressed a reluctance to depend on it. Food from the land is viewed as a positive necessity: “We weren't rich in many ways, but we were rich in the things that we got from the land” (Interview B). One interview revealed that the result of not getting any subsistence meat, particularly caribou, led to reliance on imported supermarket meats. Although the amount and what products were purchased were not explained, this highlighted the substantial cost of store-bought food and the financial importance of subsistence harvesting.

Jungsberg et al. (2022) found that “eighty-five percent of participants from Aklavik think that permafrost affects their ability to collect food from the land”. Figure IV from their findings shows that challenges related to permafrost and subsistence activities are important throughout Arctic towns, especially in Aklavik. While the reasoning for not getting any caribou is multicausal and experienced by multiple land users, permafrost thaw was acknowledged as playing a part in changing land practices: “It puts a big obstacle in our traditional harvesting, I mean, it's changing our river systems. It's changing our land and it's just something that we see almost every day” (Interview A). Participants highlighted that subsistence mobilities are being impacted by permafrost thaw: “When we're out on the land, we see it, we try to avoid it and stay away from it. We know what it is. It's not safe because it's thawing out. If you try to walk on it, it's like quicksand. You're going to get stuck in there” (Interview E). Movement across the land is necessary to access resources when and where they become available.

Changes to the land also have widespread social and economic effects. Understanding the full impacts of permafrost thaw is imperative for understanding human agency within the context of a changing physical environment (Sejersen, 2012). Subsistence mobility in the Arctic is also impacted by financial limitations, where many community members are balancing traditional harvesting activities with wage labour and this assists with acquiring the income necessary to purchase essential supplies such as equipment, fuel, and other harvesting materials (Pearce et al., 2010). However, analysis of the interviews revealed that the need for employment also restricts the timing and duration of harvesting, as working commitments can limit the ability to travel long distances for subsistence activities. For

some, the cost of fuel and equipment can prevent them from accessing locations that are further away. These financial constraints hinder the full practice of subsistence mobility. Even though, one interviewee noted that during the COVID-19 pandemic, many people found themselves with more time to go out on the land due to reduced work commitments, allowing them to engage more fully in subsistence practices despite the ongoing economic challenges.

Figure IV. Perception of challenges related to permafrost in Aklavik Qeqertarsuaq and Longyearbyen. Source: Jungsberg et al., 2022.



An important aspect of subsistence is the ability to store meat long term: “We have our icehouse. So that stores our food and that's a massive, huge thing for our food security” (Kylik Kisoun_ Inuvik). Throughout history, permafrost played a crucial role in ensuring food security by providing natural refrigeration in ice houses or simply in the ground. As the permafrost thaws, traditional storage practices are increasingly threatened, undermining community abilities to store food safely for long-term use. While many people have turned to the use of refrigerators, ice houses are still recognised as an important tool for subsistence. Kisoun later continued:

One of the big reasons why we were able to survive here so well is because of the permafrost, which allowed us to have access to massive amounts of food storage. So, when the whales came for a month and a half, we didn't just kill what we could eat and what we could dry. We killed as much as we needed, and we put it in ice houses, and it was good for years. And so, to me, it's like the permafrost here is our security. (Kylik Kisoun_ Inuvik)

Physical changes on the land impact the way people are able to be mobile as well as hunting and harvesting patterns. Soft ground and erosion are two direct results of permafrost degradation, which are inhibitors for subsistence and food security. "I don't want to say I'm scared, but I think it's [permafrost thaw] only going to get worse, and it's probably going to have an effect on our subsistence, you know, for wherever we're trying to go to harvest" (Michelle Gruben_ Aklavik). One interviewee demonstrated how the deepening of the active layer is creating difficulties in subsistence practices where they were not able to secure boats anymore in the frozen permafrost, showing the extent of impacted mobilities. Building upon previous sections, land users indicated that viability of routes is also increasingly impacted by permafrost thaw, often requiring them to alter river and land routes. Interviewees noted that there is a need, and ongoing attempts, to adapt to changing land and river routes and knowledge surrounding these. Most who actively use water routes expressed a deep concern for the viability of routes and how permafrost thaw impacts this. Pearce et al. (2010, p.171) discuss the use of alternative routes in Ulukhaktok, NWT, as an adaptation form and further states that "continued flexibility and ingenuity will play central roles in future adaptation." (Pearce et al., 2010, p. 171). This can also be seen as an adaptation effort in the study sites: "When I'm travelling, I let them [children and grandchildren] know. You know, there used to be a place here and the river used to be a lot narrower here. And you gotta watch for these sandbars here" (Interview A). Adaptations to the changing land and water routes is an ongoing process as erosion related to permafrost thaw alters landscapes. Building knowledge of the shifting river paths reflects the resilience needed to maintain subsistence mobilities.

Subsistence mobility requires local and generational knowledge of the land and physical environment. Pearce et al. (2010, p.168) acknowledge this by noting that "knowledge and skills were developed and transmitted through on-the-land education". To add on to the

discussion in the previous chapters, the knowledge of the natural environment and seasonal cycles play a critical role in shaping how people navigate and remain mobile in the Arctic. Davis et al. (2022, p. 2) found that “For Inuit in Arctic North America, the land is the heart of cultural and community life. Spending time on the land is key for livelihoods, food, culture and transport between communities”. Interviewees demonstrated this by the practice of sharing subsistence harvest and thus supporting families through winters. The remaining legacies of colonialism and the emerging landscape changes created by climate change are increasingly compounding these traditional practices, creating new challenges to subsistence mobility and survival in the region.

Loss of knowledge and the ability to live on the land is linked to immobility. The youngest generations are the first of many who are less mobile as a part of routine subsistence. However, learning how to be subsistent from family and community is how traditional mobility is maintained. Sheila Watt-Cloutier (2007) stated, “Hunting is, in reality, a powerful process where we prepare our young for the challenges and opportunities not only for survival on the land and ice but for life itself. The character skills learned on the hunt of patience, boldness, tenacity, focus, courage, sound judgement and wisdom are very transferable to the modern world that has come so quickly to the Arctic world.” Hunting and mobility play a crucial role in learning how to engage with the land and in developing important life skills. As one interviewee explained, discussions with their children about changes they have experienced often take place during times of mobility, for example going to cabins or hunting, reinforcing the connection between movement and knowledge transmission. Another interviewee highlighted that even when the desire was there for him in his youth, the possibility was not always there due to residential schooling. Participation in traditional activities and subsequently subsistence mobilities plays a vital role in health, well-being and learning culture. Community members linked the loss of culture and intergenerational trauma with the increasing presence of substance abuse and suicides, highlighting a complex, interconnected issue, with multiple contributing factors. While many seek to identify a starting point, there are consistent patterns that point to the lasting impacts of colonisation. While this is not the focus of this research it is important to highlight that access to land plays an important part in healing from the past: “Gwich’in women are notorious for picking berries. Even when we have

enough, we still go out because we love being on the land. It is healing and we sure need that today with everything that is going on” (Sarah Jerome_ Inuvik). Sarah Jerome further explained: “We had a healing camp built about twenty miles above Fort McPherson and that’s when we brought psychologists there to deal with us and with the intergenerational effects of the residential school—that’s when we started talking” (Sarah Jerome _ Inuvik). The ability to access and move throughout the land is thus deeply intertwined with identity, well-being and inter-generational knowledge.

6.5. *“Beyond control”: The future of climate and permafrost stability in the Arctic*

Ayeb-Karlsson et al. (2024, p. 2) discuss the realities of climate-induced mental health impacts, often referred to as eco-anxiety, or ecological grief. They further assert that this could fall into the UNFCCC notions of climate-induced ‘Non-Economic Losses and Damages’, which encompass intangible effects such as physiological impacts and cultural losses (Ayeb-Karlsson et al., 2024, p. 2). The interviews revealed an overwhelmingly negative perception of the future of climate and permafrost stability in the Arctic. Interviewees often indicated that climate and permafrost degradation are beyond control and have reached an irreversible state: “We are beyond the threshold” (Interview C). Others describe long-foreseen changes becoming reality: “My mom told me a story that my grandfather told her that this whole land is going to turn into a desert. We are starting to see all these changes and it is coming true. We are seeing animals that we have never seen before” (Delores and William Charlie_ Fort McPherson). Similarly, Nellie Arey asserted: “We can't control it. I don't think anybody's gonna control it now. You know, it's so soft all over. All over. It's just... sinking” (Nellie Arey_Aklavik). There is a heavy emotional toll of witnessing changes in the land and the sense of eco-anxiety adds urgency to addressing both the tangible and intangible impacts of permafrost thaw related issues.

The tangible and intangible impacts of permafrost thaw in the Arctic are intertwined. Physical changes associated with permafrost thaw affect land use and food security, contributing to feelings of eco-anxiety and concerns for individual safety and security. As one interviewee shared, the permafrost thaw is “slowly taking away our livelihood. We depend on the permafrost” (Interview B). The majority of the interviewed land users

directly expressed worry or emotional distress about losing the ability to be mobile and encountering safety issues due to land changes: “I was scared it [a landslide] would block us” (Delores and William Charlie_Fort McPherson). The land changes not only affect their immediate surroundings but also have the potential to hinder future access to crucial areas throughout the region: “If it continues to thaw, what will happen to the trails and getting to our camps?” (Elizabeth Wright_Fort McPherson). These quotes demonstrate that not only are there physical environmental consequences but also long-term emotional and well-being-related consequences and these are connected. Having to worry about sudden changes to routes and safety is taking a toll on land users leaving many yearning for past conditions. Ayeb-Karlsson et al. (2024) further discuss well-being loss under the idea of non-economic loss and damages, which is being undertaken at the international level. However, how this translates to the individual level remains unclear. Their research also found that “climate-associated immobility and collective confinement were reported to increase societal and domestic stress” (2024, p. 13). Permafrost-related disruptions to mobility practices or experiencing immobility are concerns shared in the study site regions. Experiences of immobility and subsequent loss of well-being are important factors when considering community resilience and the ability to adapt to climate change. This highlights the need for solutions at multiple scales that address both the tangible and intangible impacts.

Despite increased environmental pressures to adapt or find alternative ‘micro-mobilities’ (Zickgraf, 2022), interviewees expressed a strong attachment to staying put in the face of change. As one interviewee shared, “I mean I’ve been born and raised and hunted this area, fished this area all my life, and I would never be able to leave.” (Interview A). Scholars have described similar sentiments as forms of voluntary immobility (Boas et al., 2022). Not wanting and not being able to are two themes that emerge within the idea of immobility (Boas et al., 2022), and both were presented in various forms within the interviews. While place attachment was not always explicitly stated within the interviews, it evidently plays a major role in aspirations to stay. These compounding factors may contribute to isolations and immobility. The concepts of ‘mobility’, ‘stasis’ and ‘place-attachment’, also explored through the idea of staying put, are not necessarily opposites.

People can have a strong place attachment to a specific place or have a stable base even alongside partaking in frequent movement or mobility, in this case for seasonal or subsistence-based travel. There are strong themes throughout that link place attachment and mobility, where interviewees frequently expressed an ongoing desire to travel and be mobile within ancestral lands as a part of subsistence, culture and wellbeing. Staying close to the land is important as it is also a form of healing and provides therapeutic benefits for Inuit and for Gwich'in (Ayeb-Karlsson et al., 2024). Through their research Ayeb-Karlsson et al. (2024) noted that the land was described as a symbol of freedom enabling individuals to be self-reliant and trust in their knowledge for survival. Conversely, many interviewees drew associations between feeling immobile and equating it to a lack of freedom or increased social dependence. These social, economic, and environmental pressures are restricting land access, sparking concerns about relocation and retreat.

6.6. *Relocation and Retreat*

Fluvial and coastal erosion driven by permafrost thaw was reported to be the most concerning threat to permanent settlements and cabins that facilitate life on the land. Several interviewees had examples of the erosion taking private houses and cabins partially or completely: "I lost my whole house. My whole cabin that I built went over the bank, and I lost everything in it" (Interview F). The threat of erosion reflects the shifting nature of land reliance for subsistence and shelter. It is described as both abrupt and gradual, with one interviewee recounting the loss of one hundred feet of land, which swept away houses in the process. Relocation as a result of this is present in the discussions about how to manage and adapt to permafrost changes: "I thought about things like we are going to have to move because of erosion" (Interview C). Relocating for many along the delta and coast is no longer a matter of 'if' but 'when' and to what extent: "My sister has a cabin four miles up and her house has to be moved back because the bank is eroding away. You go up there and see all the trees falling in" (Delores and William Charlie_ Fort McPherson). This highlights the urgency and inevitability of displacement as erosion continues to threaten homes. While deltas are naturally dynamic, permafrost thaw and softer ground in some areas are making the land more susceptible to rapid erosion (Ramage et al., 2022). As

discussed in the literature review, local adaptation in the form of relocating infrastructure and livelihoods is a necessary and potentially only option for climate-induced threats (Bronen, 2014).

Relocation as a form of adapting to the natural hazards has occurred previously in the Northwest Territories, for example, consistent flooding in Aklavik led to the establishment of Inuvik. One interviewee discussed the decision-making processes and fast transformations that occurred with relocating Aklavik:

I couldn't believe how fast we changed from living on the land, being out there all the time. And all of a sudden, these groups of people in Aklavik were talking because it was flooding every so many years. These guys decided they wanted to move Aklavik. So, we were out on the land and the councillors and whatnot talked about the people and whatnot, and they decided, 'OK, the government wants to move our people to a safer place'. So, they looked around, but they figured there never could be a good place for it. So, they built it. I still went to school there for one year in a residential school. I lived there for a while, but I came back here and started my family. (Interview B).

The prospects of planned permanent relocation of entire communities continue to be a reality within the Arctic. Residents of Tuktoyaktuk are faced with the ongoing threat of being forced to relocate. Options for a new settlement location are discussed and Reindeer Point has already been established as an option (Saunders-Hastings et al., 2020). Plans to retreat from coastal erosion are ongoing although many advocate for infrastructural adaptation as a preliminary step. Similar to the example of Aklavik's community relocation, community responses to permafrost-related relocation have been mixed, ranging from a willingness to complete opposition. This resistance to relocation could be seen within the voluntary immobility spectrum, where individuals despite facing environmental or external pressures, choose to remain in place, while also advocating for alternative adaptation strategies (Boas et al., 2022). Relocation is discussed in interviews as a last resort option; it is increasingly necessary with multiple people losing cabins to abrupt erosion. Echoing comments made in Interview B about the difficulties finding a suitable location to relocate to, the viability of the land around Tuktoyaktuk is still a concern for the interviewees raising issues of soft ground and permafrost. An interviewee shared their concern and difficulty in

moving a whole community as well as the impact they see relocation having on a sense of belonging, cultural ties but also the logistical concerns for the community and individuals. Communication between scientists and stakeholders is ongoing, though efforts to identify a new location have not yet been fully successful from the perspective of the interviewees. Saunders-Hastings et al.'s (2020) in their report for Natural Resources Canada emphasised the successful relocation of four houses to a lower risk area. A positive framing in the report shows a potential disconnect between the state and individual perspectives on relocation as individuals expressed concern for the process. While the relocation of Tuktoyaktuk is important for the discussion of (im)mobilities and relocation in the Arctic, the discussions surrounding this specific example were somewhat limited. However, the few interviews conducted in Tuktoyaktuk revealed that the decision-making process surrounding relocation is complex, involving discussions across multiple scales, a range of stakeholders and the participation of the inhabitants.

Relocation has sometimes become so urgent that it must be carried out immediately, often by an individual with little to no external planning or government assistance. The sense of urgency can be felt within the interviews: "The water has come too close to the house. We have to move the house. The east wind is making waves come in and taking the land. We had forty feet of land and now about one inch" (Interview D). Cabin owners reported that a retreat can occur incrementally, where the relocation process is typically completed at the individual's own expense and effort. As one interviewee explained, "Every few years we have to move the house back" (Interview F). They further detailed the process, stating, "Eleven-thousand-pound winches, I buy those, and I keep them hooked up behind my house and I pull the house back with them" (Interview F). This further demonstrates a high level of individual agency in the retreat processes occurring. Interviewees highlighted the physical and financial burden placed on individuals as they continually adapt to the changes. The physical act of relocation is often carried out independently or with the assistance of family members. Another interviewee explained a similar retreat process, "So my camp was closer to the bank last year. I had to cut the brush behind my camp, I cut lots of brush. Then I had to buy beams to go underneath my house. I had to get chains, come-alongs and straps. And I had to get my house ready, then we hooked it up and we pulled it back, pulled it back, pulled it back. We had to because the

ground was falling” (Elizabeth Gordon_Inuvik). Another interview revealed the process for retreat is being discussed and techniques are being developed: “I put my houses on logs. It was a lot easier to pull on logs. I tied it to logs and tried rolling it back. Then somebody said to me last year: ‘Why don’t you try in the wintertime, put a lot of water and let it freeze and then your house can just skid across the ice.’ And I thought: ‘Hey, that’s another smart way to do it, I guess. It’d be a lot easier on my winch anyway’” (Interview F). The interviews did not clearly reveal the official or individual processes for land selection or the incremental relocation. However, expense, place attachment and widespread permafrost degradation were reasons given for not relocating further distances. In the interview with Elizabeth Gordon, she explained the tiring physical process of moving her house back, taking eight hours to relocate her house thirty-five feet. The decision-making process around the retreat distance was briefly discussed, though it was unclear from the interview why a distance of thirty-five feet was chosen. Gordon further mentioned that this is a form of adaptation for not just her own circumstance. Across all interviews, it remained unclear whether any governance structures exist to support individuals in their decision-making for relocation. In this case, methods for moving a permanent settlement are determined by the individual. Logistical or financial input from governing bodies also remains unclear, however there was mention of financial schemes if items or houses were lost. It was indicated that approximately CAD\$4500 was given to those affected by flooding and half for lost houses. However, the financial assistance response from the Government of Northwest Territories Environment and Natural Resources was noted to be inadequate: “I got some money back for the cabin. But it was only enough for the floor to be made. I said, ‘I can’t build a house for this kind of money’” (Interview F). While further research into local agency and decision-making processes would be highly beneficial, it lies beyond the scope of this thesis.

These examples of retreat can be viewed as autonomous adaptation through relocation, where action is taken by the individual to adapt to environmental changes (Diniega, 2024). Discussions surrounding climate-induced planned relocations span from the Pacific Islands to the Arctic (McNamara et al., 2018). However, these experiences of incremental self-relocation do not fit particularly neatly with the current relocation discourse, and only slightly more with ‘micro-mobilities’ (Zickgraf, 2022). As a form of adaptation, this

demonstrates the individual agency in circumstances of permafrost thaw. Individuals expressed that while this is a practice for cabin owners, it is not always possible to retreat, which may be multicausal and therefore requires more in-depth investigation into micro or local scale retreats. Relocation within literature is often addressing a community or state perspective which involves a planned mass movement from one unsafe location to an often separate safer location. State institutions in examples from Alaska play a major role in the orchestration of relocation (Schweitzer, 2010). Bronen (2014) suggests that despite this there is a lack of international and state frameworks that can support relocation. A report for Natural Resource Canada on the planned retreat approaches suggests that relocation “manifests over the longer term” (Saunders-Hastings et al., 2020). The report further states that while the process can be a challenging, stressful, painful process, “making sacrifices on behalf of others can also be an enriching opportunity” (Saunders-Hastings et al., 2020, p. 5). From this case study it can be seen that many individuals do not have the long term to react to the permafrost thaw nor adequate support. “There’re two cabin owners that I know that lost their house to the river. Gone. Floating down the river. Because it was just too much, they didn't have the time. They didn't have the resources, they didn't have, you know, to try and pull it back. Because it is just happening too fast. Their house was there. Now it's gone. They have zero” (Elizabeth Gordon_Inuvik). The logistical consideration in combination with the speed of change is creating issues for mobility. Even though there is a desire to relocate homes to more stable areas, many communities are facing significant barriers that prevent them from doing so. These barriers may include a lack of resources, inadequate infrastructure, and the physical dangers posed by unstable ground due to permafrost thaw.

As a result, while the need to move is recognised, the ability to respond effectively is limited, exacerbating concerns about safety, housing security, and overall resilience in these changing conditions. The follow-on effects of relocation, or even the prospect of relocation, were also highlighted, with particular consideration given to the impact on the existence and identity of communities and cultures, especially in the context of past experiences of community destruction through colonisation. Connection to ancestral lands and implications of finite habitability was also raised during the interviews. McNamara et al. (2018) highlight how loss and damages occur for any individuals forced to leave their

homes because of climate, aligning with the broader international agenda addressing the impacts of climate change under the UNFCCC framework. Here it is important to remember that relocation is complex and influenced by factors that make the decision to move neither entirely voluntary nor completely involuntary (Schweitzer, 2010, p. 32). Further research is required to identify frameworks for not only community scale relocations but incremental retreats, which acknowledge that increased permafrost thaw is not a slow on-set disaster but also at times occurring rather rapidly.

6.7. *Summary of the Results*

The interviews revealed nuanced perspectives on the intersection of permafrost and (im)mobilities and how this translates into everyday life for many individuals in the Mackenzie River Delta region and Beaufort Sea coast, within the Inuvialuit Settlement Region and Gwich'in Settlement Area. A concern across Arctic communities, including the study sites, is the disruptions to mobility related to permafrost, which affects food security, safety, livelihoods and cultural practices (Gartler et al., 2024). Cultural practices often require travelling long or short distances for community connection and subsistence (Sejersen, 2012). Interviewees described how the changing nature of soft sponge-like ground and erosion affects travel and route viability on both the water and land, highlighting the naturally dynamic but rapidly changing Delta. Interviewees reflected on the accelerated rate of transformation and a critical connection between solid, cold and predictable ground and mobility, cultural practices and identity. Social, political and economic change in the study area within the last centuries was also attributed to a history of colonisation. The shift from semi-nomadic lifestyles to sedentary settlements was described as contributing to involuntary immobility, confirming findings by Ayeb-Karlson et al. (2024). These societal changes altered infrastructure and land-use practices and have had far-reaching implications for mental health and cultural knowledge. Colonial practices, such as the residential schooling system, interrupted intergenerational skill and knowledge transfer, vital for life on the land and subsistence mobilities (Ford et al., 2016). These disruptions had a direct bearing on mobility and how people are able to partake in it. Yet, knowledge of the land and its recognised importance for life in the Arctic endures, held up

by the resilience of the communities and adapted to changes. The materialities of mobility further illustrate how both historical and contemporary practice shape the way people engage with the land. Interviewees noted the increasing costs associated with travel and mobility as a barrier to access. These rising expenses, alongside infrastructure challenges, highlight the changing mobility systems in a warming Arctic climate (Povoroznyuk et al., 2023). Mobility materialities lead to subsistence harvest practices, which are critical to food security and cultural resilience. Many of the interviewees note that the community depends on subsistence harvesting, supporting evidence from Jungsberg et al. (2022). Furthermore, subsistence is undertaken over long or short distances or temporalities. Subsistence harvesting supports not only the food systems but intergenerational knowledge transfer, promoting resilience through adaptation to permafrost thaw. There was a sense of loss as interviewees reflected on the changes to mobility and the land that were occurring, highlighting both tangible and intangible impacts of permafrost thaw. Interviewees emphasised that these impacts are not just physical but also psychological. This highlights the need for adaptation that addresses both the physical and emotional dimensions of change. Finally, community-level relocation was present in the interviews as both a historical and contemporary adaptation to land changes. The experience of Inuvik demonstrates how communities have adapted to rapid shifts. Through autonomous and incremental retreat, individuals showed a high level of agency and resilience in climate mobilities. Yet, individual self-relocation remains largely absent from broader relocation discourses. The data showed that adaptation requires diverse solutions that centre community voices when addressing mobility, ensuring sustainable and culturally appropriate responses to an uncertain future.

7. Conclusion

Permafrost is a critical landscape feature of the Arctic and plays a foundational role in maintaining the structural integrity of landscapes, supporting ecosystems, and sustaining the traditional livelihoods of Indigenous communities, thus its thaw is creating nuanced environmental and societal challenges. Permafrost thaw and the deepening of the active

layer exacerbated by anthropogenic climate change is posing a risk not only to local communities but the global ecosystem (Burn & Kokelj, 2009). Arctic Indigenous land-users' perspectives offered a unique perspective to discuss the Anthropocene and mobilities as they are everyday active observers of the physical environment around them. A secondary analysis of the semi-structured interview data collected by Mag. Susanna Gartler and Professor Susan Crate from four communities in the Mackenzie Delta and Beaufort Sea Coast indicated that the mobility in the area is being rapidly transformed and, in many ways, is disrupted by the thawing permafrost. Traditions of mobility are historically and culturally significant for the Indigenous communities in the Arctic (Whyte et al. 2019). Therefore, the impacts are felt deeply by individuals who are experiencing the rapid change. The key themes that emerged in the results include the fundamental connection between permafrost and mobility, as well as how colonisation and materialities influence and function within this relationship. Additionally, life on the land and subsistence harvest practices are increasingly at risk, creating stressors for food security, safety and future mobility. While community relocation is a factor considered potentially necessary in the study sites, a closer focus on the micro-level adaptations reveals that an incremental autonomous retreat from affected areas is becoming a necessary form of adaptation. This research had a particular focus on the everyday or micro-mobilities that were raised in land-user interviews which proved to be a fruitful lens for analysing mobility in the study area. Throughout the research it was important to consider the close linkages between historical context, modernisation, cultural learning and resilience to climate impacts, this remains true for future research on similar topics in the area. Adaptation is occurring in many tangible and intangible ways. An emerging theme appearing in the analysis that requires further investigation was education as adaptation. Education appeared frequently in the teaching and learning from community and history, playing a vital role in improving cultural resilience. Local adaptive strategies were in focus although comprehensive support from regional and national levels is still necessary.

The initial research goals and sampling of interviews predominantly aimed to focus on land-users and professionals, hence future research concerning mobilities could benefit from further exploring details surrounding, which individuals or groups within the community have the capacity to be mobile. Further research is needed on any present

generational gaps in mobility to understand broader changes in cultural identity, land use, and the ways Arctic communities interact with their environment over time. The current gap makes it difficult to fully delineate how permafrost thaw might differently affect a wider range of members of the community, including youth and non-land users. Those interviewed revealed some detail about the processes of learning to be on the land and shortcomings of passing on information to the next generation; where the older generations are looking to young people to maintain or adapt. One respondent explained that younger people often do not notice permafrost thaw or climate change because they spend most of their time in town and have not been taught traditional knowledge. Gathering of youth perspectives may fill in vital information about adaptations and agency. Stern (2021) briefly highlights that the resilience of youth and mental training through “travel on the land” is at risk due to climate change and poses a significant risk for Inuit, highlighting the role of education for effective adaptation. It was clear from the interviews that education or learning and teaching plays a major role in living in the Arctic, being subsistent and having a connection to Indigenous cultures. The theme of education as a form of adaptation emerged frequently as well as the importance of teaching children and grandchildren about culture to ensure its preservation. Adaptation through education appeared as a way forward that can contribute to healing and connection to the changing permafrost conditions. This is linked to the sharing of information and collaboration with researchers and stakeholders. During the interviews individuals consistently expressed positive feelings towards field researchers when the research aim was understood and transparent. Given this, building knowledge on permafrost and adaptation requires a collaborative approach to learning, where education and holistic strategies that consider environmental, cultural, and social factors are essential.

8. Interview Information

Name	Date	Interview Location	Duration of Interview (Minutes)	Language
Richard Gordon	03.10.22	Inuvik	62,00	English
Sarah Jerome	07.10.22	Inuvik	93,00	English
Elizabeth (Liz) Gordon	15.10.22	Inuvik	54,00	English
Max Kotokak	08.11.22	Inuvik	54,00	English
Angus Alunik	01.12.22	Inuvik	103,00	English
Kylik Kisoun	13.01.23	Inuvik	75,00	English
Bruce Inglansak	11.10.22	Aklavik	65,00	English
Johnny (JD) Storr	11.10.22	Aklavik	56,00	English
Danny and Annie Gordon	12.10.22	Aklavik	107,00	English
Nellie Arey	12.10.22	Aklavik	49,00	English
Renie Arey	12.10.22	Aklavik	77,00	English
Jonas Meyook	12.10.22	Aklavik	65,00	English
Samuel McLeod	12.10.22	Aklavik	38,00	English
Grace Ilisiak	13.10.22	Aklavik	60,00	English
Michelle Gruben	13.10.22	Aklavik	71,00	English
Lenny Emaghok	22.10.22	Tuktoyaktuk	86,00	English
Noel Raymond	23.10.22	Tuktoyaktuk	91,00	English
Elizabeth Wright	26.10.22	Fort McPherson	52,00	English
Delores and William Charlie	25.10.22	Fort McPherson	53,00	English
Wanda Pascal	26.10.22	Fort McPherson	54,00	English

Robert Alexie	25.10.22	Fort McPherson	82,00	English
Mary Snowshoe	26.10.22	Fort McPherson	66,00	English

Note: Those opting for anonymity in the consent form have been purposefully left out of this summary.

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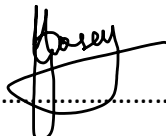
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10. Annex and Declaration

Statutory Declaration

I herewith declare that I have composed the present thesis myself and without use of any other than the cited sources and aids. Sentences or parts of sentences quoted literally are marked as such; other references with regard to the statement and scope are indicated by full details of the publications concerned. The thesis in the same or similar form has not been submitted to any examination body and has not been published. This thesis was not yet, even in part, used in another examination or as a course performance.

Place, Date: Vienna, 05 December 2024

Signature: 
(Name): Georgia Kate Mosey

Declaration on Aids and Tools Used:

The following aids and tools were used in the preparation of this work in the following ways.

Software

1. Microsoft Word: Transcribing, document formatting and finalisation.
2. Google Docs: Document drafting, writing and formatting.
3. Max QDA: Data analysis.

AI Tools

1. Otter AI: Transcribing
2. Grammarly: Spell Checking
3. ChatGPT: Revising outlines and generating feedback on spelling, grammar and sentence clarity.
4. DeepL: Translations

Hardware

1. Personal Devices: Writing and storage

All aids and tools were used responsibly and ethically. All outputs from AI tools were critically assessed to ensure accuracy and originality.