State of Knowledge and Gap Analysis on Climate Change Adaptation in Nunavik

An Update from the Bolton et al. 2011 Report [1]

[1] *What we know, don't know, and need to know about climate change in Inuit Nunangat: A systematic literature review and gap analysis of the Canadian Arctic.* By: K. Bolton, M. Lougheed, J. Ford, S. Nickels, C. Grable, and J. Shirley. Final report submitted to The Department of Indigenous and Northern Affairs Canada, Climate Change Adaptation Program (CCAP). Published by Inuit Tapiriit Kanatami, Ottawa, March 2011, 129 p.

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Executive Summary

The need for adaptation research, planning, and implementation in northern Canada in order to minimize the negative impacts of climate change began to become apparent in the early 2000s and has increasingly been recognized as a priority since this time. Nevertheless, research examining adaptation progress is in its infancy, albeit rapidly developing, consisting primarily of qualitative project-level case-studies (Berrang-Ford et al. 2011; Lesnikowski et al. 2011, 2015; Pearce et al. 2011a; Ford and Berrang-Ford 2015; Labbé et al. 2017). As such, there is a very limited understanding of how or if adaptation is taking place. Comprehensive adaptation inventories using systematic approaches are needed to assess the breadth and adequacy of the adaptation response, to inform adaptation strategy development, and to track adaptation over time (Preston et al. 2011; Ford and Berrang-Ford 2015). This report seeks to address this gap by systematically examining and characterizing climate change adaptation initiatives in Nunavik implemented since 2010. Furthermore, this report compares the state of adaptation to the nature of the risks posed by climate change, and subsequently investigates adaptation research, policy, and implementation gaps. The report serves as an update to the "What we know, don't know, and need to know about climate change in Inuit Nunangat" report funded by the Department of Indigenous and Northern Affairs (INAC) Climate Change Adaptation Program (Bolton et al. 2011), and is designed to update the Nunavik findings to 2017.

This report comprises four main sections: Chapter 1 provides a brief introduction, Chapter 2 outlines the methods used in the systematic review used to identify adaptation initiatives taking place in Nunavik, Chapter 3 provides an overview of the current adaptation landscape in Nunavik, and Chapter 4 concludes the report with a presentation of overarching findings and recommendations from the analysis. Within Chapter 3, adaptation initiatives are analyzed according to six sector categories, and adaptation gaps and future directions are also discussed.

Key findings from chapter 3 are organized into six sector categories and include the following:

- **Infrastructure and Transportation**

The Infrastructure and Transportation sector was the most active in adaptation. A significant focus of the adaptive response is attributed to changing permafrost conditions and the consequent impacts to infrastructure in the region. Collaboration across jurisdictions and with the research community has enabled a coordinated approach to addressing impacts to airport infrastructure with site specific adaptation strategies being applied to each airport. The main cause of damage to marine infrastructure is the occurrence of strong waves associated with the passing of storms. Damage often occurs during extreme conditions, which are rare but very intense, and result in the combination of several phenomena (e.g. strong waves and extreme water levels) caused by the overlapping of spring tides and storm surges. Studies are underway to precisely quantify the vulnerability of Nunavik marine infrastructure to climate change. Permafrost mapping is also being integrated into land use planning to inform climate smart infrastructural developments and community expansion in some communities. The study identified a lack of vulnerability assessments in the delivery of municipal services, such as community drinking water and sewage systems. There is thus a need to identify and assess solid waste management options in a changing northern environment, with consideration of aspects such as waste capacity levels,

storage impacts, and how permafrost and solid waste interact including the extent of the associated impacts. The facilitation of greater knowledge transfer between researchers and decision-makers can aid to further mainstream adaptation into infrastructure design, construction, and maintenance.

- **Health and Well-being**

The Health and Well-being sector was fairly active in adaptation, especially with respect to research and monitoring initiatives. No comprehensive adaptation plans for regional health authorities were documented. One third of initiatives explicitly included Inuit knowledge; additional integration would help to improve initiative uptake and effectiveness. Existing programs such as community freezers, hunter support, and community-based pathogen and contaminant monitoring are important in increasing adaptive capacity to climate change impacts in the region. Local agriculture programs such as community run greenhouses and hydroponics are already in place in some communities, among other initiatives aimed at increasing access to fresh and affordable foods. Food security and diet concerns could be additionally addressed by expanding these programs across communities, improving access to healthy store foods, and exploring a National Inuit Food Security Strategy with consideration of the climate change context. Limited initiatives addressing the specific physical and psychosocial health impacts of climate change were documented. Furthermore, there were no adaptations that addressed regional or local emergency response systems given the impacts of climate change on land and marine based travel.

- **Business and Economy**

The Business and Economy sector was not highly active in adaptation. While several broad federal initiatives existed within this sector, only four initiatives within this sector were implemented at the regional scale. Additional localized studies and initiatives would help to develop regional- and community-level adaptive capacity in Nunavik. Examples of such initiatives could include increasing the availability of adaptation best practices information and decision-making support tools. Given the potential opportunity for increased wage based employment through growth in the mining and tourism sector, efforts to better integrate subsistence activities with wage-based employment would assist Nunavimmiut in maintaining traditional adaptive capacities. Given that the systematic review methodology for this study relied heavily on online reporting, future evaluations of adaptations within this sector should focus greater resources on (private sector) stakeholder interviews.

- **Culture and Education**

The Culture and Education sector was the least active in adaptation. The erosion of traditional knowledge, land-based skills, and other Inuit cultural traditions are identified as important adaptive capacity barriers; community programs such as land skills training programs that foster inter-generational relationships and cultural preservation have therefore been highlighted as key avenues to building Inuit adaptive capacity. Community-level programming and research through the Avativut project plays a large role in addressing these concerns; however, establishing novel programs and extending existing programs promoting traditional knowledge transmission would further aid in increasing community adaptive capacity.

- **Hunting and Subsistence Harvesting**

Relatively few adaptation initiatives were documented within the Hunting and Subsistence Harvesting sector; the majority of initiatives were autonomous, with individuals undertaking adaptive changes in their own lives. Additional community-based programs improving weather and environmental conditions information and dissemination would assist residents in adapting to environmental risks. Capacity building programs based on the establishment of emergency prevention and preparedness measures, as well as disaster recovery measures for communities would serve to enhance adaptive capacity. Further research into climate change vulnerabilities and impacts on species biodiversity and Arctic ecosystems, and adaptive species substitution, would help to inform species substitution strategies.

- **Institutional and Resource Management**

This sector was the second most active in adaptation, which is noteworthy since institutions are a critical determinant of adaptive capacity. While comprehensive adaptation frameworks or plans exist at both the federal and provincial scales, no comprehensive adaptation plans were documented at the regional or community level. As such, creating a regional climate change adaptation action plan would help the region and communities to efficiently adapt to climate change. Continued discussions among stakeholders, particularly Inuit stakeholders, should be continued to improve adaptation coordination and efficiency. Lastly, further integration of Inuit knowledge into resource management regimes and adaptation plans and policies may help to improve adaptation uptake and implementation.

- **Intersectoral**

While select climate change impacts can be addressed by a single sector, many climatic factors affect several sectors and therefore require a coordinated intersectoral adaptation response. Accordingly, almost 20% of documented initiatives were classified as Intersectoral efforts. Multiple comprehensive adaptation plans or frameworks intended to inform and coordinate adaptation initiatives were documented; creation of such initiatives at regional and community scales would serve to increase adaptive capacity in Nunavik. Several adaptation guidebooks and risk assessment frameworks, as well as climate change and adaptation programs, information portals and databases were documented. Additional community-level initiatives would help to build community resilience and adaptive capacity. By working at a regional scale and enabling links between various researchers, decision-makers and end-users, Ouranos' Northern Environment Program provides an example of a platform that can be leveraged to encourage innovative multidisciplinary, multi-organizational dialogue. These interactions promote adaptation initiatives at the local level by taking into account regional considerations. Lastly, it is important to note that existing socioeconomic, health, and infrastructural disparities in Nunavik will need to be addressed through coordinated actions in order to optimize adaptation initiatives.

Chapter 1: Introduction

Over the last several decades, the Arctic has witnessed transformative changes in climatic conditions, with further changes projected for the future (Comiso and Hall 2014; Larsen et al. 2014; Jeffries et al. 2015). Climate change impacts in the Arctic are amplified by between 1.5 and 4.5 times the global mean warming (Holland and Bitz 2003; Allard and Lemay 2012; Ouranos 2015). In addition to warmer air temperatures, other documented impacts in Arctic regions include rising sea levels; higher ocean temperatures; and increased frequencies and magnitudes of extreme events, such as flooding (Comiso and Hall 2014; IPCC 2014; Jeffries et al. 2015; Ford et al. 2016a). Such climate change effects have wide-ranging implications on Arctic human and natural systems, including transforming land-based travel, threatening infrastructure integrity, increasing disease prevalence, and altering the health and abundance of a variety of wildlife species (Furgal and Seguin 2006a; Lemmen et al. 2007; Arctic Council 2013; Champalle et al. 2014; Larsen et al. 2014; Jeffries et al. 2015; Ford et al. 2016a).

In addition to the amplified climate change impacts in the Arctic, Inuit populations in Canada are highly sensitive to, and disproportionately affected by, climate change risks (Furgal and Seguin 2006a; Larsen et al. 2014; Austin et al. 2015; Ford et al. 2016a; Government of Canada 2016). This sensitivity reflects, in part, Inuit living in small remote communities; dependence on subsistence harvesting for livelihoods and food security; reliance on sea, lake, and river ice for transportation and hunting; and strong cultural and emotional links to the environment (Furgal and Seguin 2006a; Willox et al. 2013a; Government of Canada 2016). Furthermore, the socio-economic and health disparities that often exist among Inuit populations can increase climate change vulnerability (Ford et al. 2010a; Ford and Berrang-Ford 2015). Inuit have already documented negative impacts of climate change, including decreased food security, increased danger when engaging in subsistence harvesting activities, compromised wild food safety, and psychosocial consequences associated with limited abilities to participate in traditional cultural activities (Furgal and Seguin 2006a; Lemmen et al. 2007; Ford 2009; Ford et al. 2010d; King and Furgal 2014; Willox et al. 2015a).

Given the risks posed by climate change, mitigation strategies targeting reducing greenhouse gas emissions have been a major focus of government climate policies in Canada and globally (IPCC 2014; Ford et al. 2016a). However, despite efforts to reduce greenhouse gas emissions, projections suggest that some degree of climate change impacts on ecological and human systems is inevitable (IPCC 2014). As such, a coordinated response of mitigation measures and adaptation initiatives is needed in order to minimize the already observed and projected negative impacts of climate change (Ford et al. 2010d, 2011b; Lesnikowski et al. 2011; Ford and Pearce 2012; Champalle et al. 2014; Government of Canada 2016). Since the early 2000s, multiple northern-focused adaptation programs have been established by communities, Indigenous organizations, researchers, and government departments (Health Canada; INAC 2009, 2010; Ford et al. 2011b, 2014a; Pearce et al. 2012; Champalle et al. 2014; Government of Canada 2016). In addition to these formal adaptation actions, autonomous measures have been documented by household and community members throughout the Inuit Nunangat (Nickels et al., 2006; Labbé et al. 2017).

With the increased availability of adaptation-related funding, as well as the recent release of the Pan-Canadian Framework on Clean Growth and Climate Change (Government of Canada 2016), which includes adaptation as a framework pillar, implementation of adaptation initiatives in Canada is expected to increase in the coming years (INAC 2009; Berrang-Ford et al. 2011; Ford et al. 2011b; Champalle et al. 2014). Nevertheless, research examining adaptation progress is in its infancy, albeit rapidly developing, consisting primarily of qualitative project-level case-studies (Berrang-Ford et al. 2011; Lesnikowski et al. 2011, 2015; Pearce et al. 2011a; Ford and Berrang-Ford 2015; Lwasa, 2015; Robinson, 2015; Labbé et al. 2017). As such, there is a very limited understanding of how or if adaptation is taking place. Comprehensive adaptation inventories using systematic approaches are needed to assess the breadth and adequacy of the adaptation response, to inform adaptation strategy development, and to track adaptation over time (Preston et al. 2011; Ford and Berrang-Ford 2015). Such synthesis work is particularly important for exchanging insights from different Arctic regions, and for informing community- and regional-level adaptation planning and policy (Berrang-Ford et al. 2011; Lesnikowski et al. 2011; Ford and Pearce 2012; Dupuis and Biesbroek 2013; McDowell et al. 2014).

In light of this gap, the study uses a systematic methodology—pioneered by the team in a global context (Lesnikowski et al. 2011, 2016; Ford et al. 2013; Ford and Berrang-Ford 2015), and also applied in Nunavut (Labbé et al. 2017) and Canada more generally (Austin et al. 2015)—to provide a better understanding of the current state of climate change adaptation in Nunavik, Canada since 2010. It serves as an update to the "What we know, don't know, and need to know about climate change in Inuit Nunangat" report funded by the Department of Indigenous Northern Affairs (INAC) Climate Change Adaptation Program (Bolton et al. 2011). This initial study was conducted to synthesize research from all Inuit regions to pinpoint current and future exposure sensitivities to climate change, enablers and barriers to adaptive capacity, and knowledge gaps in the available literature. This report highlighted that climate change was already impacting a wide variety of sectors in Nunavik and that adaptations at many scales were already in progress. Key findings included the need to improve weather prediction in communities, research climate change impacts on health and well-being, support local business development, facilitate the transmission of local knowledge, and establish management structures to ensure Inuit involvement in climate change adaptation at all scales.

While the previous study focused primarily on climate vulnerability, the current study is intended to update the results to 2017 for Nunavik, and turns its focus towards the state of adaptation in Nunavik, how these adaptations compare to the risks posed by climate change, and lastly, adaptation research, policy, and implementation gaps. The report findings are intended to inform the development of a Northern Adaptation Strategy commissioned by the Department of Indigenous and Northern Affairs Canada. Furthermore, given the increased adaptation needs and growing interest at all levels of government, the findings outlined in this report are particularly pertinent and could inform decisions regarding adaptation policy and programming necessities, as well as resource distribution and prioritization.

This study uses reporting on adaptation in the grey (not peer-reviewed) and peer-reviewed literature published between 2010 until March 31st 2017 as a proxy for documenting adaptations that are underway or have been recommended within this period. Relevant key informants from

the provincial and regional governments and academic institutions also validated findings. Figure 1.1 below depicts the geographic region of focus, Nunavik.

Figure 1.1: Map illustrating 14 communities in Nunavik, Québec. (Makivik Corporation, n.d.).

1.1 Study region: Nunavik

The James Bay and Northern Québec Agreement (JBNQA), the first modern land claims agreement of its kind, was signed in 1975, and led to the establishment of Nunavik (Rodon & Grey, 2009). A vast territory spanning roughly 500,000km^2, it compromises one third of the landmass of the province of Québec, north of the 55th parallel (Makivik Corporation, 2017a). Nunavik is bordered in the west by Hudson's bay, Hudson's Strait in the north, and by Ungava Bay and Labrador in the east. It is a sparsely populated region inhabited by about 12,000 mostly Inuit residents (Nunavimmiut), living in 14 coastal communities scattered along the shores (Statistics Canada, 2015). All 14 communities are remote and not accessible by road.

Nunavik grapples with a number of socio-economic-health challenges and disparities when compared to southern Québec. The population growth rate is 2.6% per year, three-four times

higher than the national average, with 60% of the population below 25 years of age (Makivik Corporation, 2017b). The growing population, combined with limited and poor quality housing, has placed increasing pressure on the housing conditions with more than half of the community living in crowded conditions (Allard & Lemay, 2012). The region also suffers from epidemic tuberculosis, with an incidence 50-fold higher than the Canadian average (Lee et al., 2015). 60% of the total population aged 25 to 64 has no certificate, diploma, or degree, whereas 24% hold a high school diploma or equivalent (Statistics Canada, 2015). 56% of the Inuit of working age are not working, and the average underemployment factor is 26% (Duhaime et al. 2015). In light of the region's socioeconomic history, these issues play into the cycle of poverty that affects a disproportionate number of northern residents (compared to residents of southern Canadian communities), and these issues are compounded by a higher cost of living (Duhaime, 2008). These disparities contribute to Nunavik's increased climate change sensitivity; optimal climate change adaptation will therefore necessitate coordinated actions to respond to these wide-ranging disparities prior to specific adaptations (Furgal and Seguin 2006; Larsen et al. 2014; Austin et al. 2015; Ford et al. 2016a; Government of Canada 2016).

With the exception of Kuujjuaq and Puvirnituq, with their commercial and regional administrative functions, the economies of the communities largely depend on the public sector, subsistence hunting, and tourism. Employment and income generation is largely through the provision of services: 62% of all wage employment is in the public and para-public sectors, while 36% of all full time jobs are in the private and cooperatives sector (Chabot, 2003). The land and sea continue to provide Nunavimmiut with a source of nutrition and form a central part of livelihoods, cultures, and well-being (Chabot, 2003; Allard & Lemay, 2012; Duhaime et al. 1999). Dependency on the region's traditional wildlife resources, such as seal, whale, and caribou, for food, clothing and culture remains strong and has also been linked to reduced stress, increased productivity, and improved physical and mental well-being (Willox et al., 2013; Harper, et al., 2015).

Following the signing of the JBNQA [2], key institutions such as the Kativik Regional Government [3] (KRG) and Makivik Corporation [4] were created as components of the Kativik regional institutional structure (Bonesteel, 2006; Makivik Corporation, 2017a); collaborating with the federal and provincial government, they are instrumental in shaping the political, economic, social, legal and institutional systems of the Nunavik region.

[2] Refer to page 5 of Amiqqaaluta – Let Us Share. Mapping the Road Toward a Government for Nunavik. Report of the Nunavik Commission, March 2001 for a description of the institutional structures that were created following the JBNQA agreement

[3] The KRG is a non-ethnic public organization created in 1978, under the James Bay and Northern Québec Agreement. The organization has jurisdiction over nearly the entire territory of Québec north of the 55th parallel in areas such as municipal matters, transportation, the environment, policing, employment, labour training, income security, childcare services, renewable resources, land-use planning, civil security and economic development.

[4] Makivik is the Inuit owned entity mandated to administer and manage the Compensation provided to the Inuit of Nunavik in accordance with the James Bay and Northern Québec Agreement. Makivik's role includes the administration and investment of these funds and the promotion of economic growth by providing assistance for the creation of Inuit-operated businesses in Nunavik. Makivik promotes the preservation of Inuit culture and language as well as the health, welfare, relief of poverty, and education of Nunavik Inuit.

Chapter 2: Methods

This section outlines the systematic review methods used for this report.

2.1 Introduction

This report comprises a systematic review of grey and peer-reviewed literature related to climate change adaptation in Nunavik, Canada. The objective was to identify all climate change adaptation initiatives taking place in the region to provide a comprehensive picture of the adaptation landscape in Nunavik, as well as examine adaptation research, policy, and implementation gaps. A systematic review is a rigorous review process that is reproducible and transparent, and provides a clear method to extract and analyze data from the literature sources that are included in the review. The extracted data can be used to organize and identify gaps in knowledge (CRD, 2001). Systematic reviews have recognized value in addressing policy questions within a variety of disciplines, and have recently been adopted for use in the context of tracking and evaluating climate policy (Ford et al. 2013; Berrang-Ford et al. 2015). For the purpose of this study, "adaptation" was defined as *"the result of a deliberate policy decision, based on awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state"* (IPCC, 2014).

The systematic review methods were modelled based on those used in the initial gap analysis report (Bolton et al., 2011). The initial study's systematic process for identifying relevant peer-reviewed literature was replicated with the exception of a slightly altered search string to reflect the geographic focus on Nunavik, as well as searching an additional database to better capture all relevant articles. The initial gap analysis study used a combination of search methods to identify relevant grey literature documents, while this study used a systematic review process, similar to that used for peer reviewed literature, to identify all relevant grey literature documents. There was a heavier emphasis placed on documents published in French for this update as opposed to the initial analysis. Two regional workshops conducted in Kuujjuaq, Nunavik also informed the current study. The Climate Change and Clean Energy Workshop took place in October 2016 and involved representatives of the Kativik Regional Government (KRG), corporations, community organizations, the Government of Québec, as well as three federal government departments – Indigenous and Northern Affairs Canada (INAC), Environment and Climate Change Canada (ECCC), and Natural Resources Canada (NRCan) to ensure that renewed climate change adaptation programs reflect the needs and priorities of Indigenous Northerners. Health Canada also made significant contributions to the workshop. The second workshop was a knowledge transfer workshop that took place in February 2017 and involved representatives from KRG, Ministère des transports, de la mobilité durable et de l'électrification des transports (MTMDET), as well as scientists from the Centre d'études nordiques (CEN) of the University Laval, Ouranos, the Institut national de la recherche scientifique (INRS), and the Nunavik Research Centre of Makivik Corporation. The focus of the workshop was to share knowledge and best practices for the development of adaptation strategies by the MTMDET for transport on permafrost in Nunavik. Additionally, informational meetings with relevant key informants from the public, private and academic circles were conducted to validate the completeness and accuracy of the results captured by the systematic review, and identify any documents that were not initially identified.

2.2 Research protocol

The systematic review began with the development of a research protocol that identified the project's background information, research questions, and search strategy. Although systematic reviews vary across disciplines, this study protocol's development process generally adhered to the guidelines published by the University of York's Centre for Research and Dissemination (CRD, 2001).

For the purpose of this study, "grey literature" was defined as *"document types produced on all levels of government, academics, business and industry in print and electronic formats that are protected by intellectual property rights, of sufficient quality to be collected and preserved by libraries and institutional repositories, but not controlled by commercial publishers"*; "peer reviewed literature" was defined as *"any manuscript published within a peer-reviewed scientific journal"* (Bradley, 2016).

2.3 Research questions

The study protocol identifies the following primary research question in order to establish a starting point for defining inclusion criteria: *What is the state of climate change adaptation policy and planning in Nunavik?*

Unlike many other systematic reviews, this report includes grey literature, and studies, reviews and editorials published in peer-reviewed academic journals. This approach was used in an attempt to comprehensively assess autonomous, research-based, government, and private-sector driven adaptation initiatives taking place in Nunavik.

The following sub-questions define the specific objectives of the project, and guided the development of the adaptation initiative survey:

a. *Who is adapting to climate change impacts in Nunavik, and who is initiating these adaptations (e.g. private sector, households, federal government)?*
b. *Where are adaptation initiatives taking place (geographic focus e.g, Kuujjuaq, Nunavik, Northern Canada)?*
c. *What factors (climatic and non-climatic) are motivating adaptation strategies (e.g. extreme weather events, economic stress)?*
d. *Which sectors report adaptation initiatives (e.g. business and economy, transport and infrastructure)?*
e. *What types of adaptation initiatives are being reported (e.g. research and monitoring, policy)?*
f. *At what stage of the adaptation process*[5] *is Nunavik at (e.g. groundwork or action)?*
g. *What is the status of adaptation initiatives (e.g. recommended, ongoing, complete)?*
h. *Are adaptation initiatives including Inuit knowledge?*

[5] Refer to Figure 2.2 (page 20) for a description of the adaptation process

Note: For the purpose of this report, the term 'Inuit knowledge' is used to include understandings of indigenous knowledge, aboriginal knowledge, traditional knowledge, Traditional Ecological Knowledge (TEK), and Inuit Qaujimajatuqangit (IQ), as well as contemporary Inuit knowledge and observations. Inuit knowledge encompasses knowledge (e.g. cultural and spiritual knowledge, hunting skills, food preparation, environmental knowledge, etc.) gained through collective experiences passed down through generations (Pearce et al. 2015a).

Consistent with the 2011 study, each of these questions will be addressed using a sectoral approach, by dividing adaptation initiatives according to the following sectors: Infrastructure and Transportation; Health and Well-being; Business and Economy; Culture and Education; Hunting and Subsistence Harvesting; Institutional and Resource Management; and Intersectoral. During the Climate Change and Clean Energy workshop, representatives of the regional government, corporations, community organizations, and the Province of Québec identified and prioritized areas for adaptation actions and classified them under the following categories: Food Security; Infrastructure; Transportation and Access to Land; Capacity-building; and Emergency Preparedness and Response. Given that the categories closely align with those used in the initial gap analysis, we chose to maintain consistency with the sectors used in the 2011 study.

Given Nunavik's size, as well as the resource and capacities available, the majority of adaptation initiatives in the region represent collaborative efforts between sectors. For example, an adaptation initiative addressing sea ice travel incorporates elements from the Infrastructure and Transportation, Culture and Education, and Hunting and Subsistence Harvesting sectors). Thus, initiatives were classified within the sector that was most pertinent for that particular initiative; in the case that it was not possible to classify an initiative within a single sector, the initiative was classified as Intersectoral (e.g. Adaptation Platform Webinar Series).

2.4 Inclusion and exclusion criteria

The inclusion and exclusion criteria applied when selecting source documents from both the grey and peer-reviewed literature are found in Table 2.1.

Table 2.1: Inclusion and exclusion criteria applied when selecting source documents

Inclusion criteria	Exclusion criteria
Substantial focus on Nunavik	No substantial focus on Nunavik
Peer-reviewed article; government/non-governmental organization/not-for-profit organization/research network/private sector/ research organization/professional association document or webpage; technical documents; adaptation plans; or national/regional/provincial/ community reports or adaptation assessments.	Documents outlining vulnerability or adaptive capacity assessments; editorials; meeting or conference proceedings; or abstracts.

Climate change as the overarching adaptation focus	Does not explicitly address or mention climate change as the overarching adaptation focus or addresses climate change mitigation
Focus on human adaptation initiatives to experienced or anticipated effects of climate change	Focus on non-human adaptation efforts (i.e. adaptations in natural systems), climate change mitigation efforts, or future climate projections
Consideration of changing future hazards and vulnerabilities	Addresses current or past climate risk without a consideration of how risk will change in the medium- and long-term future
Practical focus (i.e. provides details on a discrete adaptation initiative)	Conceptual focus (i.e. description of the problem and potential hazards)
English or French	Neither English nor French
Published in or after 2010	Published before 2010
Indexed by Google, Web of Knowledge, Scopus, PubMed, Geobase	Not indexed by Google, Web of Knowledge, Scopus, PubMed, Geobase

2.5 Search strategy

2.5.1 Grey literature

Grey literature source documents were primarily identified online through a systematic Google web search using the following search string: (intitle:adaptation OR intitle:adaption OR intitle:adapting OR intitle:coping OR intitle:response OR intitle:responding AND ("climate change" OR "climatic change" OR "global warming" OR "environmental change"); an additional field was included and modified according to the type of stakeholder being researched. Added to the search string with the Boolean operator AND, this field consisted either of websites (e.g. site:gc.ca), or names of communities or private sector entities for those stakeholders that did not have a website. All fourteen communities were included in the study: the communities' English and Inuktitut names were used as search terms.

To manage the large number of search results obtained through Google, adapted the search methodology was adapted from Panic and Ford (2013). Firstly, the first 30 results were reviewed: the webpage or linked document was screened according to the inclusion and exclusion criteria. In some cases, reviewing the title or executive summary was sufficient to assess suitability; while in others cursory full-text review was necessary. Following the first 30 results, subsequent results were reviewed until 15 irrelevant consecutive results were reached. At this point, 50 results were skipped then an additional 5 results were reviewed. If all 5 results were irrelevant then an additional 50 results were skipped; if one of these 5 results was relevant, all subsequent results were reviewed until another 5 irrelevant consecutive results were reached. This process was continued until a maximum of 400 results were scanned or until the end of the search results.

Each result that was identified as relevant was subsequently reviewed in more detail; duplicates or those that did not meet the inclusion criteria were excluded. To ensure a comprehensive dataset, the remaining sources were used as the basis for a secondary backward citation-tracking search to identify additional adaptation-related webpages and documents (Berrang-Ford et al. 2015). All reviewed sources were stored in Zotero™ (version 4.0) digital information-managing library.

2.5.2 Peer-reviewed literature

With input from university librarians, four databases were selected to search: Scopus, Web of Knowledge, PubMed, and GeoBase. These databases were chosen to ensure a comprehensive search that included literature from a wide variety of disciplines.

For each database, the search string consisted of geographic place names and qualifier terms outlined in Table 2.2, to reduce the incidence of unrelated search results. The publication cut-off dates, spanning 2010 to 2017, limited the search to up-to-date articles.

Table 2.2: Search terms applied to each database

Timeframe	January 1st 2010 to March 31st 2017
Geographic terms	Nunavik, Akulivik, Aupaluk, Inukjuak, Ivujivik, Kangiqsualujjuaq, Kangiqsujuaq, Kangirsuk, Kuujjuaq, Kuujjuarapik/ Whapmagootsui, Puvirnituq, Quaqtaq, Salluit, Tasiujaq, Umiujaq, Fort Chimo, Port Harrison, Wakeham Bay, Payne Bay, Bellin, Great Whale, Sugluk
Qualifiers (english)	adapt*, coping, response, responding, climate change, climatic change, global warming, environmental change, resilience, intervention, cope, adjust, modif*, react*, transform*, impact, action*, groundwork, participatory, plans, planning, policy, capacity building, intervention, acclimatization, traditional knowledge
Qualifiers (french)	adapt*, réponse, répondre, changement* climatique*, réchauffement climatique, changement environnemental, résilience, intervention, modifi*, réagi*, transform*, action*, préparation, participatif, plan, politique, capacités d'adaptation, intervention, acclimatation, savoir écologique, savoir traditionnel, savoir local
Search string with Boolean operators	TS= ("climat* change*" OR "global warming" OR "environmental change") AND TS= (nunavik OR akulivik OR aupaluk OR inukjuak OR ivujivik OR kangiqsualujjuaq* OR kangiqsujuaq OR kangirsuk OR kuujjuaq OR kuujjuarrapik OR whapmagootsui OR puvirnituq OR quaqtaq OR salluit OR tasiujaq OR umiujaq OR kawawachikamach) AND TS= (adapt* OR resilien* OR interven* OR respon* OR cope OR coping OR adjust* OR modif* OR react* OR mitigat* OR transform* OR impact OR action* OR groundwork OR innovation* OR participatory OR plans OR planning OR policy OR policies OR "capacity building" OR intervention* OR acclimat* OR "traditional knowledge")

Figure 2.1 depicts the flowchart detailing the search and screening steps. The screening occurred in two phases. In the first phase, the title and abstract of each document were read and assessed according to the inclusion criteria. In the second phase of screening, the remaining articles were fully read to determine inclusion. A citation 'snowball' search of these journal articles, whereby the works cited of all included articles are screened for additional relevant articles, was then conducted to ensure search comprehensiveness.

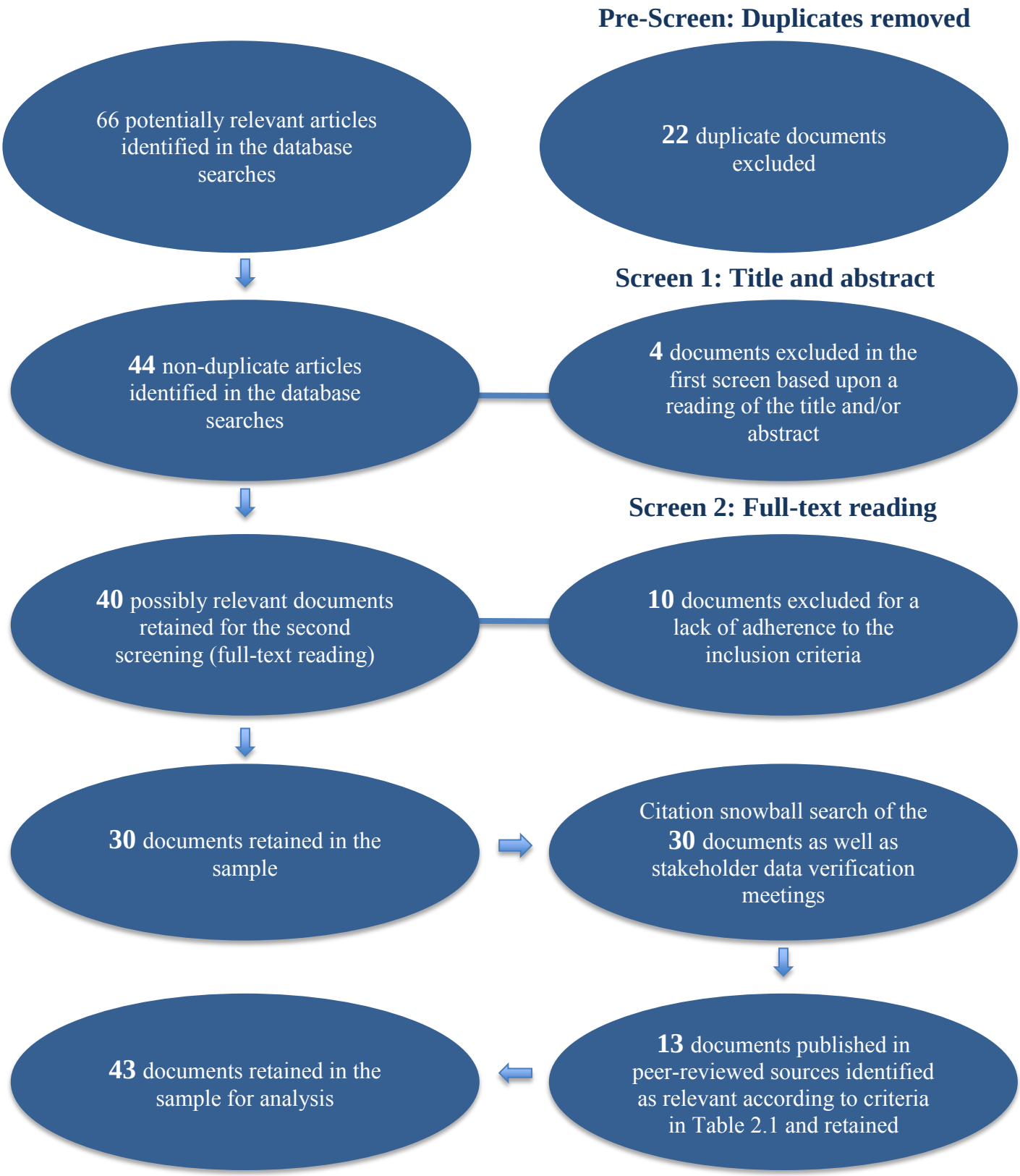


Figure 2.1: Flowchart of peer reviewed search procedures

2.6 Data extraction

Once all relevant sources were retrieved, data from each discrete reported adaptation initiative were quantitatively and systematically extracted using a detailed codebook (see Appendix II). The analytical focus was on 'discrete adaptation initiatives' (Lesnikowski et al., 2011, 2013); multiple adaptations initiatives within a single webpage or document were coded individually.

An online questionnaire consisting of fixed, forced questions reflecting each codebook indicator was derived from the codebook to standardize analysis. Initiatives were categorized by: document title, stakeholders, publishing year, type of source document, entry title, collaboration involved, stakeholder type, geographic focus, scale, sector, climatic and non-climatic factors motivating adaptation, importance of climate-related factors in motivating adaptation, adaptation typology, level, and inclusion of Inuit knowledge in adaptation, and initiative status. All parties involved in adaptation initiative design, funding, implementation, and research were listed under stakeholders; stakeholders were determined based on author affiliations, acknowledgements, and logos included within the document. These stakeholders were then organized into specified categories to gain a descriptive understanding of the types of collaborative relationships that characterize involvement in adaptation initiatives in Nunavik (see Appendix II).

As displayed in Figure 2.2, effective adaptation often occurs through a process of awareness, preparation, implementation and iterative learning vis-à-vis the varying complexities and uncertainties surrounding climate change (Eyzaguirre & Warren, 2014). The ability to characterize which levels of adaptation actions, and which type of actions are most identified by regions/communities as needed to advance adaptation, is crucial to evaluate best practices and lessons learned (Biagini et al. 2014).

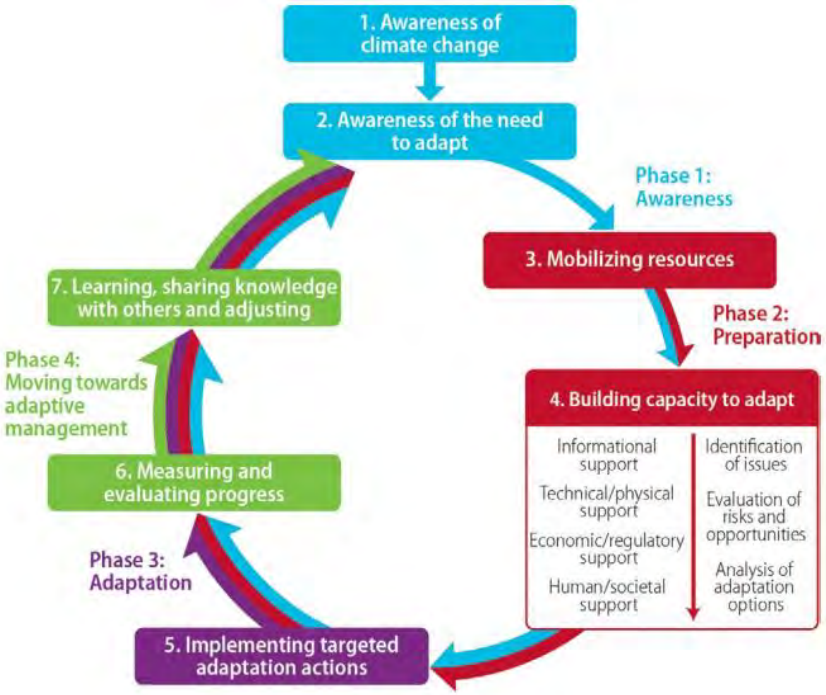


Figure 2.2: Phases (1 to 4) and stages (1 to 7) in the adaptation process (Eyzaguirre and Warren, 2014)

Adaptation initiatives were therefore categorized by level, whereby groundwork initiatives constituted preliminary steps that inform and prepare adaptation, while actions directly reduce vulnerability through tangible steps taken to alter institutions, policies, programs, or built environments in response to predicted or experienced climate change impacts (Lesnikowski et al., 2011). Using Figure 2.2 for reference, stages 1 to 4 and 6 highlight groundwork initiatives whilst stages 5 and 7 are reflective of action initiatives. Initiatives were further categorized according to nine adaptation typologies described in Table 2.3 (Biagini et al. 2014; Lesnikowski et al. 2015).

Table 2.3: Adaptation typology definitions used to classify adaptation initiatives

Adaptation phase	Adaptation typology	Definition
Ground-work (Stages 1 to 4 and 6, Figure 2.2)	Capacity building	• Equipping institutions, departments, or working groups with the capacity to adapt by identifying best practices and developing tools • Conceptual tools such as modeling programs, strategic guidelines, plans, and frameworks that guide adaptation, as well as vague statements and concepts (e.g. flood risk management, drought strategy) • Networking and idea sharing (e.g. meetings, workshops, conferences) • Does not include legally binding-goals, objectives, or priorities
	Monitoring and evaluation	• Adaptation initiative performance monitoring; includes evaluations of the extent to which initiatives are decreasing climate change risks • Evaluating the integration of climate change perspectives in existing programs and measures
	Research and monitoring	• Research and development for adaptation, impact/vulnerability assessments, and tracking environmental or atmospheric conditions • Surveillance and monitoring systems that inform authorities about notifying the public about elevated risks (e.g. weather stations that monitor and predict temperatures, used in heat warning systems)
Action (Stages 5 and 7, Figure 2.2)	Information sharing	• Systems for communicating climate information to facilitate adaptation (e.g. information databases, education campaigns) • Early warning systems that inform communities of extreme events and provide information on proper responses (e.g. storm warning systems)
	Infrastructure, technology, and innovation	• New or improved physical infrastructure or technology (e.g. buildings, construction, climate-resilient technologies) aimed at providing direct or indirect protection from climate change risks
	Management and planning	• Incorporating understanding of climate science, impacts and vulnerability into government planning and management • Creation of government agencies, departments, working groups, or ministries with mandates that address climate change adaptation

	Policy	• New or revised policies, regulations, rules, laws, or statutes to allow flexibility to adapt to climate change
	Practice and behaviour	• Revisions or expansions of practices and on the ground behaviour that are directly related to building resilience to climate change impacts.
	Resource transfers and financial support	• New financing or insurance strategies to facilitate adaptation • Funding for autonomous adaptation research and actions at other jurisdictional levels (e.g. local initiatives)

To provide a more accurate portrayal of the adaptation landscape, a combination of status and level indicators was used. Status indicators are complete, ongoing, recommended or planned, while level indicators are action or groundwork. For example, an initiative recommending infrastructural changes would be categorized as 'Recommended' for status and 'Action' for level.

All sources were double coded to ensure consistency. A Microsoft Excel database of adaptation initiatives was created; each row in the database represented a discrete adaptation initiative, with indicators organized by column.

2.7 Data verification

As mentioned in Chapter 2 (section 2.1), two regional workshops held in Kuujjuaq (Nunavik) aided in capturing autonomous adaptation initiatives. The three-day Climate and Clean Energy workshop brought together representatives from all levels of government. It gathered input from Northerners on their priorities and needs regarding climate change adaptation (Stratos Inc 2017). The second workshop aimed at sharing results from research taking place on climate change and adaptation on infrastructures (terrestrial and marine) in Nunavik with a focus on permafrost and ice-monitoring. The findings from these workshops were used to supplement the information from the peer reviewed and grey literature.

Additionally, information meetings were held with relevant stakeholders from the provincial, regional, and community governments, the private sector, and academic institutions to present preliminary results in order to ensure the completeness and accuracy of the database, and identify any additional literature sources or adaptation initiatives that were not captured by the systematic review process. Each stakeholder was presented a summary of documented initiatives from the review that were relevant to their agency or field of work, and requested for feedback on inaccurate or missing information. In order to maintain consistency in the methodology, initiatives recommended by key informants were only included in the database if they were supported by documentation that met the inclusion criteria outlined in Table 2.1.

2.8 Limitations

The identification of adaptation initiatives was limited to material that was documented and publically accessible. This was an issue when searching for private-sector adaptation initiatives;

few documents were identified through searches identifying any private-sector adaptation initiatives. This limitation also applied to those adaptations that lacked English or French written documentation. Search comprehensiveness is also a limitation for any adaptation tracking study (Berrang-Ford et al. 2015). This review therefore represents a proxy sample rather than an exhaustive list of all adaptation initiatives occurring in Nunavik.

As a result of the search strategy, adaptation initiatives that were not directly framed as adaptation or within the context of climate change may not have been captured. Similarly, by focusing on policies that are substantially and intentionally designed for climate change, initiatives seeking to address the broader determinants of climate vulnerability (i.e. poverty reduction initiatives) may have been missed (Dupuis and Biesbroek 2013). As discussed in Section 2.3, given Nunavik's size, as well as the resources and capacities available, the majority of adaptation initiatives in the region represent collaborative efforts between sectors. Consequently, future research should examine the potential for Inuit-designed systematic review methodologies that recognize climate change adaptations as integrated approaches to addressing a broad range of climate vulnerability determinants.

It is important to note that while the inclusion criteria (Table 2.1) necessitated that adaptation initiatives included in the database have a substantial focus on Nunavik, it was difficult to determine whether some broader scale initiatives (i.e. national, provincial) would have a direct impact on Nunavik. In these cases, an initiative was included if it was intended to impact decision-making or programming at the broader governance and resource-availability scales. Future updates on this report would therefore benefit from distinguishing the applicability and impact of these higher-level initiatives (federal and provincial) at the regional and/or community scales. Similarly, while information on the different stakeholder categories involved in initiatives illustrates the importance of collaborations in adaptation planning and programming, detailed information regarding the type of contribution by stakeholder (ex. by way of authorship, funding, mandating, coordinating etc.) was not captured consistently over the breadth of initiatives (n=675) catalogued.

All of these challenges have been noted in the broader scholarship on adaptation tracking (Ford and Berrang-Ford 2015) and underpin the framing of the work as providing a baseline characterization of adaptation in the region. Nevertheless, by including grey literature, workshops held in 2017, and key informant validation meetings in the search, most adaptation initiatives that have been undertaken in Nunavik since 2010 were likely captured within the database.

Chapter 3: Climate change adaptation in Nunavik

3.1 Introduction

This chapter provides a comprehensive overview of the adaptation landscape in Nunavik. The first two sections, section 3.2 and 3.3, detail the number of adaptation initiatives published over time and provide a description of who is involved in adaptation. Adaptation initiatives are then addressed according to where they are occurring: section 3.4 illustrates the geographic region (ex. name of community) and the scale of implementation. The following section 3.5 then summarizes the characteristics of adaptation initiatives occurring within Nunavik. This includes the factors (climatic and non-climatic) that are motivating adaptation response, the types of adaptations that are taking place, and the current status of adaptation initiatives[1]. Inclusion of Inuit knowledge in adaptation initiatives is examined in section 3.6. The chapter concludes with a discussion of climate impacts and sensitivities, current adaptation and future directions for each of the seven sectors: (i) Infrastructure and Transportation; (ii) Health and Well-being; (iii) Business and Economy; (iv) Culture and Education; (v) Hunting and Subsistence Harvesting; (vi) Institutional and Resource Management; and (vii) Intersectoral.

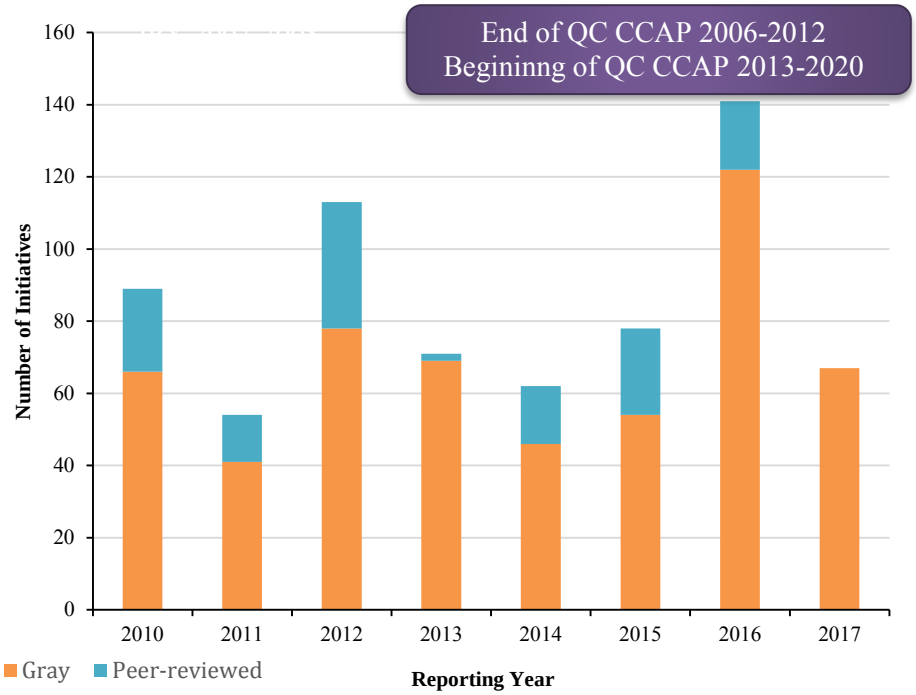
The results of the systematic review draw from the analyses of 97 webpages/grey literature documents and 33 peer-reviewed documents published since 2010. A total of 675 discrete adaptation initiatives were identified among these sources; 543 initiatives were identified from grey literature sources, while 132 initiatives were identified from peer-reviewed sources.

3.2 Temporal Variation in Adaptation Initiatives

This section addresses the number of adaptation initiatives documented over the years included in the study (January 2010 to March 2017). As shown in Figure 3.1, the number of published adaptation initiatives fluctuated yearly, with two major peaks in 2012 (17%, n=113), and 2016 (21%, n=141). The 2012 peak in adaptation initiatives was primarily attributable to the Government of Québec's 2006-2012 Climate Change Action Plan (CCAP) and Strategy for Adaptation. Lastly, in 2016, discrete initiatives were distributed across a larger number of documents; however, Inuit Tapiriit Kanatami's report 'Inuit Priorities for Canada's Climate Strategy: A Canadian Inuit Vision for our Common Future in our Homelands' and the Pan-Canadian Framework on Clean Growth and Climate Change substantially contributed to the 2016 peak in adaptation initiatives.

Note: While publishing year can be used loosely to deduce trends in adaptation activity over time, it is important to exercise caution in doing so, as reporting year does not necessarily equate to the year initiatives were implemented and nor does it take into account the duration of the initiatives. Specific information on year of implementation, completion, and initiative duration would be necessary to accurately represent the temporal variation in adaptation trends, however this information was largely unavailable in the literature reviewed.

[1] More detailed information on variables such as definitions and indicators can be found in Appendix II.



*Note: 2017 initiatives include those documented until March 31st

Figure 3.1: Number of discrete adaptation initiatives published by year according to literature source (n=675) *

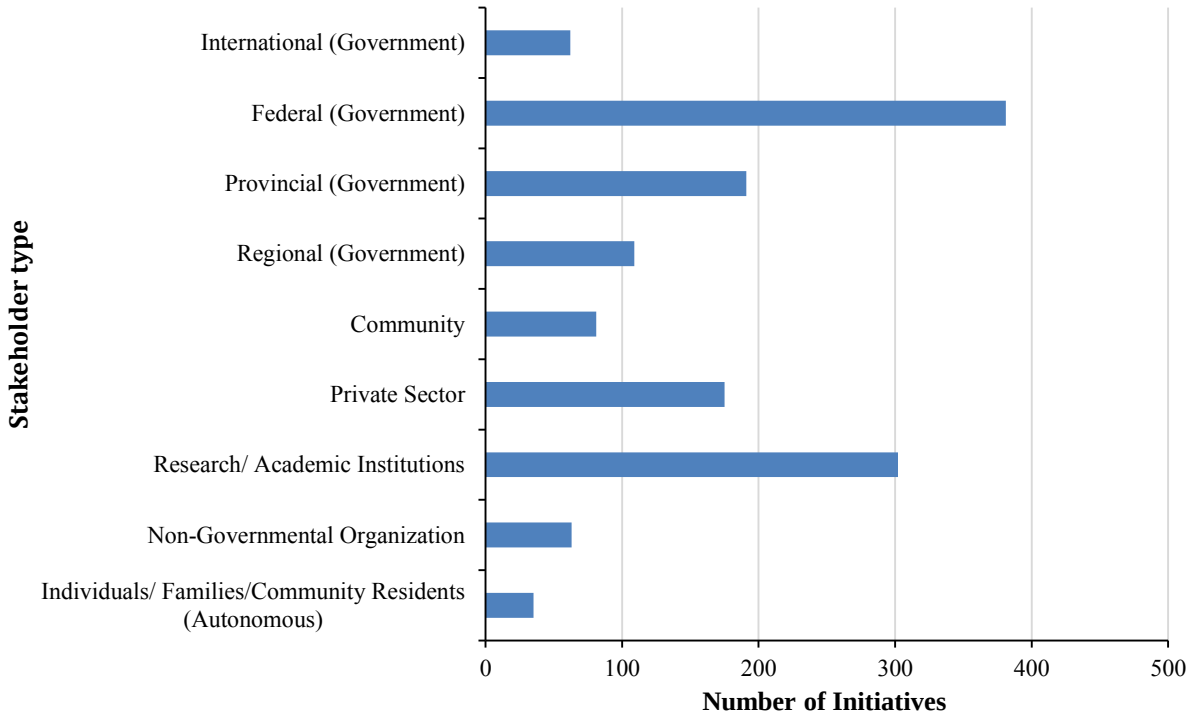
3.3 Stakeholders Involved in Adaptation Initiatives

This section gives a broad overview of the stakeholders involved in adaptation initiatives. In this context, 'stakeholder' is broadly defined as a party affiliated with adaptation initiative design, funding, implementation, or research; stakeholders were determined based on author affiliations, acknowledgements, and logos included within the source document. Figure 3.2 shows the breakdown of stakeholder categories across adaptation initiatives. Cross-scale coordination and leadership was very common, with 60% (n=320) of initiatives involving more than one stakeholder category. Such institutional coordination of adaptation across sectors and scales has been identified in general scholarship as important in bringing adaptation onto government agendas, and catalyzing coherence, coordination, and long-term planning (Biesbroek et al. 2010; Dickinson and Burton, 2011).

Federal involvement in Northern adaptation is guided by a broad range of legislation and other policy vehicles, for example the mandate of INAC specifically and more broadly the Adaptation Policy Framework (APF) which stipulates a primary threefold role for the departments of the federal government: generate and share knowledge; build capacity to adapt and help Canadians to take action; and mainstream adaptation. This framework outlines the general direction and justification for the importance of adaptation in federal level work and provides criteria for federal departments and agencies to consider when engaging with adaptation. The federal role in Nunavik has thus involved funding many of the regional and community-based adaptation initiatives documented here, and establishing northern focused adaptation programs or partnerships in different departments (e.g., INAC's Climate Change Adaptation Program, Health

Canada's Climate Change Adaptation in Northern First Nations and Inuit Communities, NRCan's Adaptation Platform Northern Working Group, the Northern Infrastructure Standardization Initiative etc.). Provincially, the Government of Quebec's Climate Change Adaptation strategy outlines priorities and objectives for adaptation, structured around building adaptive capacity, providing funding, and developing and supporting research, infrastructure and innovation related interventions. Regionally, public and private entities (such as the Kativik Regional Government and Makivik Corporation) contribute to increasing adaptive capacity by facilitating the coordination of federal and provincial initiatives at the local level and through capacity building and information sharing initiatives of their own. 79% (n=238) of the initiatives that reported participation of research or academic institutions involved collaborations with other stakeholder types.

Note: While information on stakeholder involvement can be used to deduce the importance of collaborations in adaptation planning and programming, detailed information regarding the type of contribution by stakeholder (eg. by way of authorship, funding, mandating, coordinating etc.) was not captured consistently over the breadth of initiatives (n=675) catalogued in this systematic review. Definitive conclusions regarding attribution and ownership of initiatives to specific stakeholder groups fall beyond the scope of this report. To elaborate on this using an example, an initiative mandated and funded by the Ministry of Transport but undertaken by a university-led research group would be documented as an initiative with both 'provincial' and research/academic institutions' involvement.



*Note: Categories are not mutually exclusive

Figure 3.2: Breakdown of stakeholder categories across adaptation initiatives (n=675)*

3.4 Geographic variation in adaptation initiatives

This section addresses where adaptation initiatives are occurring, both in reference to geographic focus and scale of implementation.

> Note: In this context, *geographic focus* represents the location where the adaptation initiative is occurring (ex. Québec-wide) whereas *scale* provides information on the extent of implementation according to the categories outlined by the scale variable in Appendix II (ex. province-wide). To elaborate on this difference using an example, the scale of an adaptation initiative may be categorized as 'community' wherein the geographic focus may be 'Quebec'; this would imply that the initiative is being implemented at the community level across all of Quebec.

As illustrated in Figure 3.3, the majority of adaptation initiatives were geographically focused on Canada as a whole (32% n=248) within which a focus on Nunavik was developed, Northern Canada (22%, n=166), or in one or multiple communities (21%, n=162). As found in the previous gap analysis study, reported adaptation also varied across communities (Bolton et al., 2011), with certain communities, such as Salluit and Umiujaq, emerging as leaders (Figure 3.4). This may have implications for communities if their adaptation needs are being overlooked.

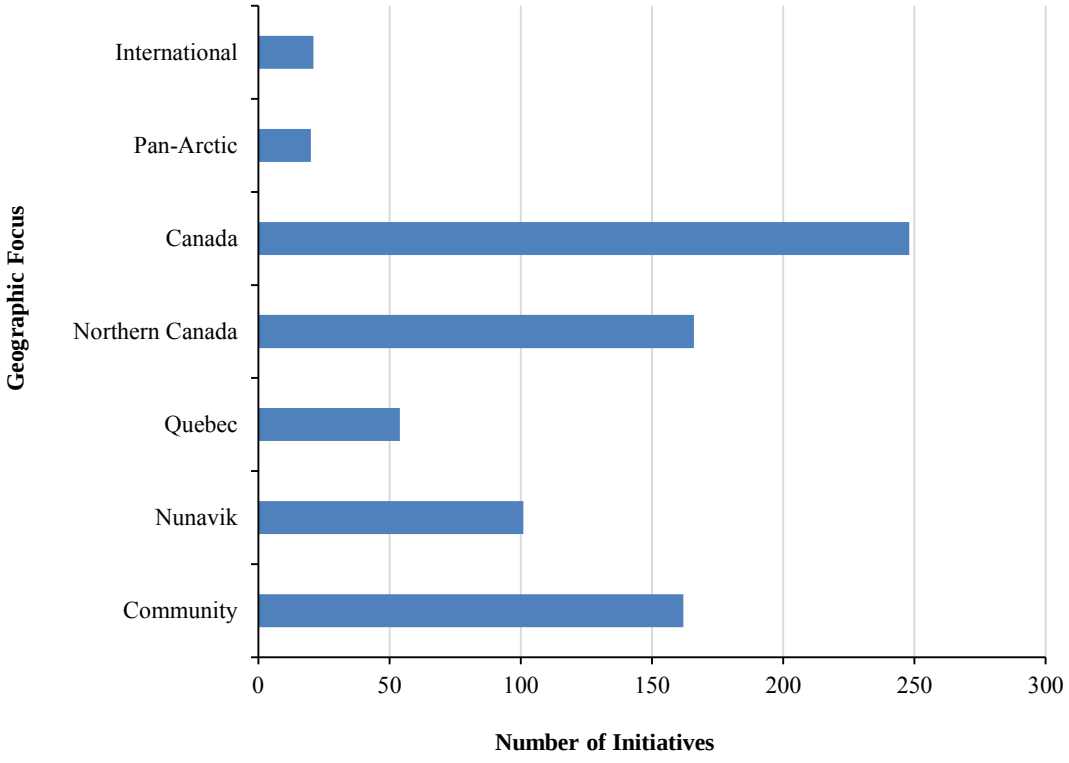
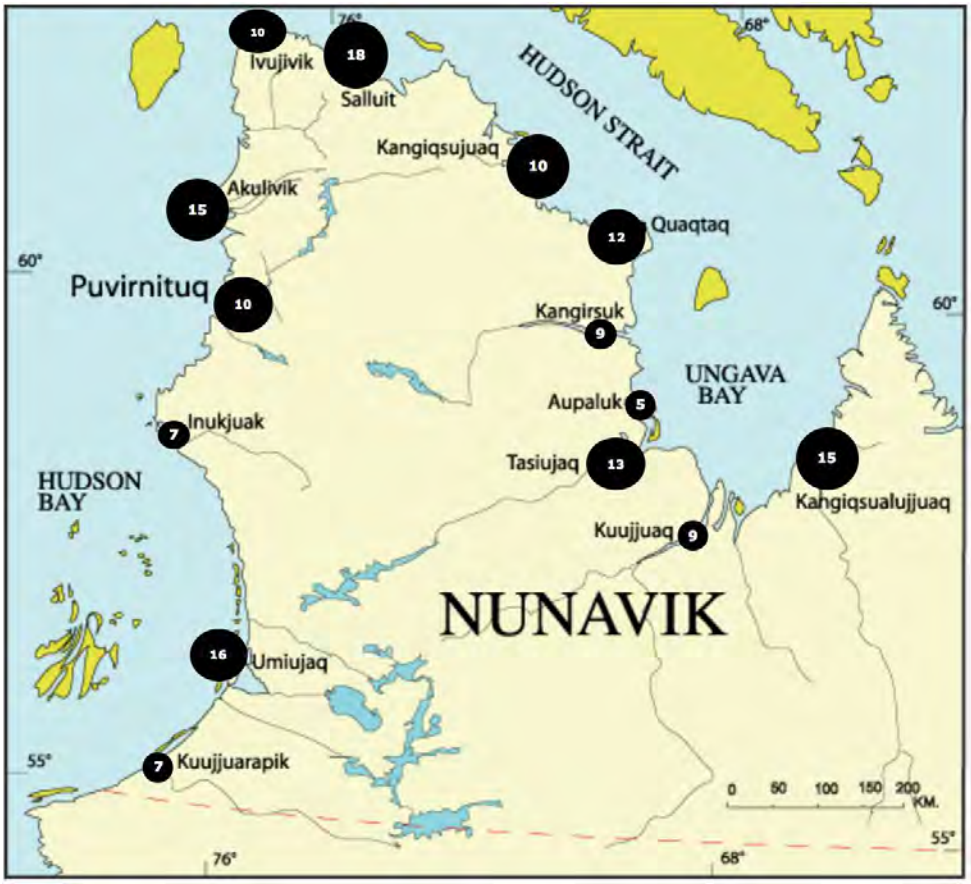


Figure 3.3: Adaptation initiative geographic region of focus



*Note: Categories are not mutually exclusive

Figure 3.4: Adaptation initiatives by community

Figure 3.5 illustrates that the majority of initiatives were being implemented at the national (39%, n=264), northern Canadian (15%, n=103), community (14%, n=97) and regional (12%, n=81) scales[6]. Community and regional level initiatives are critical to effectively building resilience and promoting adaptation (Pearce et al. 2011a; Bours and Pringle 2014; Loboda 2014). Moreover, local and regional-scale initiatives are more likely to progress faster towards adaptation (Arctic Council, 2013; Austin et al., 2015). Approximately a quarter (26%, n=147) of documented initiatives were implemented at the regional or community scale; this is important given that communities have varying exposure sensitivities and adaptive capacities. While this portrait of the adaptation landscape is promising, no regional or community specific adaptation plans were documented; this contrasts with findings from Nunavut, in which many communities have developed adaptation plans (Bolton et al., 2011; Labbé et al., 2017). Regional-level adaptation initiatives show an upward trend, which may indicate an increasing adaptation focus in Nunavik. Furthermore, within the Pan-Canadian Framework on Clean Growth and Climate Change, the government pledges to *"provide support for Indigenous communities to monitor climate change in their communities and to connect Traditional Knowledge and science to build a better understanding of impacts and inform adaptation actions"* (Government of Canada, 2016). This commitment may therefore lead to an increased number of initiatives being implemented at the regional and community-level.

[6] See note on page 28

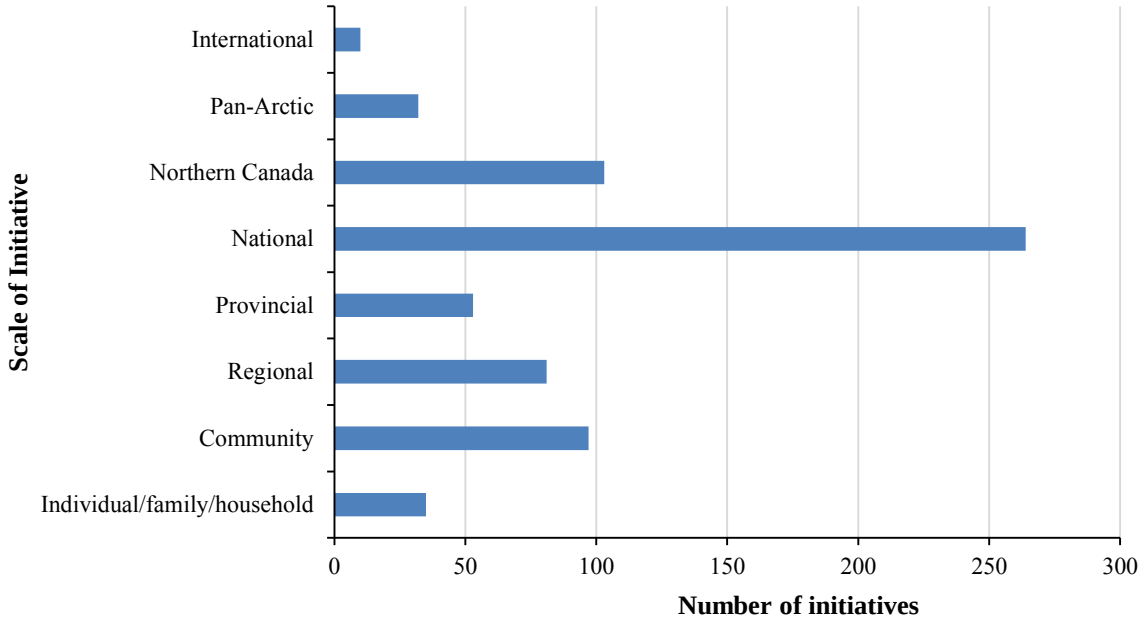


Figure 3.5: Scale of implementation for adaptation initiatives

Note: Federally administered initiatives that applied to Inuit Nunangat and provincially administered initiatives that applied to Quebec were included in the analysis due to the direct, indirect or potential impacts they may have on Nunavik. This justifies the comparatively higher number of initiatives documented at the federal and provincial compared to the regional jurisdiction. Caution should therefore be applied when interpreting results about stakeholder contribution to and scale of adaptation planning. Moreover, these results provide a baseline to contextualize and guide future research that should aim to understand which higher or broader scale initiatives and programs have Nunavik focused components.

3.5 Adaptation Initiative Characteristics

This section summarizes the characteristics of adaptation initiatives occurring within Nunavik. This includes the factors motivating adaptation initiatives, the type of adaptations taking place, and their current status.

A large majority (91%, n=615) of adaptation initiatives were motivated by both climatic and non-climatic factors: for example, the Kativik School Board's Avativut program was motivated by changing permafrost regimes, wildlife and plant dynamics, as well as cultural change and traditional lifestyles, human health (physical), and transportation. Following general climate-related impacts (63%, n=425), permafrost change (9%, n=58), wildlife changes (7%, n=48), sea ice changes (6%, n=40), and extreme events (4%, n=55) were the most common primary climatic factors motivating adaptation. Important non-climatic stressors included general non-climatic factors (23%, n=156), infrastructure and transportation (24%, n=161), human health (physical) (15%, n=100), and resource development (9%, n=63) as outlined in Table 3.1.

These findings support reports that adaptation in the Canadian Arctic is occurring in response to multiple climatic and non-climatic stimuli (Ford et al. 2014a; Labbé et al. 2017). Consistent with other adaptation tracking studies, many initiatives targeted a combination of climatic and non-climatic factors, with climatic changes being embedded within responses to other socio-economic and environmental challenges such as existing health disparities (Lesnikowski et al. 2011; Ford et al. 2014a; Labbé et al. 2017). This mainstreaming is of particular advantage in an Arctic context as it allows climate change to be integrated into ongoing policy priorities, such as increasing economic development and improving access to social services (Ford 2009; Berrang-Ford et al. 2011; Ford et al. 2014a, b). Nevertheless, given the projected magnitude of Arctic climate change impacts, the literature suggests that interventions targeting specific climatic drivers will be required to prepare and respond to climate change (Arctic Council 2013; Ford et al. 2014a).

Table 3.1: Primary climatic and non-climatic factors motivating adaptation initiatives

Climatic factor	Number of Initiatives & Frequency (%)	Example of adaptations (stakeholders involved)
General effects/impacts	425 (62.9)	Adaptation guide (ICLEI Canada, NRCan)
Permafrost change	58 (8.59)	Monitoring permafrost under Nunavik MTMDET owned airport infrastructure (MTMDET, CEN)
Wildlife changes	48 (7.11)	The Nunavik Arctic charr Database (ArcticNet, NRC)
Extreme Events	25 (4.38)	Natural Risk Prevention Framework (Québec Ministry of Public Safety) Storminess and Storms surged in Hudson and James Bay (Ouranos, NRCan, LaSalle Consulting, MTMDET)
Weather/environmental conditions uncertainty	22 (3.26)	Taking spare gas and food supplies when out hunting (Autonomous)
Sea level rise/coastal impacts	20 (2.96)	CanCoast Framework (NRCan, GC)
Sea ice extent/stability/ duration decline	20 (2.96)	Sea Ice monitoring (Glencore-Raglan, KRG, INRS)
Water supply and/or quality concerns	17 (2.52)	Development of a water table monitoring network (GQ)
Precipitation increase	15 (2.22)	Snow removal and sanding guide (Ouranos, KRG, Trent University)
Temperature increase	11 (1.63)	Best Practices Guidebook on Heat Alert and Response Systems (HC)
Indeterminate	7 (1.04)	N/A
Changing ocean conditions	4 (0.32)	Assess and perform projections of wave conditions in Nunavik (MTMDET, University of Québec at Rimouski)
Air pollution	2 (0.29)	Upgrading air quality station network (GQ)
Temperature decrease	1 (0.15)	Policy recommendation: Tools to allow Inuit regions to share knowledge for cold weather infrastructure design (ITK)
Non-climatic factor		
General factors	156 (23.1)	Climate Change Geoscience Program (NRCan)
Infrastructure	103 (15.2)	Guidelines for marine infrastructures design in a context

		of Climate Change (MTMDET, Ouranos, Trent University)
Human health (physical)	100 (14.8)	Website: Mon Climat Ma Santé (INSPQ)
Resource development	63 (9.33)	Regional Adaptation Collaboratives (NRCan)
Not Applicable	60 (8.89)	Establishment of a 100-m exclusion zone at the base of the cliff (KRG, Ministère de la sécurité publique)
Transportation	58 (8.59)	Guidelines for design criteria for transportation infrastructures on sensitive permafrost (MTMDET, CEN)
Food quality/quantity	50 (7.40)	Evaluation of the impacts of climate change on food and water safety and public health outcomes (PHAC)
Economic stress/development	30 (4.44)	Economic Working Group (NRCan, University of Prince Edward Island)
Cultural change and traditional lifestyle	28 (4.15)	Avativut Project (Kativik School Board, CEN, ArcticNet, INRS, Université du Québec à Trois-Rivières)
Mental Health	14 (2.07)	Educate patients on the mental health impacts of climate change (King's College London, McGill University, Cape Breton University)
Indeterminate	12 (1.77)	Civil Protection Act revised to include Climate Change considerations (GQ)

Note: CEN: Centre d'études nordiques; GC: Government of Canada; GQ: Government of Québec; HC: Health Canada; INRS: Institut national de la recherche scientifique; INSPQ: Institut national de santé publique du Québec; ITK: Inuit Tapiriit Kanatami; KRG: Kativik Regional Government; MERN: Ministère de l'énergie et des ressources naturelles; MTMDET: Ministère des transports, de la mobilité durable et de l'électrification des transports; NRCan: Natural Resources Canada; NRC: Nunavik Research Centre; PHAC: Public Health Agency of Canada; TC: Transport Canada.

Documented adaptations were classified by type; examples are highlighted in Table 3.2. Comparing findings to adaptation-tracking studies in other regions and sectors, climate change whilst on Nunavik's radar still remains in its early stages (Lesnikowski et al. 2011; Panic and Ford 2013; Ford et al. 2014a; Austin et al. 2015; Labbé et al. 2017). The majority (60%, n=403) of adaptations were groundwork initiatives (i.e. preliminary steps that inform and prepare for adaptation), preparing the conditions for more substantive adaptive actions. Although groundwork initiatives are critical first steps in the adaptation process, as stated in the Government of Canada's Federal Adaptation Policy Framework and the Pan-Canadian Framework on Clean Growth and Climate Change, additional translation of these initiatives into actions would help to concretely prepare communities for a changing climate (Government of Canada 2011, 2016; Lesnikowski et al. 2011; Araos et al. 2016).

Research and monitoring (40%, n=272) and capacity building (26%, n=174) were the most frequent adaptation types; initiatives of these types included vulnerability and risk assessment initiatives, climate monitoring and projection projects, working group creation, and workshop development. Among action (40%, n=272), policy initiatives were most common (10%, n=67). As reported elsewhere in the Arctic and global climate change literature, there was less evidence of monitoring and evaluation of adaptation initiatives (2%, n=14) (Lesnikowski et al. 2011; Ford et al. 2014a; Loboda 2014; Araos et al. 2016; Labbé et al. 2017). This is important to note, as monitoring and evaluation are core components of adaptation planning, and are needed to track and assess initiative outcomes, target and justify adaptation funding, inform and improve

initiatives, and reduce the risk of maladaptation (Lesnikowski et al. 2011; Preston et al. 2011; Bours and Pringle 2014; Ford et al. 2014a; Araos et al. 2016). In light of the increasing attention and funding for climate change adaptation, the need for monitoring and evaluation is increasing (Brooks et al. 2011; Bours and Pringle 2014). In this regard, the Pan-Canadian Framework on Clean Growth and Climate Change states that implemented programs and policies will be monitored, effectiveness will be assessed, and performance will be publically reported (Government of Canada, 2016). Additional monitoring and evaluation of adaptation initiatives would therefore help to improve the efficiency and effectiveness of adaptation initiatives.

Table 3.2: Examples of select adaptation initiatives according to adaptation type and level

Adaptation phase (Figure 2.2)	Adaptation typology	Number of initiatives/ frequency (%)	Initiative examples (Stakeholders involved)
Ground-work (Stages 1 to 4 and 6)	Research and monitoring (Groundwork)	199 (30%)	• Northern Housing Laboratory (SHQ) • Map created using GIS tools to identify vulnerable development zones (Université de Montreal, Université Laval) • Snow avalanche forecasting and warning program (INAC, KRG, Ministère de la sécurité publique)
Ground-work (Stages 1 to 4 and 6)	Capacity building (Groundwork)	163 (24%)	• 2013-2020 Climate Action Plan (GQ) • Guidelines for design criteria for transportation infrastructures on sensitive permafrost (MTMDET, CEN) • Workshops: Building capacity and raising awareness on climate change among local governments and land use planners in Nunavik (KRG, Makivik Corporation)
Action (Stages 5 and 7)	Policy (Action)	67 (10%)	• Managing changing snow load risks for building in Canada's North (Standards Council of Canada, INAC) • Establishment of a 100-m exclusion zone at the base of the cliff (INAC, Québec Ministry of Public Safety, KRG) • Community drainage system planning, design, and maintenance in northern communities (Standards Council of Canada, INAC)
Action (Stages 5 and 7)	Information sharing (Action)	57 (11%)	• CanCoast (NRCan) • Website: Mon Climat Ma Santé (INSPQ) • SUPREME system (Québec Ministry of Public Safety)
Action (Stages 5 and 7)	Practice and behaviour (Action)	51 (8%)	• Learning how to harvest and process new species (e.g. beaver, moose) (Autonomous) • Raising animals on farms (e.g. importing reindeer, muskox, chickens) (Autonomous)

			• Growing food in greenhouses (Autonomous)
Ground-work (Phases 1 to 4 and 6)	Resource, transfers, financial support (Action)	46 (7%)	• Climate Change Adaptation Program: Funding (INAC) • $10 million financial support to Ouranos (GQ) • Health Canada's Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities: Funding (HC)
Action (Stages 5 and 7)	Monitoring and evaluation (Groundwork)	30 (4%)	• Adaptation Platform assessment reports (NRCan) • Monitoring and Evaluation of Adaptation Strategy for Nunavik infrastructure (MTMDET) • Evaluation Update of the Climate Change Adaptation Program (INAC)
Action (Stages 5 and 7)	Management and planning (Action)	28 (4%)	• Climate Change Advisory Committee (MDDELCC) • Adapt project management tools and policy framework to guide the integration of Climate Change parameters for infrastructure projects (MTMDET) • Technical Committee on Climate Change and Soil Instability in Nunavik charged with adapting community development to changing climate (KRG, MAMOT)
Action (Stages 5 and 7)	Infrastructure, technology, innovation (Action)	23 (3%)	• Housing Prototype adapted to climate change (KRG, SHQ, KMHB, Makivik Corporation) • Implementation of a heat drain (MTMDET) • Adapting a basic radar satellite ice mapping technology (Trent University, KRG)

Note:
CEN: Centre d'études nordiques; GC: Government of Canada; GQ: Government of Québec; HC: Health Canada; INAC: Indigenous and Northern Affairs Canada; INRS: Institut national de la recherche scientifique; INSPQ: Institut national de santé publique du Québec; ITK: Inuit Tapiriit Kanatami; KMHB: Kativik Municipal Housing Bureau; KRG: Kativik Regional Government; MAMOT: Ministère des affaires municipales et de l'occupation du territoire; MDDELCC: Ministère du développement durable, de l'environnement et de la lutte contre les changements climatiques; MTMDET: Ministère des transports, de la mobilité durable et de l'électrification des transports; NRCan: Natural Resources Canada; NRC: Nunavik Research Centre; PHAC: Public Health Agency of Canada; SHQ: Société d'habitation du Québec; TC: Transport Canada.

The majority of adaptation initiatives, as shown in Figure 3.6, were still at the stage of being recommended (39%, n=266) or planned (9%, n=60), providing an additional indicator that climate change adaptation in Nunavik is in its early stages. Initiative status distribution did not vary as years progressed.

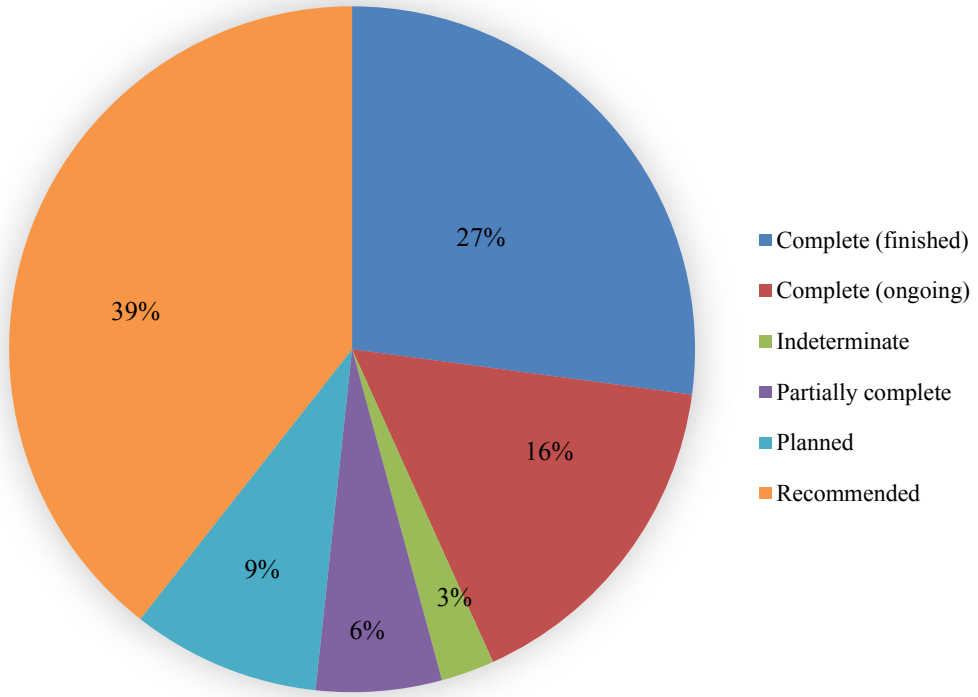


Figure 3.6: Adaptation initiative status

3.6 Inclusion of Inuit knowledge

This section will examine the explicit inclusion of Inuit knowledge[7] in adaptation initiatives. The importance of engaging with local populations and traditional knowledge systems when adapting to climate change is being increasingly recognized in the climate change and Arctic literature traditional knowledge systems as "an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change" (Anisimov et al. 2007). Inuit have highly specialized knowledge with respect to weather, snow, ice, and natural resources, which underpins their long history of resilience and adaptation in the face of changing climate and environmental conditions (Ford 2009; Nakashima et al. 2012; Pearce et al. 2012; Arctic Council 2013).

The findings indicate that approximately 25% (n=173) of adaptation initiatives explicitly included Inuit knowledge, which is comparable to adaptation initiatives in Nunavut (Labbé et al., 2017). The majority of initiatives that incorporated Inuit knowledge did so through Inuit stakeholder consultations or direct Inuit involvement. Inuit knowledge inclusion varied in scope, with some initiatives including it in each stage of adaptation planning and implementation, while others included it only in initial adaptation planning. As shown in Figure 3.7, individual, pan-arctic, northern Canadian, and community were scales of implementation at which Inuit knowledge was most likely to be integrated. In contrast, the integration of Inuit knowledge was

[7] For the purpose of this report, the term 'Inuit knowledge' is used to include understandings of Indigenous knowledge, Aboriginal knowledge, traditional knowledge, Traditional Ecological Knowledge (TEK), and Inuit Qaujimajatuqangit (IQ), as well as contemporary Inuit knowledge and observations. Inuit knowledge encompasses knowledge (e.g. cultural and spiritual knowledge, hunting skills, food preparation, environmental knowledge, etc.) gained through collective experiences passed down through generations.

not documented at the provincial scale where initiatives either did not or made no explicit mention of inclusion. As such, further integration of Inuit knowledge with broader-scale scientific research is needed to provide a foundation for successful, cost-effective, and culturally-appropriate and cost-effective community-based adaptation strategies (INAC 2010; Nakashima et al. 2012; Arctic Council 2013). Programs that have already successfully integrated Inuit knowledge, such as the Avativut Project (see section 3.7.4) could be used as models for other adaptation initiatives.

It should be noted, that the following recent developments suggest that progress is being made with respect to the inclusion of Inuit knowledge. Firstly, as measured by the proportion of initiatives that explicitly included Inuit knowledge over the years, the inclusion of Inuit knowledge in adaptation initiatives increased over the time period under study. Secondly, Inuit and Indigenous groups alike have taken on lead roles in forming national climate change strategies. In 2016 Inuit Tapiriit Kanatami published the Inuit Priorities for Canada's Climate Change Strategy report, which detailed climate policy recommendations to the federal, provincial, and territorial Ministerial Tables (Inuit Tapiriit Kanatami 2016). Indigenous peoples have also helped shape the Pan-Canadian Framework on Clean Growth and Climate Change; within this framework signatories agreed to recognize and respect the rights and traditional knowledge of Indigenous Peoples in planning for climate change impacts, engage and partner with Indigenous Peoples as actions are implemented, and ensure that all decision-making is guided by both scientific and Inuit knowledge (Government of Canada 2016).

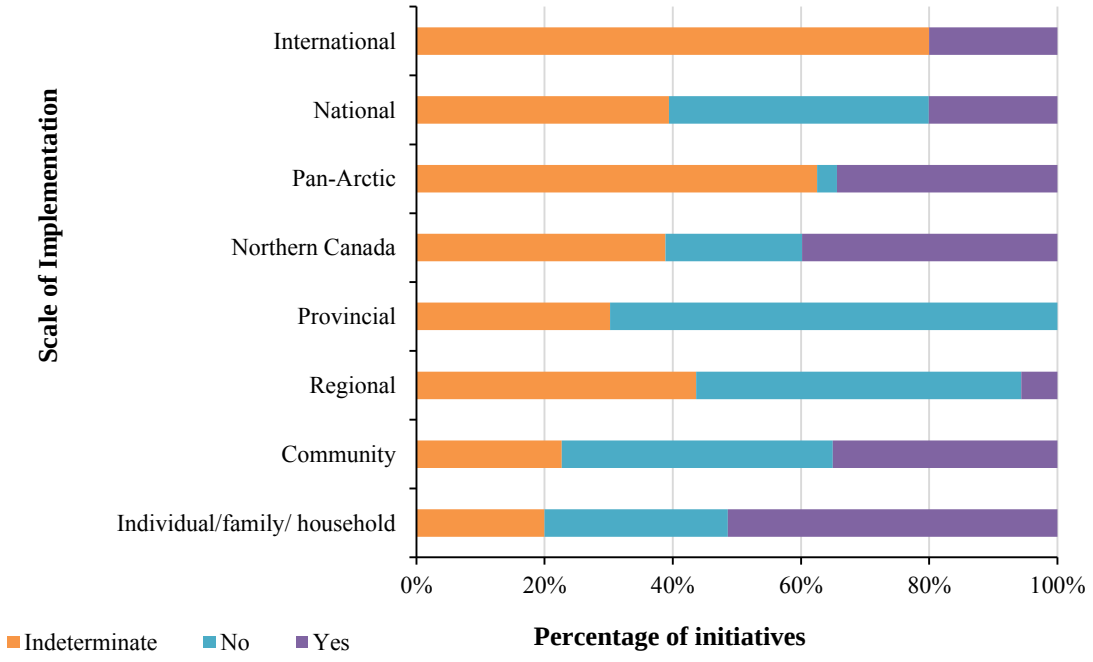


Figure 3.7: Inclusion of Inuit knowledge in adaptation initiatives according to scale

3.7 Discussion by sector

The following sections will examine adaptation initiatives by six sectors: (i) Infrastructure and transportation; (ii) Health and wellbeing; (iii) Business and economy; (iv) Culture and education; (v) Hunting and subsistence harvesting; and (vi) Institutional and resource management. As

discussed in Chapter 2, adaptation initiatives that did not clearly fit into one sector or another were classified within the sector that was most pertinent for that particular initiative. If it was not possible to classify an initiative within a single sector, the initiative was classified as Intersectoral. Figure 3.8 provides an overview of which sectors are adapting most frequently: the Infrastructure and Transportation (26%, n=176) sector documented the greatest activity, followed by Institutional and Resource Management (20%, n=135) and Intersectoral (16%, n=105) efforts. Culture and Education (3%, n=18) was the least frequently involved sector.

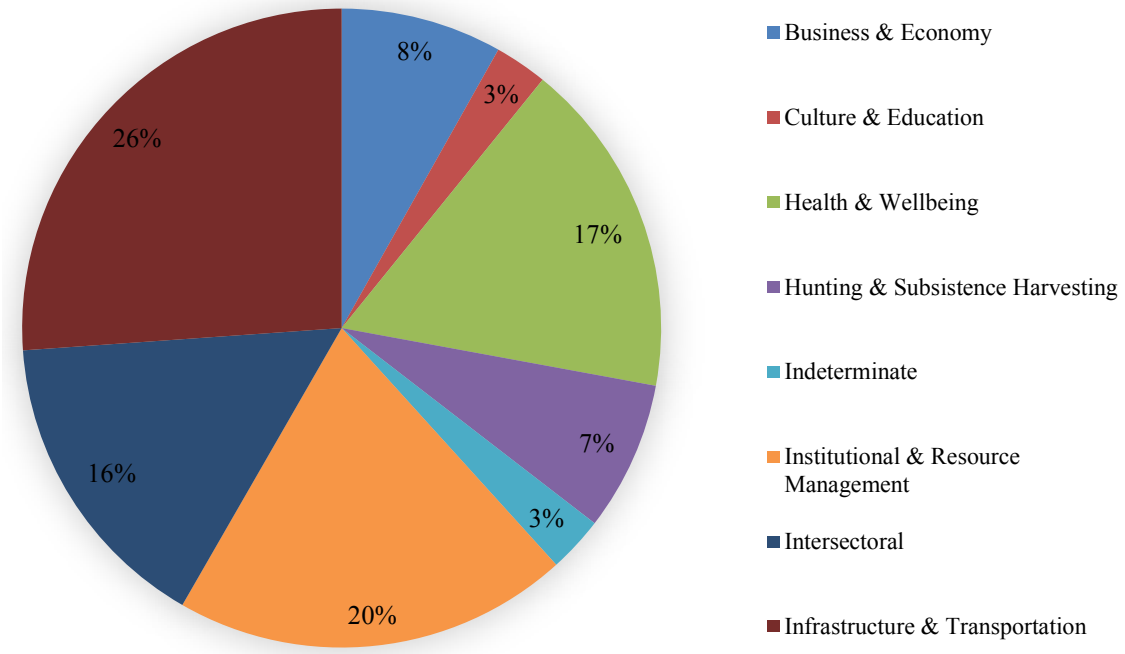


Figure 3.8: Sectors involved in adaptation initiatives

The following sectoral sub-sections are organized as follows: an introduction briefly outlines the sector's climatic sensitivities and exposures, the current state of adaptation as well as future directions for adaptations discussed, followed by a summary table for each sector. Within each sectoral analysis, findings are compared to those from the 2011 gap analysis report.

3.7.1 Infrastructure and Transportation Sector

Infrastructure, for the purpose of this sector analysis, includes housing, buildings, and built structures associated with air and marine transportation, water and waste disposal infrastructure. These types of infrastructure are lifelines for the communities in Nunavik, providing the basic services of mobility and shelter.

In Nunavik, travel between communities within the region and to external locations is largely dependent on year-round air transport, whereas goods provision and cargo transport is by sealift on a seasonal basis. These travel options are highly weather-dependent and regularly disrupted. To access cabins, traditional lands, hunting grounds, and certain communities, residents travel using skidoos, all-terrain vehicles (ATVs), or motorboats. The JBNQA agreement enabled the

construction of airports such that there is now one in each of the 14 communities, all of which are designed with a gravel landing strip[8], an access road to the airport, a terminal and a garage (Boucher and Guimond, 2012). Marine infrastructure facilities, including breakwaters, concrete wharves, access ramps, and floating pontoons, have also been installed in each community through the two phases of the federally and provincially financed Marine Infrastructure Program (Ropars et al., 2012; Makivik Corporation, 2017c). Housing continues to remain a challenge in the region, both in terms of quantity and quality. The growing population is placing increasing pressure on the limited housing units, many of which require extensive renovation due to premature wear and tear from aging structures and/or overcrowding (SHQ, 2014).

Changing environmental conditions, such as the accelerated thawing of permafrost and ground ice, reduced slope stability, extreme events, sea-level rise and increased coastal erosion, present additional challenges to the design, development, and management of infrastructure in Northern Québec (Allard and Lemay, 2012; Lemmen et al., 2016; Boucher and Guimond, 2012; Ford et al., 2012). Although all infrastructure systems carry some risk of failure, unanticipated and rapid changes in their operating environment can increase this risk and overwhelm systems' coping capacity, with related financial losses, health and safety risks, and impacts on ecosystems (Canada NRTEE, 2009; Morse & Doré, 2012). While new infrastructure investment has the opportunity to incorporate consideration of a changing climate, existing infrastructure faces a range of risks and opportunities, as well as options for adaptation. Adaptation planning is therefore necessary to ensure the quality, safety, and sustainability of Nunavik's infrastructure, and to avoid increasing costs related to protection and maintenance in the long-run.

Adaptation initiatives related to transportation on sea ice for hunting and subsistence harvesting purposes were not classified under this sector. They were included in the "Hunting and Subsistence Harvesting" sector in section 3.7.5.

Climatic sensitivities and exposures

The cryosphere (solid precipitation, snow and ice cover, glaciers, and permafrost) is responding rapidly to warmer temperatures, which has important implications for infrastructure maintenance and design (Lemmen et al. 2007; Prowse et al. 2009; Charrron, 2015). Moreover, annual average atmospheric temperature in Nunavik has increased by 3.5°C between 1990-2007 (Allard and Lemay, 2012; L'Hérault et al, 2013), five to seven times the global average annual increase for those years (IPCC, 2007). Warming temperatures, snow collection and poor drainage are causing accelerated rates of permafrost thaw and degradation, which is contributing to irreversible landscape changes, such as slumping, erosion, and ground instability (Grandmont et al. 2012; Doré et al. 2016). Salluit has experienced a 2.6°C temperature increase between 1990 and 2003 and has witnessed the problems that such an increase can inflict – damaged buildings, roads and embankments, and the relocation of 20 new homes from unstable land.

A large proportion of the infrastructure in Nunavik, including airstrips, access roads and buildings, is dependent upon a stable permafrost foundation (Allard et al. 2002; Palko and Lemmen, 2017). Permafrost degradation, recorded as the climatic indicator motivating the greatest level of adaptation initiatives at the regional scale, will therefore result in a loss of

[8] Except for Kuujjuaq which has a paved airstrip.

infrastructure support, strength, and stability, thus leading to costly damage and unsafe conditions (Ouranos, 2015; Doré et al. 2016). Since the early 2000's, major damage related to permafrost thaw has been observed on five access roads – Umiujaq, Akulivik, Salluit, Tasiujaq and Kangiqsualujjuaq – and eight runways –Umiujaq, Inukjuaq, Puvirnituq, Akulivik, Salluit, Quaqtaq, Kangirsuk and Tasiujaq (Figure 3.9) (Boucher and Guimond, 2012). Changes in these critical transportation infrastructures may influence store food transport, as well as emergency medical services, thus having significant impacts on Nunavik's communities (Palko and Lemmen, 2017).

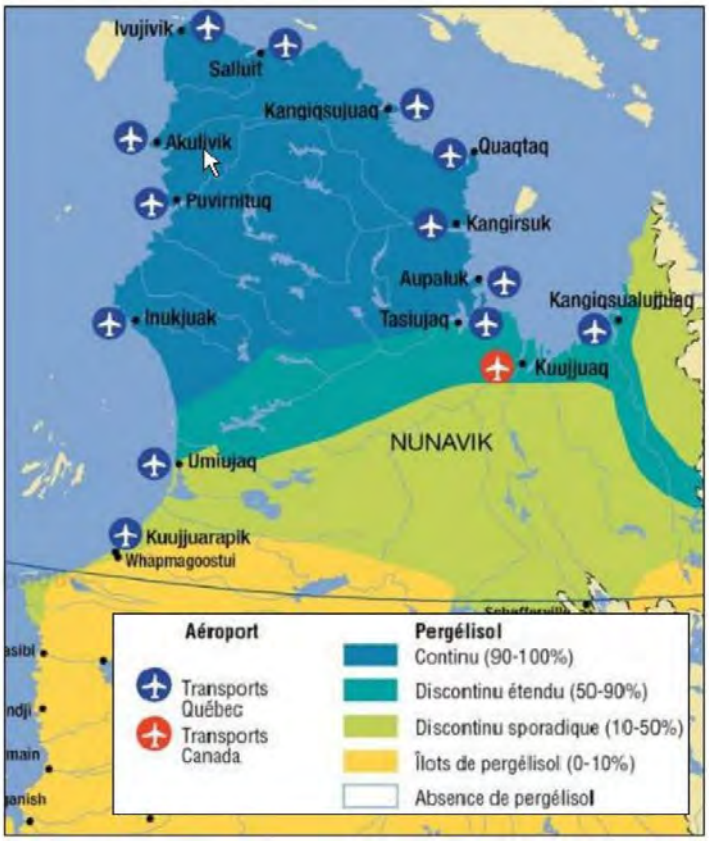


Figure 3.9: Permafrost and Airports (MTMDET and TC) in Nunavik (Boucher and Guimond, 2012).

Additionally, the combined effects of rising temperatures, permafrost degradation, loss of sea ice, and sea-level changes, are leading to noticeable rates of coastal erosion along Nunavik's coastline (Clerc et al. 2011; Ropars et al. 2012; Lemmen et al. 2016). Responses to thawing exacerbate local coastal hazards and erosion response by enhancing the ease with which wave action can remove sediments and by increasing susceptibility to inundation (Lemmen et al. 2007, 2016). Sea-ice acts as natural protection for the coast by suppressing wave action, loss of which results in the shoreline and coastal infrastructure being vulnerable to erosion and inundation from waves and storms. Climate change is expected to increase the severity and frequency of extreme events, including storm surges, high winds, and storms (Savard et al. 2014; Lemmen et al. 2016). An unfavorable combination of these climatic factors may result in unstable shorelines, loss of archaeological and cultural heritage sites, and increasing costs for infrastructure protection and maintenance (Lemmen et al., 2016). Marine infrastructures, including breakwaters and water

access ramps, in some communities have already experienced localized failure due to movements of ice cover, while extreme water levels documented in Salluit have affected the wharf (Ropars et al. 2012; Palko and Lemmen, 2017).

Transportation to and from Nunavik communities, for residents, food, and supplies, is currently largely dependent on a seasonal ferry service and year-round planes. Increased temperatures and the resulting decline in sea ice cover and duration is projected to increase the length of the open water season, thus providing greater access to communities by making marine transportation more viable throughout the year (Government of Québec, 2015). This may have major impacts on Nunavimmiut, including decreasing the cost of living and increasing potential business opportunities. Nevertheless, while the summer season is projected to be extended, ice conditions are expected to remain highly variable from year to year (Gauthier et al. 2010).

Lastly, warming temperatures and permafrost change are likely to have negative implications on the already constrained housing situation in Nunavik. As the probability of permafrost thaw increases, thaw settlement, thermal erosion, and landslides, are likely to occur with greater frequency, having serious implications on permafrost and infrastructure reliability, stability, and durability (Grandmont et al. 2012). With a population growth rate faster than any other region of Canada, the demand for housing and new infrastructure is very high; this demand comes at a time of increasing uncertainty as to the capability of the land to support development. Terrain that was previously considered safe to build on would now have to be evaluated for safety and sustainability criteria (Allard et al. 2007; L'Hérault et al. 2013). The same would apply for industrial development, more specifically mining (Allard and Lemay, 2012).

Current state of adaptation and future adaptation directions

In response to the risks posed by climate change, the infrastructure and transportation sector, accounting for 26% (n=176) of total adaptation initiatives, registered the greatest amount of activity at the regional scale of all sectors analyzed in this study. Initiatives were being implemented at the community (30%, n=53), national (25%, n=44), and regional (18%, n=33) and scales, with a higher proportion of initiatives at the groundwork stage (62%, n=109) as opposed to action (38%, n=67). Furthermore, close to half of the initiatives at the action level (48%, n=32) were still at the stage of being recommended if not planned. Research and monitoring (34%, n=59), and capacity building (24%, n=42) initiatives were the most frequent adaptation types as indicated in Figure 3.10. A small proportion (21%, n=36) of initiatives explicitly included Inuit knowledge.

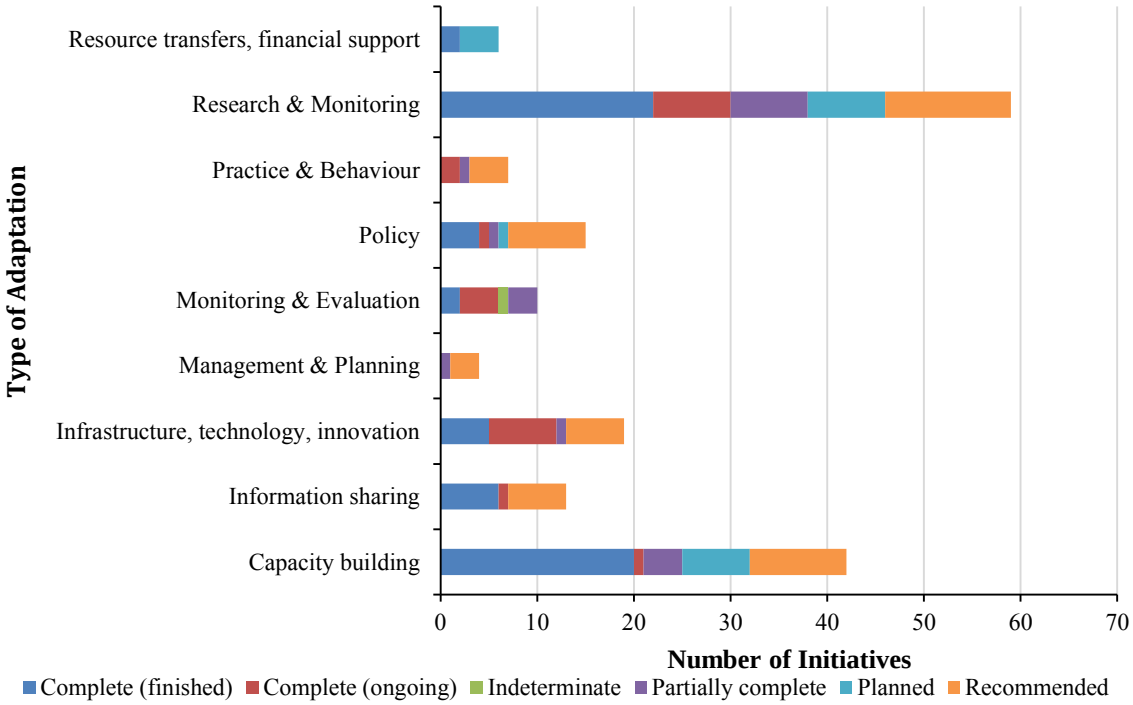


Figure 3.10: Adaptation type by status of action for Infrastructure and transportation initiatives (n=176)

Numerous vulnerability assessments, adaptation planning tools, and infrastructure and technological innovations have been developed and applied to assist various communities in adapting infrastructure to the effects of climate change. These initiatives, some of which are outlined in Table 3.3, target a variety of climatic exposures and serve to increase the adaptive capacities of community infrastructure.

Table 3.3: Examples of infrastructure related climate change adaptation initiatives in Nunavik communities

	Kangiqsualujjuaq	Kuujjuaq	Tasiujaq	Aupaluk	Kangirsuk	Quaqtaq	Kangiqsujuaq	Salluit	Ivujivik	Akulivik	Puvirnituq	Inukjuaq	Umiujaq	Kuujjuarapik	Deception Bay
Airport Infrastructure (Air strip & access road)															
Monitoring of airport infrastructure	X	X	X	X	X	X	*	X	*	X	X	X	X		
Creation of Adaptation Strategy [1]: 1) Geotechnical investigation 2) Permafrost characterization 3) Integrated adaptation strategy	X		X		X	X		X		X	X	X	X		
Implementation of adaptation strategy [1,2]			X					X			X				
Monitoring & evaluation of implemented strategy[2,3]			X					X			X				
Instrument fasciltated monitoring of permafrost conditions [4]			X	X	X	X		X		X	X	X			
Installation of fibre optic cable technology [4]								X							
Marine Infrastructure															
Installation and maintenance of 6 weather stations [4]						X	X		X	X	X		X		
Ice observation near marine infrastructures [4]				X		X		X	X					X	X
Real-time monitoring of ice conditions (Cameras, local consultations, RADARSAT-2images) [5]		X				X							X		
Municipal Planning															
Maps [6]: 1) Surficial geology 2) permafrost conditions 3) hazards 4) construction potential	X	X	X	X	X	X	X	X	X	X	X	X	X		
Community training workshops on climate-sensitive building techniques [7]				X	X	X		X	X		X		X	X	

* Information for these communities was not captured by the systematic review
[1] (L'Hérault et al. 2012); [2] (Allard and Lemay, 2012); [3] (Perier et al. 2016); [4] Information obtained from Knowledge Transfer Workshop held in Kuujjuaq (February, 2017); [4] (Kativik Regional Government, 2010); [6] (L'Hérault et al. 2013); [7] (Kativik Regional Government, 2012)

Considering permafrost was the most important climatic factor initiating adaptation within this sector, sustainable development of Nunavik requires that the current and future potential thawing of permafrost be considered for the design life of transport infrastructure and buildings (Canadian Standards Association, 2010). Geohazards related to permafrost degradation need to be evaluated prior to construction to ensure that adequate engineering techniques are applied to counteract the adverse impact of permafrost warming (Allard et al. 2007).

During the design and construction of Nunavik airports, between 1984 and 1991, permafrost was considered a stable foundation and climate change was not anticipated. Consequently, no evaluation was undertaken to evaluate the effects of building infrastructure on permafrost and nor were there any specific protective measures to minimize the effect of permafrost thaw. Since degradation of airport infrastructures became noticeable in 2004, MTMDET has undertaken important research initiatives to improve knowledge of permafrost, the factors affecting its stability, and appropriate methods of construction on unstable terrain (Guimond et al. 2010; Boucher & Guimond, 2012). This research, which was conducted through simulation with the help of numerical models, laboratory experimentation and/or on-the-ground experimentation, is informing the improved performance and durability of airport infrastructure in Nunavik (Allard et al., 2007a; Fortier et al. 2011b; L'Hérault et al. 2012).

This sector reported the highest infrastructure, technology and innovation initiatives. In depth permafrost characterization and geotechnical tests have been carried out for 8 of 14 airport sites (L'Hérault et al. 2012b). The results informed the development of adaptation strategies for those sites with highest risk to permafrost degradation; monitoring, adaptive, and stabilization measures have consequently been put in place to meet site-specific requirements (Boucher & Guimond, 2012). Transport Canada, charged with the ownership of Kuujjuaq airport, has also initiated research collaborations for the management of impacts related to precipitation and permafrost change, including the installation of the first fibre optic cable to enable continuous ground temperature monitoring and surveillance (Allard et al. 2014). Table 3.3 summarizes the adaptation initiatives that have been applied to each community airport. The Northern Transportation Adaptation Initiative (Transport Canada, 2012) has also funded similar research projects testing new technologies to reduce permafrost degradation due to groundwater and to minimize impacts of climate change on the surface friction of northern airport runways. It remains unclear to what extent these projects have been applied in Nunavik. The Arquluk permafrost engineering research program, initiated in 2012, encompassed several initiative typologies including infrastructure, innovation and technology initiatives such as the use of high albedo surfaces for thermal stabilization or the implementation of thermal drains to allow air circulation below embankments (Dumais and Doré 2013; Perer et al. 2015). Bringing together expertise from academic, governmental, and private sectors, this pan-Canadian research program promotes adaptive capacity through information sharing and the development of technical solutions geared at solving issues pertaining to transport infrastructures on permafrost (Arquluk, 2012).

Within the framework of the Climate Change Adaptation Plan (CCAP) 2006-2012, the development of a scientific program aimed at evaluating the risks associated with climate change on newly built infrastructure was initiated. The 2013-2020 Québec CCAP has renewed emphasis on the need to continue monitoring, maintaining and managing infrastructure most likely to be affected by climate change impacts. As a result, various federal, provincial, and academic institutions are continuing to collaborate on extensive data acquisition and numerical modelling projects to define the conditions influencing the performance and durability of air and marine infrastructures in Nunavik. The focus of the marine research has been to model storm, wind, wave, ice, and sea-level patterns around infrastructures incorporating both local expert knowledge and climate scenarios in order to inform and ultimately prioritize efforts and target adaptations based on needs (Clerc et al. 2011; Bleau, 2012; Savard et al. 2014; Gauthier et al. 2010). In addition, private sector involvement in financing community based research projects of this nature has also been documented in Nunavik; the Raglan mine, for example, has collaborated with the Institut national de la recherche scientifique (INRS) and the Kativik Regional Government (KRG) to monitor sea ice around Kangiqsujuaq, Salluit and Deception Bay (INRS, 2016). Table 3.3 summarizes the communities in which various initiatives are being applied to enhance marine infrastructure resiliency to climate change.

There is presently a better understanding of permafrost degradation processes and the factors that aggravate or accelerate these processes for various communities in Nunavik compared to others in the Canadian Arctic (Ford et al. 2012; Allard and Lemay, 2012). As highlighted in Table 3.3, several communities in Nunavik–have participated in permafrost-monitoring and mapping

projects to inform future development and land-use planning (Allard et al., 2009 and 2010; Grandmont et al. 2012; Furgal and Laing, 2013; L'Hérault et al. 2013, Carbonneau et al. 2015). These projects have involved field observations, shallow drilling, and community involvement through exchange of information and consideration for local concerns involving construction, housing, municipal services and long-term land management. Resulting maps have informed recommendations on where to place infrastructure and which developed areas need repair or will need repair in the future. This knowledge has enabled the exploration of adaptation measures as they relate to building techniques and design guidelines to better address permafrost degradation. One example is the preparation of pads for construction of new buildings 1–2 years in advance in order to allow the ground to stabilize and avoid damaging ground shift after the building is constructed. Engineers, through this initiative, have also provided community members with training on how to construct pads that minimize the risk of affecting permafrost for select communities in Nunavik (see Table 3.3) (Kativik Regional Government, 2012; L'Hérault et al. 2013).

While remedial action or engineering modifications to existing infrastructure are possible to adapt to future climate change risk, the establishment of mainstreaming mechanisms for climate change into infrastructure and land use planning can proactively ensure durable and resilient infrastructure, and therefore reduce costs in the long-term by reducing the need for repairs or modifications. The Housing Society of Québec (SHQ), for instance, created the Northern Housing Laboratory in 2013 to focus on challenges, including climate change, facing sustainable construction in a northern environment (SHQ, 2014). In 2017, SHQ in collaboration with regional partners developed a good practice guide to provide building experts with performance criteria for sustainable construction in Nunavik (SHQ, 2017). Following the 1999 avalanche in Kangiqsualujjuaq, community participation and the involvement of the municipal and provincial authorities has enabled the implementation of a snow avalanche forecasting and warning program. The outcomes of this research enhanced risk reduction, led to the relocation of buildings to safe areas, and the creation of a 100m exclusive zone at the base of the mountain (Germain, 2016). These initiatives promote adaptive capacity and reduce the risk of maladapted infrastructure developments in the region.

Due to the comparatively large number of adaptation initiatives catalogued, it appears that adaptation is on the agenda of numerous actors affiliated to Nunavik's infrastructure and transport sector. Whilst this is indeed promising, it is important to note that focus on adaptation within this sector has primarily been at the groundwork level, aimed at informing and preparing for adaptation through impact and vulnerability assessments, and research and monitoring to inform recommendations. While these are important groundwork steps necessary for building readiness for adaptation (Ford and King, 2015), there exists opportunity to develop more concrete actions moving forward, such as changes to municipal land use planning policies, alterations to building and infrastructure design, and enhanced disaster planning and emergency preparedness; initiatives that are present in the current adaptive response, but largely at the planned or recommended stage.

Several standards regarding permafrost and infrastructure construction have been developed through the Northern Infrastructure Standardization Initiative (Standards Council of Canada/Aboriginal and Northern Development Canada, 2014), whether or not these have been

incorporated by the regional government remains unclear. Although, as outlined in Table 3.3, there have been several vulnerability and hazard-mapping initiatives at the community scale, results have not been applied to support the development of region specific building standards or codes. A recommendation from the Climate Change and Clean Energy Workshop held in Kuujjuaq, highlighted the need for greater knowledge transfer between practitioners, within and across levels of government, and other end-users. Since research on impacts of changing permafrost conditions on infrastructure has largely been conducted by research institutions, guidelines on best practices and lessons learned for use by end users (such as municipal workers and private actors) could be key to maintain ongoing adaptation efforts and to initiate new ones to ensure sustainable development of communities and establishment of good municipal management and construction practices on permafrost (Carbonneau et al. 2015).

Infrastructure vulnerability assessments seek to characterize susceptibility to harm in a system in response to stimuli (Ford et al. 2014), in order to prioritize and target adaptation efforts based on needs. Continued assessment of the current and future vulnerability of infrastructure is needed, with consideration of climate projections and human use and practices, and research to enable the prioritization of appropriate investment options (Allard et al. 2012). Thus, long-term data collection is important both to continue to document the impact of climate change, and to define design criteria and best practices for maintenance and management. Enhanced knowledge also allows for the exchange of best practices regarding infrastructure design, construction and maintenance. Future implementation of adaptation initiatives, especially for underserved communities, will be dependent on the availability of these assessments and data, as effective adaptation strategy needs to be carefully designed and site- specific.

Additionally, the lack of vulnerability assessments in the delivery of municipal services, such as community drinking water and sewage systems, may account for an absence of adaptation initiatives modifying existing physical infrastructure in response to climatic risks. There is thus a need to identify and assess solid waste management options in a changing northern environment, with consideration of aspects such as waste capacity levels, storage impacts, and how permafrost and solid waste interact including the extent of the associated impacts. In recognition of increasing natural resource development activities in the North, and the expanses over which this development will occur, there will be a need for hazard maps at larger scales. This will require advancing understandings of how particular hazard-related factors can be interpreted to suggest hazard dynamics across much broader areas.

Limited evidence of private sector activity was documented for this sector. Nunavik's resource extraction projects are poised to expand considerably in the coming years and will require a large investment in roads, waste management facilities, and other infrastructure. Efforts that independently assess the potential impact of climate change on these projects, as well as their impact upon communities, will be important in advancing adaptive capacity and action.

Finally, no adaptation plans for regional authorities were documented. Such comprehensive plans would assist in creating a coordinated adaptation response within the sector, thus improving the efficiency and effectiveness of initiatives, and could enhance a greater translation of groundwork initiatives into action. In Nunavut, the six communities that have published community adaptation plans registered a higher number of adaptation actions as opposed to those

without the plans, highlighting the importance of adaptation plans in advancing adaptation needs (Labbé et al. 2016).

Table 3.4: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions in the Infrastructure and Transportation sector

Climatic sensitivities and exposures	• Permafrost degradation presents an important threat to infrastructure support, strength, and stability • Loss of sea ice, and permafrost degradation are leading to coastal erosion, which may lead to unstable shorelines, loss of cultural heritage sites, contaminated water supplies, and increased infrastructure protection and maintenance costs • Increased severity and frequency of extreme events, such as storm surges and landslides, could lead to surface infrastructure damage • Declining sea ice cover and duration will increase open water season length, thus increasing access to Nunavik communities by marine transportation throughout the year • Increasing uncertainty as to the capability of the land to support development in certain communities • Warming temperatures, permafrost degradation, and increased storm frequency will affect the safety and consistency of air transportation to and from communities
Current state of adaptation	• Several vulnerability assessment and adaptation planning tools have been developed by a variety of stakeholders to assist communities in adapting to climate change • A small number of infrastructure policies and guidelines have been publically released to ensure that climate change factors are incorporated into infrastructure design and community planning • Geographic discrepancies exist in number of adaptation initiatives catalogued by community • MTMDET and MAMOT has funded several research projects examining how permafrost will impact airport infrastructures, as well as new adaptive strategies that may help reduce the impacts of climate change on air transportation. • Permafrost characterization and geotechnical tests have been carried out for 10 of 14 airport sites • 9 adaptation strategies have been developed and implemented to increase resiliency for 5 airstrips and 4 access roads. Future work entails extending these initiatives to 3 more airstrips and 2 access roads • Community focused permafrost-monitoring and mapping projects to inform future development and land-use planning for 4 communities • Several research projects to model storm, wind, wave, sea ice, sea level patterns have been carried out or are ongoing • Creation of the Northern Housing Laboratory, an applied research initiative by SHQ to incorporate the impacts of climate change on housing design • Guidelines for best practices to inform building practices on permafrost have been created and shared with municipalities. • One hazard forecasting and warning program has been developed in collaboration with community members for Kangiqsualujjuaq following 1999 avalanche • Limited evidence of private sector activity was documented for this sector

Gaps and Future needs	• No community-wide adaptation plans were published • Continue efforts to promote knowledge transfer within and across stakeholder groups charged with the management of municipal infrastructure to inform and promote best practices and application of adaptation strategies to increase resiliency of infrastructure to a changing climate • Monitoring and evaluation of existing community level adaptation initiatives whilst ongoing in some cases must continue and extend to those areas where it is lacking • Lack of vulnerability assessments in the delivery of municipal services, such as community drinking water and sewage systems • Research that independently assess the potential impact of climate change on proposed development and resource extraction projects is limited • Long-term data collection is important both to continue to document the impact of climate change, and to define design criteria and best practices for maintenance and management

3.7.2 Health and Well-being

Climate change has been identified as one of the biggest health threats of the 21st century (Costello et al. 2009). Recent health indicator data including food and nutrition, infectious diseases, and injuries indicate the Nunavimmiut experience health challenges (Allard and Lemay, 2012). Moreover, due in part to existing socio-economic disparities combined with Inuit populations' close relationship with the land, relative to other Canadians, Inuit are expected to be disproportionally affected by climate change impacts on health (Furgal and Seguin 2006b; Ford et al. 2010b).

Climatic sensitivities and exposures

Climate change is impacting the quantity, quality, and accessibility of freshwater resources in Nunavik (Furgal & Nickels, 2005; Lemmen et al. 2007). Residents have noted gradual drying trends wherein important freshwater sources traditionally used for drinking water are drying up (Martin et al. 2007; Furgal and Nickels, 2005). A future drop in summer and winter precipitation could also contribute to a decline in the levels and flow of surface water: some communities might be led to use sources of supply much more distant than those currently used. In addition to altered freshwater quantity, changing temperature and precipitation are impacting permafrost regimes causing pathogens to migrate to the sub-permafrost aquifers or, via runoff, to the neighbouring watercourses and lakes, thereby increasing the risk of water-borne pathogen contamination (e.g. *Giardia lamblia*), thus impacting water quality (Martin et al. 2007). Increasing temperatures are also supporting increased algal and plant growth in waterways, thereby decreasing drinking water quality and quantity (Nickels et al. 2006; Bolton et al. 2011).

The incidence and transmission of vector-borne, zoonotic, and food-borne diseases are also expected to increase as a result of increased temperatures associated with climate change (Lemmen et al. 2007; Parkinson et al. 2008; Ford et al. 2010b; Messier et al. 2012). Increased temperatures are expected to increase the range of insect vectors and alter the types and incidence of zoonotic diseases (e.g. *Toxoplasma gondii* in mammals) in Nunavik, with increased illness and parasitic infection already being observed among many animal species, including

caribou and arctic fox (Nickels et al. 2006; Parkinson et al. 2008; Allard and Lemay 2012; Simon et al. 2014). Additionally, rising temperatures are also expected to increase the incidence of temperature-dependent food-borne diseases, including *Salmonella* and *Staphylococcus aureus* (Lemmen et al. 2007; Parkinson et al. 2008; Allard and Lemay 2012). This is particularly important in an Inuit context, due to the common consumption of raw meat and the outdoor storage and transportation of traditional foods (Ford et al. 2010b).

Research also suggests that climate change will enhance transport and uptake of anthropogenic contaminants (e.g. mercury and polychlorinated biphenyls (PCBs)) into Arctic ecosystems, thereby increasing the exposure and sensitivity of Nunavimmiut through country food consumption (Furgal and Seguin 2006b; Lemmen et al. 2007; Donaldson et al. 2010; Calder et al. 2016). Currently, levels of exposure to mercury and other contaminants among some segments of the population in Nunavik exceed Canadian and international safety guidelines; among other effects, such contaminants are known to adversely affect neurodevelopment and cardiovascular health (Lemmen et al. 2007, Allard & Lemay, 2012; Calder et al. 2016). Increased snowmelt and ocean temperatures are both expected to increase bioaccumulation of contaminants in the food chain (Lemmen et al. 2007; Bolton et al. 2011). Contamination risks will also increase with the growing number of industrial developments in the region (Ricard, 2015).

Food security is defined as "when all people at all times have physical, social and economic access to food, which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life" (Council of Canadian Academies 2014). Food insecurity is linked to a multitude of health risks including obesity and mental health challenges, and is significantly higher in Nunavik than the rest of Canada (not including the northern territories), with residents reporting consistent challenges accessing sufficient food quantities (Beaumier & Ford, 2010; Bolton et al., 2011; Ford et al., 2012; Allard & Lemay, 2012). High food costs, availability of country foods, low household income, decreased country food consumption, and lack of nutritious food options contribute to the high food insecurity levels in Nunavik, and other Northern Canadian regions (Beaumier and Ford, 2010; Allard and Lemay, 2012; Robitaille et al. 2016). The Inuit diet is comprised of a combination of store foods transported to communities by air or boat, and country foods harvested from the land; food security is therefore highly sensitive to climatic changes, which will impact store food transportation networks (see Section 3.7.1) as well as country food accessibility, availability, and quality (see Section 3.7.5) (Chan et al. 2006; Furgal & Seguin, 2006; Nickels et al., 2006; Lemmen et al., 2007; Allard & Lemay, 2012; Khunlein and Humphries, 2017). As such, climate change is expected to exacerbate existing community food insecurity in Nunavik (Furgal & Seguin, 2006; Allard & Lemay, 2012).

Increasingly unpredictable weather and environmental conditions, combined with sea ice loss and other climatic impacts, are expected to increase the dangers associated with spending time on the land (see Section 3.7.5) (Nickels et al. 2006). Following an avalanche in 1999 in the Nunavik community of Kangiqsualujjuaq that killed nine people and injured 25, the Ministère de la sécurité publique du Québec conducted a review of avalanche risks and protective measures in 2000 (Lied, 2000). Topography, early winter rain, freezing, heavy winds and snowfall on a crust

of ice that allowed the destabilization of the snow mass were included among conditions reported as associated with this avalanche, most of which will increase in intensity and frequency as the climate changes (Lemmen et al. 2007).

Disproportionate rates of mental health issues are already documented throughout the Inuit Nunangat, with Inuit communities reporting some of the highest rates of suicides in all of Canada (Allard and Lemay, 2012). Climatic and environmental changes are expected to further challenge the mental health and well-being of Nunavimmiut, whose culture and identity are strongly connected to the natural environment (Allard and Lemay, 2012; Bolton et al. 2011; Cunsolo Willox et al. 2015b). Studies in Nunatsiavut indicate that the ability to engage in land-based activities is essential to Inuit mental health and well-being; as such, disruption of traditional subsistence harvesting activities due to climate change (see Section 3.7.5), combined with other factors including the loss of important cultural sites due to coastal erosion, may contribute to psychosocial distress among Inuit communities (Cunsolo Willox et al. 2013; Nickels et al. 2006). In addition to personal well-being, subsistence harvesting activities and the subsequent food sharing maintain important social bonds within communities; a decreased ability to engage in such activities is therefore impacting social cohesion in communities (Allard & Lemay, 2012; Cunsolo Willox et al. 2013b).

Temperature extremes, both cold and hot, will also directly influence morbidity and mortality (Bolton et al., 2011; Nickels et al., 2006; Seguin, 2008). Although the incidence of cold-related injuries, such as frostbite and hypothermia, may be expected to decrease as temperatures rise, increased weather instability may result in increased extreme cold exposure associated with storms (Seguin 2008; Lemmen et al. 2016). Conversely, as heat waves increase in frequency, heat-related stresses will increase: reports of respiratory distress on hot summer days have already been reported among Nunavimmiut Elders (Bolton et al. 2011; Nickels et al. 2006). Higher temperatures also contribute to increased air pollution and production of pollens, and worsening of allergies and asthma (Allard and Lemay, 2012).

Climate change is projected to exacerbate ozone loss, resulting in increased ultraviolet (UV) radiation exposure (Bolton et al. 2011; Lemmen et al. 2007). Among other impacts, UV radiation is associated with sunburns, skin cancer, and eye damage; Nunavimmiut have indeed recently reported increased incidence of sun rashes, burns, and snow blindness (Ouranos, 2015; Bolton et al. 2011; Lemmen et al. 2007; Nickels et al. 2006).

Current state of adaptation and future adaptation directions

The Human Health and Well-being sector was fairly active in adaptation, with 17% (n=115) of all initiatives being reported within this sector. Initiatives were primarily being implemented at the national (29%, n=33), northern Canadian (18%, n=21), and regional (16%, n=18) scales. These broader non-specific location scales were included in the analysis as they may apply to the region of Nunavik but due to a lack of location specific information it is unclear which, if any, communities in Nunavik are involved. As presented in Figure 3.11, more than half of the documented initiatives (64%, n=74) were groundwork, and almost half (48%, n=35) remained at the stage of recommendation. Frequent adaptation typologies included research and monitoring (42%, n=48), capacity building (21%, n=24), or policy (12%, n=14). Almost one quarter of

initiatives (28%, n=20) included Inuit knowledge, primarily in the form of including Inuit voices in research studies.

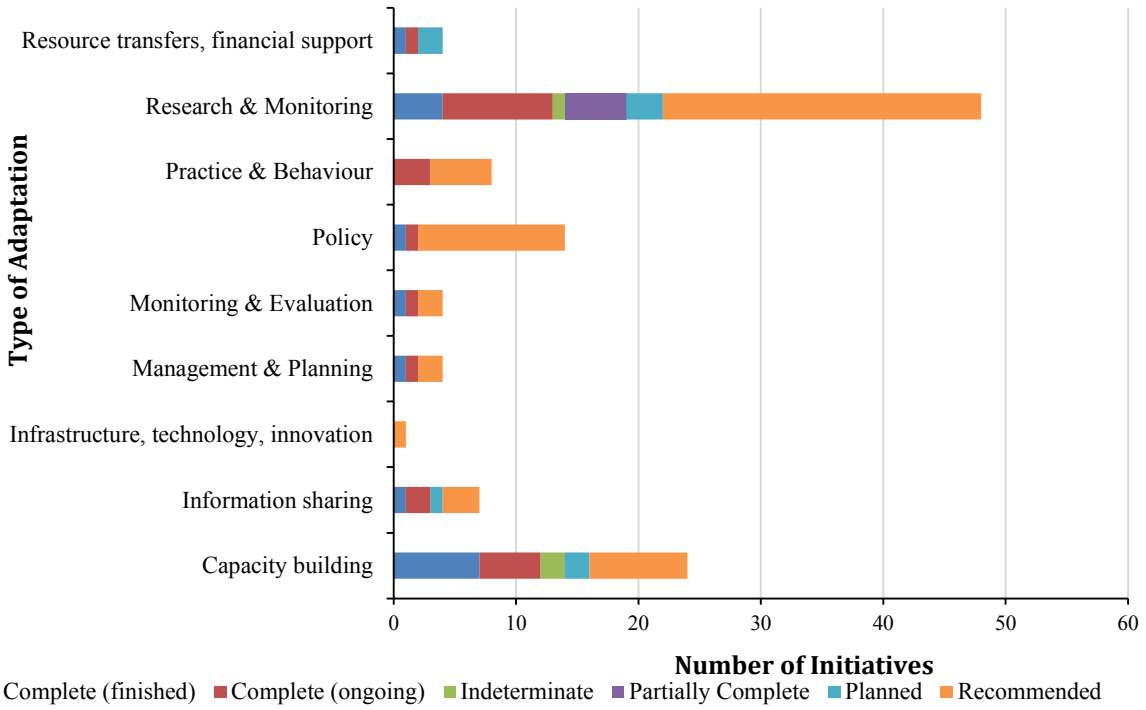


Figure 3.11: Adaptation type by status for Health and well-being initiatives (n=115)

Similar to the Infrastructure and Transportation sector, no adaptation plans for regional health authorities were documented. Such comprehensive plans would assist in creating a coordinated adaptation response by health authorities across jurisdictions, thus improving the efficiency and effectiveness of initiatives. Additionally, research and monitoring adaptation initiatives dominated the sector, accounting for 42% (n=48) of initiatives. Further translation of these results into action could accelerate the climate change adaptation process in Nunavik.

Federal health adaptations emphasized capacity building and research and monitoring initiatives, addressing infectious diseases, heat-related risks or general health risks, a finding that confirms results from a Canadian health adaptation tracking study (Austin et al. 2015). Contributing to the large number of capacity building initiatives is a series of heat risk guidelines and guidebooks prepared by Health Canada for public health officials, emergency management officials, health care workers and health administrators. Meanwhile, most research and monitoring initiatives reflect research conducted by the Public Health Agency of Canada that focuses on food and water safety and vector-borne diseases. Provincially, Québec is fairing comparatively better with respect to health adaptations than any other province (Austin et al. 2015). The province has a comprehensive climate change adaptation plan with a detailed health section that addresses most regional health risks and has a diverse assortment of adaptation types. Examples are included in Table 3.5. Gosselin et al. (2011) suggest adaptation to the health impacts of climate change in Québec is taking place because of stable financing (money from the province's carbon tax funds its climate change action plan), willingness for transdisciplinary collaboration, openness to

public health innovation, and the knowledge provided by Ouranos on the current and projected impact of climate change in the province. However, it still remains unclear to what extent these provincially initiated adaptation initiatives are being applied at the regional level.

Thus, although adaptation efforts are underway, there remains limited knowledge on governance and institutional factors constraining and enabling adaptation, or the overall readiness of governing bodies and institutions to develop, implement, and promote adaptation (Ford and King 2015; Jude et al. 2017; Labbé et al. 2017). Readiness assessments examine the steps being completed to prepare for adaptation, focusing on the strength and existence of governance structures that determine the preparedness to build support for action and effectively develop, implement, and monitor adaptation initiatives (Ford and King 2015). Future work would therefore benefit from an assessment of this nature wherein interviews with key informants can be conducted to gain a more detailed understanding of which national and provincial level initiatives are being implemented in Nunavik. Additionally, tracking adaptation initiatives at the federal and provincial levels (examples in Table 3.5) enables the identification of areas where intervention is needed to enhance adaptation preparedness (Ford and King 2015; Tilleard and Ford 2016).

Table 3.5: Examples of Health Adaptation initiatives included, by adaptation type for Québec

Adaptation Category	Provincial Initiative
Resource transfers, financial support	• $22.3million for preventing and limiting diseases, injuries, mortality and psychosocial impacts
Research & Monitoring	• Analyze incidence and distribution of gastrointestinal disease in at-risk populations and risk factors associated with climate change • SUPREME System—Monitoring and surveillance system for public health
Practice & Behaviour	• Enhance assistance and psychosocial support measures following disasters (freezing rain, high tides, flooding) • Usage of air conditioners in homes
Policy	• Air Quality Policy (promoting local and regional air quality management) • Elaborate legislation governing land-use planning and urban planning to prevent the appearance of new urban heat islands
Management & Planning	• Establishment of expert panels to assess measures needed for climate change adaptation • Use flooding research results to map restricted development zones, prepare regulations and civil security plans • Committees of experts will also be struck to advise health institution managers on applicable actions required to ensure that buildings and infrastructures are better able to resist the harmful effects of extreme heat
Infrastructure, technology, innovation	• Personalized, automated warning systems (by telephone and internet) for vulnerable individuals
Information sharing	• Launch of “Mon climat, ma santé” website to disseminate accessible information • Development of an interactive atlas of health vulnerabilities to climate change • Installation of a warning system for intense heat • Enhancement of information and training tools and methods intended for the general public, organizations, medical staff and elected officials

Capacity building	• Developing a Climate Change Adaptation Plan: Guide for the Québec Municipal Sector • Intervention plan to protect populations from West Nile virus • Training sessions for public health, clinic service and civil protection personnel concerning infectious diseases and emerging health problems

Research has shown that health interventions in an Indigenous context are often rendered ineffective if they do not consider Indigenous understandings of health and illness (Gracey and King 2009; Smylie et al. 2009). In addition, health adaptations without traditional knowledge integration will lack an important local and holistic perspective of climate change impacts on health (Bolton et al. 2011; McClymont Peace and Myers, 2012; Pearce et al. 2015). Approximately one fifth of Health and well-being initiatives (22%, n=20) included traditional knowledge. A prominent example is Health Canada's Climate Change and Health Adaptation Program (CCHAP) for Northern First Nations and Inuit Communities. CCHAP was designed to support northern Indigenous communities in researching climate change impacts on health: communities chose relevant areas of research, developed the tools and methods to adapt, incorporated scientific and traditional knowledge, and engaged their members in emerging the results (McClymont Peace and Myers, 2012). Since its establishment in 2008, this program has funded four initiatives in Nunavik, including the Real-Time Monitoring for Travel Safety and Food Security program conducted in Akulivik, Salluit, and Kuujjuarapik. The Nunavik Ice portal (see section 3.7.5), an output of CCHAP, is an example of a community-based research initiative that combines scientific research and Inuit knowledge to develop a monitoring tool that assists subsistence hunters to make safer decisions when accessing traditional foods (Health Canada, 2011). As such, as mentioned in the initial 2011 study, additional integration of traditional knowledge into health adaptation initiatives would help improve initiative uptake and effectiveness. Likewise, multiple collaborators recommended creating culturally appropriate health services and adaptation strategies through the integration of traditional knowledge in adaptation initiatives.

Corresponding to the recognition that climate change has substantial negative impacts on mental health through a variety of direct and indirect mechanisms, 14% (n=13) of Health and Well-being adaptation initiatives' primary non-climatic motivating stimulus was mental health. In line with findings from the initial gap analysis, highlighting a lack of adaptations addressing mental health impacts in Nunavik, one action initiative was captured by the systematic review in the form of the mental health component of the Nunavik health survey. Documented initiatives took the form of policy recommendations some of which are highlighted in table 3.6; translating these recommendations into actions would contribute to assisting individuals in adapting to the mental health impacts of climate change. In Nunatsiavut for example, the Inuit Mental Health Adaptation to Climate Change project, is a community-based project aimed to highlight existing mental health programs that need additional support, as well as determine gaps in the current health-care system within the context of a changing climate in five communities (IK-ADAPT, 2016). Alongside training mental health professionals to help those dealing with environmental change, similar projects in Nunavik could increase adaptive capacity by understanding community specific relationships between climate change and mental health and well-being.

Table 3.6: Examples of adaptation initiative policy recommendations targeting mental health

Year	Policy recommendation	Collaborators
2014	Research best practices in implementing evidence-based mental health strategies	King's College London, McGill University, Cape Breton University
2014	Climate change and mental health training for professionals	King's College London, McGill University, Cape Breton University
2014	Educate patients on the mental health impacts of climate change	King's College London, McGill University, Cape Breton University
2015	Funding, creating, and mobilizing mental health programs and infrastructure	Cape Breton University, McGill University, University of Minnesota Medical School, King's College London, McMaster University, Sami National Centre for Mental Health, University of Illinois, University of Winnipeg, Haverford College, University of Sunshine Coast

An array of adaptations in response to the increasing food security risks posed by climate change have been suggested; these include addressing transportation infrastructure risks (see Section 3.7.1), engaging in species substitution (see Section 3.7.5), and promoting regional sharing networks (see Section 3.7.5). However, the decreased food availability due to climate change is also contributing to the documented diet transition, in which consumption of store foods is on the rise. Accordingly, a completed adaptation initiative responding to food security concerns was an autonomous initiative in which individuals reported purchasing additional store foods due to decreased access to country foods. However, due to the high costs of nutritious store foods combined with low knowledge of healthy food choices, such food switching is contributing to unhealthy consumption habits, thus adding to the rise in chronic diseases, including obesity and diabetes (Beaumier & Ford, 2010). In response to these concerns, documented policy recommendations included maintaining nutritional monitoring data, developing nutrition supplement programs, and implementing a National Inuit Food Security Strategy. While the Government of Canada's Nutrition North Canada subsidizes nutritious foods in northern communities, consumption of healthy foods still remains low in Nunavik (Allard and Lemay, 2012). Additional policies and programs designed to improve access to low-cost healthy store foods and to promote health and nutrition education within communities would help to address the emerging food security and chronic disease crises.

In 2014, the Council of Canadian Academies, tasked by Health Canada, published an assessment of the state of knowledge of Aboriginal food security in Northern Canada, which contained several food security policy recommendations (Council of Canadian Academies, 2014). Importantly, this report emphasized the significance of lived northern experience and traditional knowledge in defining and addressing food security issues; the lack of a comprehensive review of northern food security derived from the first-hand experience and knowledge of northern peoples was therefore a major knowledge gap identified within the report (Council of Canadian Academies 2014). Ongoing incorporation of Inuit knowledge and consideration of residents' lived experiences will therefore be essential for any initiatives that seek to address food security concerns (Council of Canadian Academies, 2014).

Community freezers are present in all communities, and are stocked by local hunters or community programs intended to increase time spent on the land (see Section 3.5.4 and 3.7.5).

The use of these freezers increases the adaptive capacity of communities by providing all residents with an access point for country foods. Since the initial gap analysis, alternative local food provisioning strategies are being piloted in three communities (Kuujjuaq, Quaqtaq and Akulivik) in Nunavik. The Government of Québec has entered a five-year partnership with KRG to foster technology transfers in the agro-food sector, as well as to support initiatives that promote agricultural potential, greenhouse production, food processing, and food security more generally. Results from a research project examining the long term viability of a community run greenhouse in Kuujjuaq showed that there is interest in and concerted support from all sectors for this type of initiative (Avard, 2015). Findings also showed that a greenhouse-based local food strategy in Nunavik is technically feasible and can be developed in a manner that is culturally appropriate and socially acceptable. Consequently, two community run greenhouses are operational in Kuujjuaq and supply residents with vegetables on a rotational basis. In another more recent initiative (2014), the CCHAP is assessing the feasibility of a small scale hydroponic rotating garden in the community of Quaqtaq (Health Canada, 2016). Additional research into local food production opportunities could help communities benefit from climate change impacts by increasing the affordability and accessibility of fresh and healthy foods. The third initiative, supported by the local hunter and trapper's organization, involves the installation of a heated chicken coop and egg production facility enabling distribution and sale in the communities of Kuujjuaq and Akulivik. Expanding existing initiatives or establishing new initiatives to help serve all Nunavik's communities could serve to increase regional adaptive capacity.

Climate change is expected to exacerbate water contamination, as well as water-borne, food-borne, vector-borne, and zoonotic disease risks. Martin et al. (2005) found that 30% of the Inuit population in Nunavik depend on untreated water for consumption, and increased rates of illness are already being seen compared to the rest of Québec. The 2004 Nunavik health survey indicated that frequent cleaning of domestic water reservoirs had a protective effect with the prevalence of diarrhea episodes being lower among households that cleaned their domestic water reservoir at least every two to six months, compared to those who did so less often (Government of Québec, 2007). An update to the Nunavik health survey that is currently underway (Qanuippitaa 2015-2018) presents an opportunity to re-assess these findings. The objective of this second phase includes a follow up of the health status of the 2004 participants covering chronic diseases, infectious diseases and mental health; a new youth cohort to identify indicators of health and well-being pertaining to this age-group; and a diagnosis of health and well-being at the community level. By adopting a participatory approach to identify needs and themes of interest, this survey increases adaptive capacity through the collection of data that can be used to inform multi-sectorial health, social and environmental policies promoting health and well-being and fostering Inuit culture and resilience.

As documented in the initial gap analysis study, community-based monitoring programs for contaminants and pathogens increase the involvement of residents in local policy action and develop adaptive capacity (Allard & Lemay, 2012; Martin et al., 2007). Such programs have provided valuable information to inform evidence-based decision making in order to combat the spread of pathogens, reduce the consumption of contaminated food or water, and prevent potential disease outbreaks (Martin et al. 2007; Gauthier et al. 2010; Allard and Lemay 2012). Under the Northern Contaminants Program (NCP), levels of mercury, cadmium and other metals have been measured in fish and marine mammals through a community sampling network that

extends throughout the Canadian Arctic. Gauthier et al. (2010) implemented onsite micro-biological tests for food-borne pathogens. A goal of the project was to assess the feasibility of various testing methods applied to samples obtained from hunters and community freezers in Nunavik. The testing method was found to be rapid and inexpensive, and if implemented successfully, it would both monitor community freezers for the presence of food-borne pathogens and build community level capacity. The Nunavik *Trichinellosis* Prevention Program is yet another similar initiative led by NRC with a current focus on hunted walrus meat (Larrat et al. 2012). Seroprevalence studies have also been undertaken for *Toxoplasma gondii* in seal populations (Simon et al. 2011) while more recent work is focusing on human exposure to rabid animals (Simon et al. 2014, Leighton, 2017). Further research and monitoring of other regional sources of parasites such as polar bear, black bear, wolf and fox could certainly increase adaptive capacity and inform additional adaptation initiatives (Larrat et al., 2012).

In response to higher temperatures and increasing heat-wave frequency, Health Canada initiated the Heat Resiliency Project, which has since produced a Best Practices Guidebook on Heat Alert and Response Systems (2011) and Guidelines for Health Care Workers regarding Extreme Heat Events (2011). The Government of Québec has also taken several initiatives, some of which are outlined in Table 4.5 to enhance adaptive capacity in the face of rising temperatures. These initiatives promise to increase the resilience of Nunavik's communities to the health impacts of extreme heat, however region-specific guidebooks and guidelines may assist in developing specific adaptation and response options.

Although increased UV radiation exposure has already had documented negative health impacts on Nunavimmiut (Bolton et al., 2011; Nickels et al., 2006), no initiatives targeted this climatic risk. Data on UV exposure levels, and their relationship to the incidence of related health impacts, would help with developing guidelines for the Inuit who often spend lots of time outside.

Finally, an increase in accidents while engaging in land-based activities has already been reported in Nunavik (Government of Québec, 2007; Allard and Lemay., 2012). Several documented policy recommendations therefore identified the need to evaluate and enhance search and rescue capacity in Nunavik. As described in Section 3.7.5, ensuring that youth have adequate education with respect to land skills and Inuit knowledge could also help to increase safe travel practices. Additionally, information regarding travel and safety practices, as well the circumstances surrounding land-based injuries could be collected to inform initiatives seeking to promote injury prevention.

Table 3.7: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions in the Health and well-being sector

Climatic sensitivities and exposures	• Climate change has been identified as one of the biggest health threats of the 21st century • Inuit are expected to suffer disproportionally from climate change impacts on health • Climate change is reducing the quantity, quality, and accessibility of freshwater resources • Incidence and transmission of vector-borne, zoonotic, and food-borne diseases are expected to increase as a result of increased temperatures • Climate change will increase ecosystem contaminant concentrations; contamination risks will increase as mining and extraction activities intensify.

	• Climate change will impact food security by affecting transportation networks, country food accessibility and quality, and small-scale local agriculture opportunities • Increasingly unpredictable weather and environmental conditions, combined with sea ice loss and other factors, are expected to increase the dangers of spending time on the land • By disrupting land-based activities and destroying important cultural sites, climate change will exacerbate mental health and well-being issues in Nunavik • Climate change is expected to increase temperature-related morbidity such as frostbite, hypothermia, respiratory distress, asthma, and allergies • More ultraviolet (UV) radiation exposure is linked with skin cancer and eye damage
Current state of adaptation	• Research and monitoring adaptation initiatives dominated the sector • One fifth of adaptation initiatives included Inuit knowledge • Nunavik health survey (Qanuippitaa 2015-2018) serves as an update to the 2004 survey and aims at expanding thematic focus to include a new youth cohort as well as community level programming • Martin et al. (2007) tested the quality of raw and stored water sources throughout Nunavik, and recommend the active involvement of community members in the regular assessment of resource levels and quality • While Québec has a comprehensive climate change adaptation plan with a detailed health section, it still remains unclear to what extent these provincially initiated adaptation initiatives are being applied at the regional level • No adaptation plans for regional health authorities were documented • Alternative local food provisioning strategies are being piloted in two communities in Nunavik including greenhouses and a hydroponic rotating garden • No evidence of an increase in residential monitoring of stored water quality beyond the weekly testing of water commissioned by the KRG prior to supply and distribution. • Levels of mercury, cadmium and other metals are being monitored in fish and marine mammals through a community sampling network under the Northern Contaminants Program • Makivik's Nunavik Research Centre houses a pathology laboratory that monitors wildlife diseases that affect animal health or can infect humans such as the Trichinellosis Prevention Program • Health Canada's Heat Resiliency Project will increase communities' heat resilience • No initiatives addressed increase UV exposure
Gaps and Future needs	• Comprehensive adaptation plans for regional health authorities would assist in creating a coordinated adaptation response within the sector • Further translation of research results into action could accelerate the adaptation process • An institutional readiness-focused assessment in Nunavik would help to identify areas where intervention is needed to enhance adaptation preparedness • Additional integration of traditional knowledge into health adaptation initiatives would help improve initiative uptake and effectiveness • Community based projects such as Inuit Mental Health Adaptation to Climate Change in Nunatsiavut could be replicated in Nunavik to better understand climate impacts on mental health and increase adaptive capacity • Food security policy recommendations included implementing a National Inuit Food Security Strategy; additional policies/programs to improve access to healthy store foods and promote nutrition education would help to address food insecurity concerns • Further research into the potential for small-scale local agriculture and scaling up successful initiatives that are currently underway could help increase the affordability and accessibility of fresh and healthy foods

	• Policy recommendations included evaluating and enhancing search and rescue capacity • Information regarding travel and safety practices, and circumstances of land-based injuries could be collected to inform injury prevention initiatives especially in the face of a changing climate • Extending community-based pathogen and contaminant monitoring programs to include other species used for country food could inform decision making to reduce infection and contamination • Research concerning vector-borne and zoonotic disease transmission in the Arctic environment could inform additional adaptation initiatives • Region-specific guidebooks and guidelines for extreme heat may assist in developing specific adaptation and response options • UV exposure and related health impact data would help develop adaptation guidelines

3.7.3 Business and Economy

Nunavik residents rely on a mixed economy with contributions from the public sector, the private sector, the social economy and traditional harvesting of renewable resources. Economic sectors include mining, tourism, transportation and the service industry. In addition, the Makivik Corporation through ownership and management invests into a number of Nunavik-based businesses, including First Air, Air Inuit, Nunavik Creations, and Kauqtaq Construction to name a few, to generate employment opportunities and reinvests profits into community projects (Rodon, 2015). Aside from financial earnings, these subsidiaries enhance adaptive capacity by generating training and employment opportunities.

As described in Section 1.1, Nunavik's communities are disproportionately faced with low socio-economic status, high unemployment rates, and low educational achievement levels, each of which contribute to pronounced community- and regional-scale climatic vulnerability (Bolton et al., 2011; Ford, Berrang-Ford, King, & Furgal, 2010; Ford & Berrang-Ford, 2015). Limited infrastructure and high transportation costs also contribute to the high cost of living, thereby exacerbating financial constraints and further constraining adaptive capacity (Bolton et al., 2011). However, new business and economic development opportunities hold promise for providing access to cash resources and reducing poverty, which is often a major factor creating climate change vulnerability (Ford et al. 2010b, 2012; Bolton et al. 2011).

Climate change impacts present both risks and opportunities for Nunavik's mixed economy. Warmer winters, extended periods of ice-free waters, and sea-ice retreat will improve accessibility to ports enhancing potential for development (Plan Nord, 2015). While beneficial for the region's business and economic sector, the wave of industrial development in the region will have direct implications on Inuit lifestyles and traditional practices that will already be stressed by changing climatic pressures (see section 3.7.4 and 3.7.5). Therefore, while increased opportunities exist for industrial development bringing wealth into the region, they also carry the potential to threaten the resources essential to maintaining the Inuit way of life (Philie, 2013).

Climatic sensitivities and exposures

Climatic changes are projected to have a variety of impacts on Nunavik's natural resource economy (Bolton et al., 2011; Furgal et al., 2008; Lemmen et al., 2016). The mining sector will be faced with both challenges and opportunities as climate change progresses (Ford et al., 2011;

Furgal et al., 2008). Nickel and copper mines, such as Glencore's Raglan and Canadian Royalties' Nunavik Nickel are important employers and economic activity generators in the region (Makivik Corporation, 2016). Mining development is expanding rapidly, aided by reduced sea-ice cover in summer months, which is improving shipping access and is expected to be beneficial for future expansion (Pearce et al., 2011; Ford et al., 2011). Additionally, a survey of Canadian mining practitioners found that offsite and on-site transportation were identified as the aspects of mining operations most sensitive to climate change (Ford et al., 2011). Due to the primary dependency on marine shipping, Nunavik's mining sector is expected to benefit from reduced sea ice extent due to longer shipping seasons (see Section 3.7.1) and greater expansion and exploration opportunities (Furgal et al. 2008; Ford et al. 2011a, 2012; Pearce et al. 2011c). Nevertheless, since the mines are fly-in/fly-out operations (i.e. employees depend on air transportation to access the mine), they are also vulnerable to climate change impacts affecting air transportation, including increased storm frequency (see Section 3.7.1) (Ford et al., 2011a; Savard et al. 2014; Lemmen et al., 2016).

Climate change is expected to result in mixed outcomes for Nunavik's tourism industry (Bolton et al. 2011; Lemelin et al. 2012). Current tourism opportunities being offered in the region include guided hunts of caribou, fishing of trout and charr, canoeing, hiking, mountain climbing, cruise tourism and ecotourism (Lemelin et al. 2012). However, following a rapid decline in herd numbers, sport hunting of caribou will be banned at the beginning of 2018 as herds can no longer sustain this activity. Changing sea-ice regimes are increasing the opportunities for cruise boat tourism, with potential employment and income generating opportunities (Stewart et al. 2007; Dawson and Stewart 2014). However, sea ice and the wildlife it sustains are key appeals for Arctic cruise tourism; decreasing sea-ice extent and coverage may therefore reduce interest in Arctic tourism (Stewart et al. 2010). It may however also create a spike of 'last chance tourism,' in which tourists seek vanishing landscapes and culture (Mattina 2014). The continuing possibility of iceberg encounters presents dangers to cruise ships (Stewart et al. 2010). Lastly, tourism activities that rely on fishing are especially sensitive to climate changes driving down the abundance of several important species including Arctic charr (see section 3.7.5). However, while some species are being threatened by climatic changes, the northerly range shift of other species, including cod, due to rising ocean temperatures, could present new opportunities (Power et al. 2012; Bélanger et al. 2013).

As mentioned above and in Section 3.7.1, an extended open-water season will expand opportunities and reduce costs for food and goods transportation, lower costs of mineral exploration and exploitation, and provide more reliable transportation routes connecting Nunavik's communities with southern ports (Allard and Lemay, 2012). These will have significant impacts on Nunavik's residents, including decreasing the cost of living, increasing affordability of a wider variety of fresh foods, and enhancing potential business opportunities (Bolton et al. 2011; Lemmen et al. 2016).

As described in Section 3.7.5, climate change is presenting a number of challenges for Nunavik's subsistence economy, and these impacts are projected to continue into the future (Nickels et al. 2006; Ford et al. 2008; Lemmen et al. 2016). The increased risks associated with subsistence activities combined with reduced species availability and accessibility due in part to climate change are decreasing engagement in and yields from, land-based activities (Bolton et al. 2011;

Pearce et al. 2015; Lemmen et al. 2016). This is resulting in reduced traditional knowledge transmission and country food consumption, which are key components to Inuit adaptive capacity (see Section 3.7.4) (Ford et al. 2012; Lemmen et al., 2016; Pearce et al. 2015). In addition to dangerous environmental conditions, the continually increasing costs of equipment required for safe participation in subsistence harvesting activities, such as satellite phones, are further restricting individuals' capacity to engage in these activities (see Section 3.7.5) (Ford et al. 2010c, 2012; Bolton et al. 2011). Thus, research has found that the most productive households with respect to subsistence harvesting are generally also the wealthiest in terms of monetary assets, whereas households with few monetary assets no longer have the means to engage in this sector (Allard and Lemay, 2012). Lastly, wage-employment is becoming increasingly prevalent and is tied to rigid work schedules that are often at odds with the timing of subsistence activities (Ford et al. 2010c). As a whole, decreasing participation in the subsistence economy is having knock-on effects on the monetary economy. Individuals are forced to rely on expensive market foods, thereby exacerbating existing poverty, food insecurity, and health challenges (see Section 3.7.2) (Allard and Lemay, 2012; Beaumier and Ford, 2010).

Current state of adaptation and future adaptation directions

The Business and Economy sector was a relatively active sector in adaptation, with 55 (8%) initiatives documented. As summarized in Figure 3.12, initiatives were predominantly implemented at the national (60%, n=33) and northern Canadian (18%, n=10) scale, with the remainder applied at the regional (7%, n=4) or autonomous level (7%, n=4). More than two thirds (78%, n=42) of the initiatives were groundwork, and a vast majority (62%) were past the stage of recommendation. The most frequent typology was research and monitoring (49%, n=27). No infrastructure, technology, innovation or information sharing initiatives were documented. Unique to this sector, none of the initiatives explicitly included traditional knowledge.

Note: The low number of initiatives reported for this sector may be a function of the systematic review methodology, which relied heavily on online reporting. Though grey literature sources were consulted, no documents pertaining to the local or regional scale was captured in the reviewed literature. While findings were complemented with input from the Climate Change and Clean Energy workshop and the Knowledge Transfer Workshop both held in Kuujjuaq, future evaluations of private sector initiatives should focus resources on stakeholder interviews.

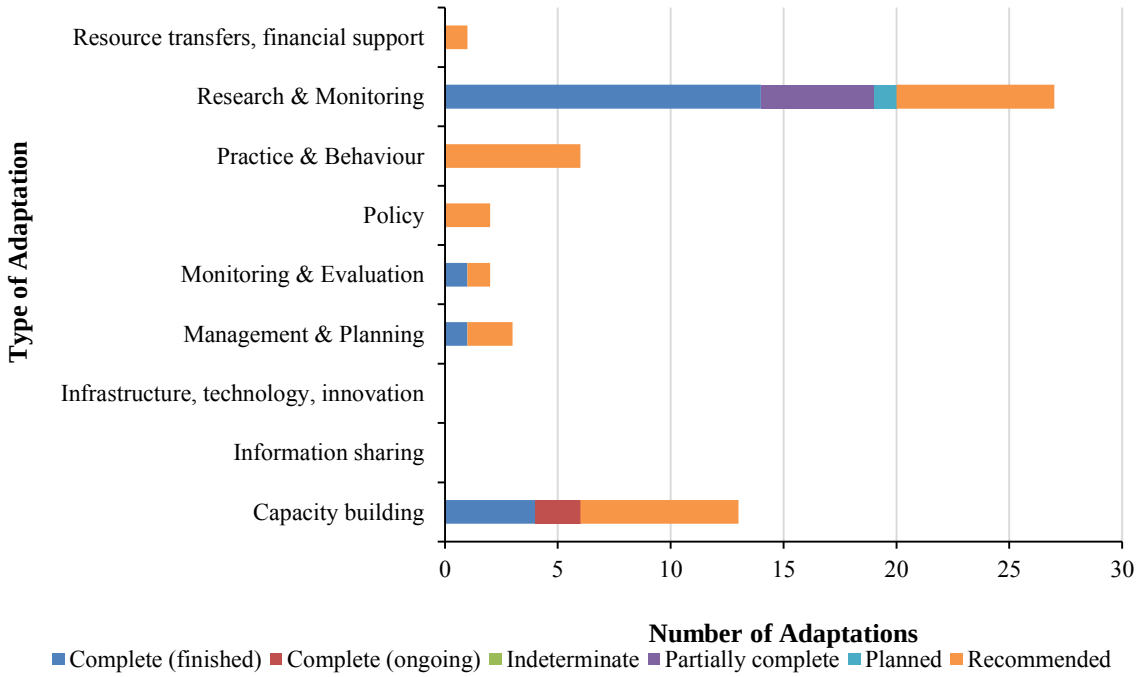


Figure 3.12: Adaptation type by status of action for Business and Economy initiatives (n=55)

In response to the climate change threats to the Business and economy sector, several initiatives have been developed since the publication of the initial gap analysis study to assist stakeholders in this sector to better understand the economic impacts of a changing climate. The Climate Change Impacts and Adaptation for Key Economic and Natural Environmental Sectors project (2011) within Natural Resources Canada's Climate Change Geoscience Program was a key initiative examining the potential impacts of climate change on energy supply, agriculture, and northern Canadian natural capital, and identifying adaptation options (Natural Resources Canada, 2011). Documented initiatives applied to economic sectors at the national scale with none specific to Nunavik. This is noteworthy given that while the private sector may be expected to autonomously exploit new opportunities, northern Canadian economies face unique logistical, regulatory, environmental, and financial barriers (Lemmen et al. 2016). As such, Nunavik's private sector, such as mining and energy development, may lack the capacity to adapt autonomously; regional scale initiatives are therefore particularly important to assist in this process. Increasing the availability of adaptation best practices information and decision-making support tools, as well as providing funding opportunities, could help the private sector undertake adaptation initiatives of its own. Moreover, localized studies examining climate change impacts on key economic activities in Nunavik could aid in informing a streamlined strategy better tailored to enhance adaptive capacity for the regional economy and local businesses alike.

Mining operations are rapidly expanding in the region and are expected to play a growing role in northern economies (Government of Québec, 2015). This activity was reflected in the review as more than half (63%, n=13) of the initiatives documented beyond the recommendation stage consisted of research studying the effects of climate change on mining activities at the national scale. Aside from industry environmental assessments, no studies tried to determine the local socio-economic and environmental impacts of mineral extraction on surrounding communities

and their implications (positive or negative) for climate vulnerability and adaptation. Whilst mining employment has the potential to address certain economic adaptive capacity constraints at the community level, it may also negatively affect communities and local resources (Bernauer, 2011). Few initiatives (Philie, 2013) investigated the broader socio-economic, cultural, and environmental impacts of industrial development on local communities and their subsequent implications for climate vulnerability and adaptation; a better understanding of these effects could assist with adaptation planning within this sector.

As industrial development continues to intensify, greater importance would need to be placed on methods to better integrate subsistence harvesting activities with a modern income and employment generating sector (Conference Board of Canada, 2013). Impact-benefit agreements have become standard components of resource governance in the Canadian North, but no public policy framework guides their negotiation, terms of reference, or implementation (Keeling et al., 2012). No initiatives addressed the interactions of industrial development and the traditional economy. Given the importance of the mixed economy for Inuit adaptive capacity, efforts to better integrate subsistence activities with wage-based employment could serve to assist Nunavimmiut in maintaining traditional adaptive capacities.

Although controversial, as proposed in the 2011 gap analysis study, the commoditization of country food has been noted as an adaptive capacity enabler by providing means to adapt to the costs of engaging in subsistence activities through changing environmental conditions (Ford 2009; Ford et al. 2012). As described further in Section 3.7.5, the Hunter Support Program and Community Freezer Programs have also contributed to supporting Nunavik's subsistence economy. They are present in all communities, and are stocked by local hunters or community programs and increase the adaptive capacity of communities by providing all residents with an access point for country foods (Chan et al. 2006; Finner 2015). With regards to species substitution, as discussed in Sections 3.7.3 and 3.7.6, following the While cultural tradition disfavors the selling or buying of traditional foods, it may create an economic opportunity with respect to supporting traditional ways (Ford et al., 2012, 2016b). Moreover, during the regional workshop in 2017, residents discussed the need to find ways to increase the availability of country foods circulating in communities via commercial sale and distribution. Several projects that market and commercialize local products, including caribou meat, processed fish, and plants (herbal teas) have been undertaken in Nunavik with the approval of the Kativik Environmental Quality Commission (Jacobs et al., 2009). No evaluation of the opportunities and challenges pertaining to commoditizing traditional foods in Nunavik were captured by the review, unlike in Nunavut (Ford et al., 2016b); such research would contribute to understanding how best to assist the subsistence economy in adapting to climate change. Participants of the workshop also recommended the need for training in those sectors less susceptible to the impacts of climate change. As discussed in detail in section 3.7.2 and 3.7.5, climate pressures on subsistence activity will have adverse impacts on country food harvesting. Although the idea was met with mixed opinions at the workshop, the potential for training programs in greenhouse food production and animal husbandry was discussed.

With respect to the potential for significant economic benefits with climate change as reduced ice extent opens up opportunities for shipping (Stephenson et al., 2011), only a single research study was captured by the review to examine the opportunities and how they should be managed. Supported by Glencore's Raglan mine and the Institut national de la recherche scientifique (INRS),

the Regional government (KRG) has initiated a sea-ice monitoring project at Deception Bay, Salluit and Kangiqsujuaq with the aim of analyzing the impact of increased shipping traffic in the region and on the local ecosystem (Kativik Regional Government, 2016). Additionally, while an increased open-water season is promising, it is also important to note that warmer temperatures combined with increased shipping will exacerbate loss of ice, increase risks of accidents and spills, and could magnify the risks associated with travelling to harvesting grounds (Lemmen et al., 2016). Additionally, milder Arctic summers have also sent hard-packed icebergs into shipping routes, potentially increasing the dangers associated with marine transportation (Lemmen et al., 2016, Clark and Ford, 2017). Research into the impacts of climate change on marine transportation in terms of the risks and benefits could be conducted to better understand and quantify these risks.

Finally, economic development trajectories in the North are highly uncertain, influenced by external conditions (e.g., market conditions, transportation access, government policy, international regulations) (Keskitalo and Kulyasova 2009; Ford et al. 2012; Lemmen et al. 2016). However, no initiatives examined how these broader influences will affect vulnerability and adaptation in Nunavik. Scholarship on the topic has documented the limited power of local and regional governments to influence these trends (Keskitalo and Kulyasova 2009; Ford et al. 2012), thus presenting an important policy-entry point for higher levels of government.

Table 3.8: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions in the Business and Economy sector

Climatic sensitivities and exposures	• Nunavimmiut rely on a mixed-economy composed of monetary and subsistence economies; climate change impacts present risks and opportunities to both economies • Numerous socio-economic factors contribute to regional-scale climatic vulnerability • Economic development can reduce poverty, thereby increasing adaptive capacity • An erosion of adaptive capacity via social, cultural, economic, and political changes accompanied by increased industrial development will further challenge capacity to adapt. • Declining sea ice cover and duration will increase open water season length, thus increasing marine navigability; however, this may be accompanied by increased risks of accidents and spills. • Mining infrastructure is sensitive to permafrost degradation and extreme weather events • The mining sector will benefit from reduced sea ice extent through longer shipping seasons and more expansion/exploration opportunities; however, it is also vulnerable to climate change impacts affecting air transportation, including increased storm frequency • Increased storm frequency, reduced sea ice, and changing species distribution will have mixed effects on the commercial fishery and aquaculture industry • Cruise tourism opportunities may increase as the open-water season is extended; however, declining sea ice may reduce interest in Arctic tourism • Climate change will challenge the subsistence economy (see Section 3.7.5); wage-based employment often also competes with participation in the subsistence economy
Current state of adaptation	• The majority of initiatives were groundwork oriented, with research and monitoring of mining related development at the national scale featuring most prominently • No infrastructure, technology and innovation or information sharing initiatives were documented. • No localized initiatives investigating impacts on key economic activities

	• The Climate Change Impacts and Adaptation for Key Economic and Natural Environmental Sectors project examined climate change impacts and adaptation options for the Business and economy sector; no similar localized initiatives were documented • Evidence of continued integration of subsistence harvesting activities with income and employment generating sector • Aside from industry environmental assessments, no studies tried to determine the local socio-economic and environmental impacts of mineral extraction on surrounding communities and their implications for climate vulnerability and adaptation • No documented adaptation initiatives included Inuit knowledge • The commoditization of country food has occurred in Nunavik yet opportunities and challenges have not been explored to inform the viability of such an initiative to enhance adaptive capacity in the future
Gaps and Future needs	• The uptake of commercial agriculture (greenhouses and animal husbandry) is a controversial yet possible enabler of adaptive capacity, worthy of further investigation. • Tourism will be impacted by climate change. Mechanisms that allow Inuit to benefit from these activities, such as cultural tourism, should be identified and communicated to the region in order to maximize the potential benefits • Adaptation initiatives suggested exploring methods to increase the availability of country foods circulating in communities via commercial sale and distribution • Research into the impacts of climate change on marine transportation in terms of the risks and benefits could be conducted to better understand and quantify these risks • Localized studies grounded in the understanding of climate change impacts on key economic activities in the region could aid in informing a streamlined strategy better tailored to enhance adaptive capacity for the regional economy and local businesses alike. • Economic development trajectories in the region are highly uncertain and impacted by external conditions (e.g., market conditions, transportation access, government policy, international regulations), presenting an important policy-entry point for higher levels of government. • Assessing the extent to which traditional knowledge is integrated and consulted in decision-making would be key to evaluating adequacy of current methods of participation in environmental and social governance processes surrounding industrial development and climate change adaptation. • Efforts to better integrate subsistence activities with wage-based employment would serve to assist Nunavik residents in maintaining traditional adaptive capacities

3.7.4 Culture and Education

Climate change poses a variety of indirect threats to Nunavik's Culture and Education sector. Given that Inuit culture is closely intertwined with the environment and the activities that it sustains (e.g. hunting, fishing, trapping), subtle alterations to the land can substantially impact Inuit communities by influencing their ability to engage in land-based activities, the health and abundance of culturally valued wildlife species, and the integrity of culturally important infrastructure and sites (Bolton et al. 2011; Ford et al. 2012; Cunsolo Willox et al. 2015b; Pearce et al. 2015; Lemmen et al. 2016). These climatic influences are compounded by a broader context of cultural transition documented within Inuit communities, due in part to modernization, the introduction of a waged economy, and hunting quotas (Lemmen et al., 2016). Since Inuit culture and knowledge underpin the substantial resilience and adaptive capacity exhibited by Inuit populations in the past, the erosion of traditional knowledge, land-based skills, and other

cultural traditions has been identified as a clear inhibitor of adaptive capacity (Bolton et al., 2011; Ford et al., 2012; Pearce et al., 2015). As such, by increasing sensitivities to climatic risks, climate change impacts on the Culture and education sector have substantial knock-on effects on other sectors (e.g. Hunting and Subsistence Harvesting (see Section 3.7.5), Health and Well-being (see Section 3.7.2)).

Climatic sensitivities and exposures

As described in Section 3.7.5, changing snow and ice regimes, unpredictable weather conditions (including extreme weather events), and altered wind patterns are significantly increasing the dangers associated with subsistence harvesting activities (Ford et al. 2008; Lemmen et al. 2016). These activities are integral to Inuit identity and culture, and are important opportunities for traditional knowledge, language, and value transmission between Elders and younger generations (Cunsolo Willox et al. 2013b; Pearce et al. 2015; Lemmen et al. 2016). Inuit knowledge is typically transmitted by Elders and other experienced individuals through hands-on land-based education (Pearce et al., 2015). However, research has documented that the increased risks associated with subsistence activities due to climate change are negatively impacting individuals' confidence, ability, willingness, and desire to engage in land-based activities (Bolton et al., 2011; Lemmen et al., 2016; Pearce et al., 2015). These limits to engaging in subsistence harvesting activities are further compounded by time constraints due to wage-based employment, financial barriers, and a general disengagement of younger generations from the land and subsistence activities (see Section 3.7.5) (Bolton et al., 2011; Lemmen et al., 2016). As a result, traditional knowledge and land-based skill transmission is believed to be on the decline, thus hampering Inuit adaptive capacity and increasing the vulnerability of younger generations to the unpredictable travel conditions that are expected to increase in frequency as a result of climate change (Section 3.7.5) (Ford et al., 2012; Lemmen et al., 2016; Pearce et al., 2015). The weakening of close relationships between the younger generation and their Elders due to less time devoted to traveling on the land is also threatening Inuit cultural identity (Ford et al., 2012).

In addition to participation in subsistence harvesting activities, country food consumption is an important component to Inuit culture, as well as food security and physical health (see Section 3.7.2) (Bolton et al., 2011; Cunsolo Willox et al., 2013b). Declining participation in subsistence activities due to climate change, combined with climatic factors influencing the abundance, migration, distribution, and ranges of several animal species important for subsistence harvesting activities, are limiting the availability of country food in Nunavik's communities (Prowse et al. 2009; Sharma et al. 2009; Allard and Lemay 2012; Lemmen et al. 2016). This effect is particularly pronounced for caribou, which are considered the most important terrestrial subsistence resource for Nunavimmiut, due in part to the strong cultural connection associated with this species (Mameamskum, 2013; Le Corre et al., 2014; Wilson et al. 2014). Consequently, climate change is a major contributing factor to the decreasing country food consumption recorded in Nunavik (Allard & Lemay, 2012). Furthermore, community country food sharing networks are an important element of Inuit culture, which unite community members, maintain important social connections, and contribute to Inuit adaptive capacity (Bolton et al. 2011; Ford et al. 2012; Cunsolo Willox et al. 2013b; Lemmen et al. 2016). Reduced availability of country food, combined by broader societal changes such as the development of the waged economy are affecting the integrity of traditional sharing networks, thus impacting the development and

maintenance of cultural connections and heightening the vulnerability of Inuit communities to climate change (Bolton et al., 2011; Ford et al., 2012; Lemmen et al., 2016).

Other cultural impacts of climate change may stem from the potential for increased risk of pathogens and contaminants in country foods due to climate change (see Section 3.7.2) (Nickels et al. 2006; Parkinson et al. 2008; Donaldson et al. 2010; Allard and Lemay 2012; Calder et al. 2016). The perception of country foods as less safe may reduce consumption levels or increase anxiety associated with eating country foods, thus impacting cultural traditions that are often centered around country food consumption (Nickels et al. 2006; Donaldson et al. 2010; Bolton et al. 2011; Lemmen et al. 2016).

Lastly, climate change may also affect impact culture through damage to important cultural sites (e.g. graveyards, hunting grounds) by permafrost thaw and coastal erosion (see Section 3.7.1) (Lemmen et al. 2007; Prowse et al. 2009; Ford et al. 2010c; Bolton et al. 2011).

Current state of adaptation and future adaptation directions

The Culture and Education sector was the least active sector in adaptation, with 18 (3%) adaptation initiatives documented. Unlike most sectors, initiatives were predominantly implemented at the community (44%, n=8) or individual/family (22%, n=4) scales. Groundwork initiatives (61%, n=11) were more common than action adaptations (38%, n=7), with capacity building (50%, n=9) and information sharing (28%, n=5) initiatives featuring most prominently. No management and planning, or infrastructure, technology and innovation initiatives were documented. Additionally, as shown in Figure 3.13, 7 adaptation initiatives were beyond the stage of being recommended or planned; some of these initiatives are described in more detail in Table 3.9. 83% of all adaptation initiatives included Inuit knowledge.

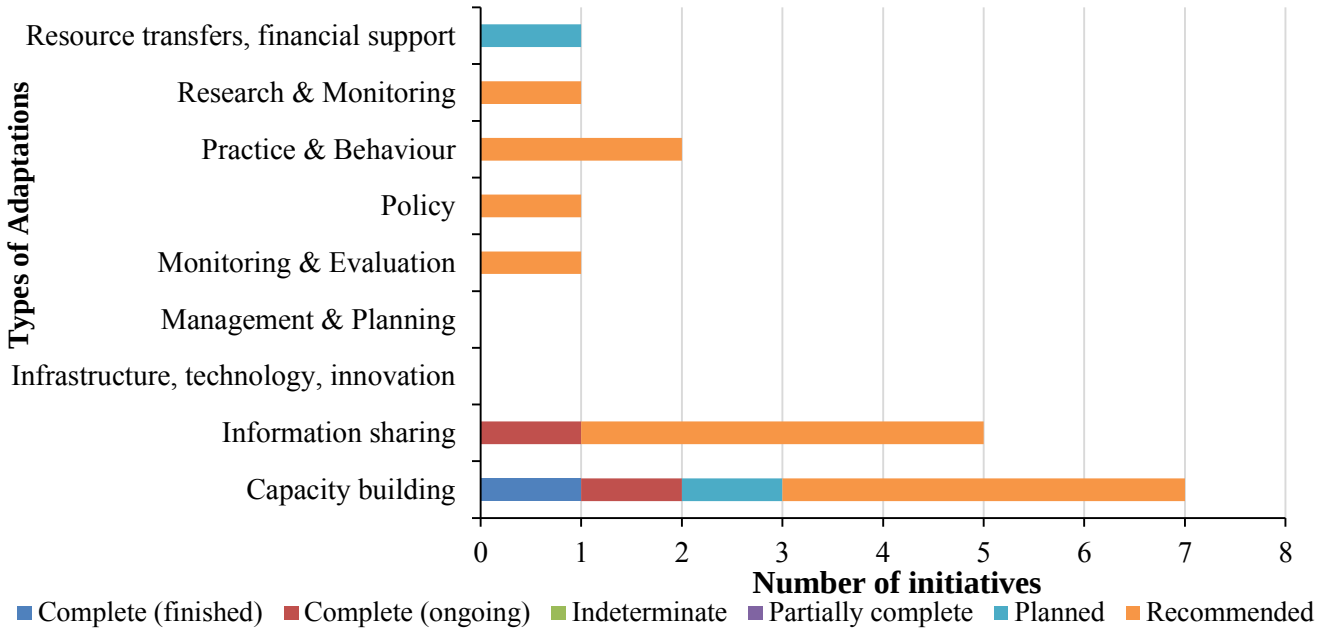


Figure 3.13: Adaptation type by status of action for Culture and Education initiatives (n=18)

Given the major role of Inuit knowledge and cultural traditions in adaptive capacity, cultural preservation has been highlighted as a key avenue to reducing Inuit vulnerabilities and building adaptive capacity to climate change (Ford et al. 2010c, 2012; Pearce et al. 2015). Although climate change may decrease the reliability of some aspects of traditional knowledge, the promotion of knowledge and land skill transmission would better equip Nunavimmiut to manage changing climatic and environmental conditions (Ford et al. 2010b; Pearce et al. 2015). As such, programs providing cultural education and training are identified as central components to climate change adaptation (Pearce et al. 2011a, 2015).

Table 3.9 documents the three Culture and Education initiatives that have progressed beyond the stage of recommendation in Nunavik. By establishing hands-on land-based scientific educational modules, the Avativut program fosters opportunities for intergenerational knowledge transfer and encourages the teaching of environmental sciences to be more connected with the local environment, culture and expertise. Such programs are also documented to promote community wellbeing, strengthen social networks, and increase self-esteem (Bolton et al., 2011; Ford et al., 2012); evaluating the possibility of replicating the program to other subject areas would therefore contribute to increasing the adaptive capacity and wellbeing of the communities. Greater attention on incorporating traditional skills, cultural elements, and practical training in non-traditional skills such as GPS navigation into the school curriculum could further enhance the adaptive capacity of the younger generation. Although integration of culturally relevant material into educational curricula has been relatively successful in Nunavik, stakeholders have expressed concern regarding the long term sustainability of these programs highlighting the need for them to be recognized by teachers as a fundamental part of curriculum to withstand pressures of an evolving science curriculum.

In addition to suggesting the creation of additional land-based educational programs, several collaborators suggested the establishment of programs promoting two-way skills transfer among youth and hunters, wherein hunters teach youth traditional land-based knowledge, while youth offer new technical skills such as efficient GPS navigation. Programs of this type would represent effective integration of traditional and scientific knowledge to help communities adapt to climate change. As discussed in Section 3.7.5, efforts, such as KRG's Hunter's Support Program, aid in alleviating the financial barriers inhibiting participation in subsistence activities would be an important complement to programs supporting traditional knowledge transmission, as they would provide additional opportunities for organic knowledge transfer (Bolton et al., 2011). The Unaaq Men's association provides a good example of an initiative aimed at promoting two-way skills transfer among youth and elders. By supporting the youth in Inukjuaq to strengthen their cultural identity through land oriented skill building workshops and practical training in non-traditional skills such as GPS navigation, this initiative has enhanced the adaptive capacity of the younger generation in this community.

The 'Study of Inuit Knowledge of Climate Change in Nunavik, Québec: A Mixed Methods Approach' serves as a research project that promotes the documentation of cultural traditions and changing cultural trends over the years (Cuerrier et al., 2015). Additional programs of this type would help to document and preserve traditional Inuit cultural knowledge, whilst simultaneously discovering innovative ways of integrating Traditional Knowledge with scientific approaches. Lastly, as found in a previous study (Ford et al. 2012), there was an absence of scholarship

comprehensively examining how climate change is impacting Inuit culture, and how these impacts may evolve in the future. Baseline research on this topic would help to anticipate, and

Table 3.9: Documented culture and educatiaptation initiatives that are in progress or completed

Year	Initiative title	Collaborators	Description
2012 (ongoing)	Avativut Project: Berry Productivity Module (2012); Ice Mission Module (2014); Permafrost Dynamics Module (2015)	Kativik School Board (KSB), Université du Québec à Trois-Rivières (UQTR), Laval University, Institut national de la recherche scientifique (INRS)	The Avativut program aims to engage high school students of Nunavik in environmental science, including data collection and archiving through various hands-on learning activities integrated into the science and technology curriculum. The program combines and takes advantage of two knowledge systems and two ways of learning that are complementary: 1) the standardized science that is analytical, verbal, and theoretical; and 2) the Inuit knowledge that is visual, oral, and practical. By producing inventive and culturally relevant educational material for Inuit students, this program contributes to sparking interest in science and is contributing to local capacity-building and research support through monitoring activities based on themes closely related to Inuit culture and local climate change issues.
2012 (ongoing)	'Mon climat, ma santé' 'Mon climat et moi'	National Institute for Public Health Québec (INSPQ), Government of Québec, Ouranos, Fonds vert.	The website platform, developed by INSPQ as part of the Government of Québec's Action Plan on Climate Change 2006-2012, is mainly used to serve as a knowledge dissemination tool tailored for different user types: 'Mon climat, ma santé', is for an experienced audience whilst 'Mon climat et moi' targets a student population. The aim is to raise awareness on the health impacts of a changing climate and the different strategies that can be adopted to adapt. Although provincially initiated, this tool is relevant to Nunavimmiut as it has a section tailored to impacts specific to the region.
2015 (complete)	The Study of Inuit Knowledge of Climate Change in Nunavik, Québec: A Mixed Methods Approach	University of Montreal, McGill University, UQTR, Centre d'études nordiques (CEN)	This study aimed at documenting and characterizing indigenous knowledge of climate change in Umiujaq, Kangiqsualujjuaq and Kangiqsujuaq. Acknowledging the difficulties of translating indigenous knowledge into western decision making processes, the researchers devised a mixed method approach to studying TEK. The study combined the depth of qualitative inquiry with the need for quantitative input into western management systems. The study provides useful insights on how to overcome barriers in the uptake and integration of TEK into western science and decision making,

In addition to implementing land-based programs into educational curricula, a variety of stakeholders emphasized the importance of creating training and leadership programs promoting youth interaction with community Elders thus enabling inter-generational knowledge transfer. This is increasingly important in region where growing wage based employment has heightened time constraints on hunting and other cultural practices.

Table 3.10: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions in the Culture and Education sector

Climatic sensitivities and exposures	• Climate change, compounded by a broader context of cultural transition, is increasing the risks associated with subsistence harvesting activities, thus contributing to decreased participation levels; this is reducing the transmission of traditional knowledge and land-based skills to the younger generations • Declining participation in subsistence activities due to climate change, combined with climatic factors influencing the abundance and distribution of species important for subsistence harvesting, are limiting the availability of country food and affecting the integrity of traditional sharing networks • Increased risk of country food contamination may reduce country food consumption levels or increase anxiety associated with eating country foods • Permafrost thaw, sea-level rise, and coastal erosion may also cause damage to important cultural sites • Since Inuit culture and knowledge underpin Inuit adaptive capacity, the erosion of traditional knowledge and cultural traditions is inhibiting adaptive capacity • Cultural preservation has been highlighted as a key avenue to reducing Inuit vulnerabilities and building adaptive capacity to climate change
Current state of adaptation	• Least active sector in adaptation • The majority of initiatives were action-oriented, with practice and behaviour, policy, and capacity building initiatives figuring prominently • No monitoring and evaluation, management and planning, or infrastructure, technology and innovation initiatives were documented • Only four adaptation initiatives were beyond the stage of recommendation: 'Avativut Program', 'Mon climat ma sante; mon climat et moi,', 'The Study of Inuit Knowledge of Climate Change in Nunavik, Québec: A Mixed Methods Approach', and 'the Unaaq Men's Association' • No research comprehensively examining how climate change is impacting Inuit culture, and how these impacts may evolve in the future
Gaps and Future needs	• Continued efforts to preserve and promote Inuit culture and traditions in the face of climate and broader societal changes will serve to maintain the adaptive capacity demonstrated by Inuit over the years • Efforts to alleviate the financial barriers inhibiting participation in subsistence activities would complement programs supporting traditional knowledge transmission • Policy recommendations included establishing programs promoting two-way skills transfer among youth and hunters, whereby hunters teach youth traditional land-based knowledge and youth teach hunters technical skills, such as efficient GPS navigation • Policy recommendations included the development of a climate change course into the school curriculum

	• Promoting traditional country food sharing networks would help to increase communities' adaptive capacity • Greater attention on incorporating traditional skills, cultural components, and practical training in non-traditional skills, such as GPS navigation into the school curriculum, would further enhance the adaptive capacity of the younger generation

3.7.5 Hunting and Subsistence Harvesting

Despite the socio-economic changes faced by the region, hunting and subsistence harvesting activities, including fishing, trapping, and berry picking, continue to play important roles in the lives of Nunavimmiut; these activities are crucial components to Inuit culture and tradition, food security, community cohesion, and mental well-being (Cunsolo Willox et al. 2013b; Lemmen et al. 2016). Due to the inherent dependence on environmental conditions, this sector is extremely sensitive to climate change (Ford et al., 2008). Changing snow and ice regimes, unpredictable weather conditions, increased frequency and severity of extreme events, and altered wind patterns are significantly increasing the dangers associated with travel, hunting, and access to land and resources (Ford et al., 2008; Tremblay et al. 2008; Lemmen et al., 2016). Furthermore, the monetization of Nunavik's economy has stressed traditional sharing networks, resulting in higher levels of income inequality, inter-generational segregation, and a decline in both country food-sharing and participation in hunting and subsistence harvesting (Allard and Lemay, 2012). Climate pressures are exacerbating the situation further by driving up adaptive costs related to the purchase of new equipment (e.g. an ATV to replace snowmobile transportation, a satellite phone to increase the capacity for communication in case of emergency) or gasoline due to the alternative use of land-based trails, which are often longer in length than traditional sea-ice routes (Bolton et al., 2011; Ford et al., 2012).

While Nunavimmiut have a long history of adaptation, the limits of these adaptive strategies in light of the current pace of change are not well understood. Moreover, higher scale initiatives that proactively pursue adaptation are equally necessary to ensure the sustainability of traditional practices and by extension culture, identity, and well-being of Nunavimmiut.

Climate change impacts on many other sectors, including health and well-being (Section 3.7.2) and culture and education (Section 3.7.4), are propagated through the hunting and subsistence harvesting sector (e.g. food security is exacerbated by declining participation in subsistence activities). As such, initiatives were only classified under the Hunting and subsistence harvesting sector if they were specifically designed to optimize safety or subsistence outputs while on the land.

Climatic sensitivities and exposures

In Nunavik, recent and rapid warming since the mid 1990s has offset a cooling trend, and communities are reporting difficult travel conditions due to dangerous sea-ice conditions, as well as the beginnings of permafrost degradation, thus increasing the risks of injuries and decreasing access to ice dependent wildlife species and specific subsistence harvesting areas (Ford et al., 2008; Nickels et al. 2006). Additionally, weather conditions are becoming more variable and thus more unpredictable as compared to the past, with storm events progressing more quickly than previously (Allard and Lemay, 2012; Nickels et al., 2006). In the face of these changing climatic conditions, traditional knowledge, the backbone of safe and effective hunting practices,

is being rendered less dependable; increasing the risks of being stranded or involved in an accident while on the land (Tremblay et al., 2008; Nickels et al., 2006; Ford and Smit, 2004; Lafortune et al., 2004) .

The incidence of injuries associated with travel during subsistence activities is increasing in northern coastal communities, and residents have reported decreased confidence and increased fear when travelling on the land (Allard and Lemay, 2012). In addition to these increased winter risks, higher wind speeds, altered wind directions, and increased storm frequency are increasing the dangers associated with summer boating and decreasing access to some areas used for subsistence activities (Savard et al. 2014; Allard and Lemay, 2012; Nickels et al., 2006). These current vulnerabilities are expected to persist into the future, with additional concerns raised about the potential dangers associated with novel climatic risks, such as rain in the winter or increased snowfall in autumn which could hide dangerously thin ice (Ford et al., 2012).

In addition to climatic factors impacting subsistence harvesters, climate change is expected to affect the health, abundance, migration, distribution, and ranges of several animal species important for subsistence harvesting activities (Lemmen et al. 2016; Allard and Lemay, 2012; Prowse et al. 2009; Laidre et al. 2008). Firstly, in light of changing sea ice regimes, there is concern about population stability of many marine species such as polar bears and ringed seals, which rely on sea ice for reproduction and survival (Hovelsrud et al. 2008; Post et al. 2013; Lemmen et al. 2016). Arctic charr are among the most locally important fish species in Nunavik likely to be affected by climate change. Warming temperatures are expected to facilitate range extension of potential competitor fish species, thus leading to Arctic charr displacement (Power et al., 2009, 2012). Secondly, caribou, which are an extremely important species in Nunavik for cultural and food security reasons, and are expected to be more northerly distributed in the coming years due to climate change (LeCorre et al., 2013; Sharma et al., 2009). Climate change is also expected to compound the downward trend in natural cycles of caribou population numbers through increased risks of breaking through the ice during migration, increased energy expenditures required to dig for food under deeper snow, and increased parasite and disease occurrence (Leblond et al., 2016; Mameamskum, 2013; Sharma et al., 2009). Additionally, an increase in parasites in caribou has been reported by surveys in Nunavik (Allard & Lemay, 2012). While these impacts will likely decrease the availability of species traditionally used in subsistence harvesting activities, novel subsistence harvesting opportunities may develop as new species move north and the open-water hunting and fishing season expands (Berteaux, 2016; Ford et al., 2012).

Finally, climate change is expected to contribute to longer and warmer growing seasons, which will impact all vegetation in Nunavik (Allard & Lemay, 2012; Lévesque et al. 2012; Bokhorst et al. 2008). Nunavimmiut are concerned about changes in berry shrub growth and productivity because of the importance of berries in tundra ecosystems to wildlife, human health and indigenous culture and identity. It is expected that in areas where erect shrubs and trees are present, berry shrubs will need to invest more energy in growth to compete with taller shrubs for light (Berteaux, 2016; Lavallée, 2013). This may result in an overall decrease in berry productivity among sites. On the other hand, in open habitats, warmer conditions may increase berry productivity if moisture remains sufficient and pollinating insects abundant (Lavallée, 2013). Given that berry productivity is sensitive to the amount and timing of precipitation, wind,

and extreme events, changing climatic conditions may contribute to an overall decreased berry productivity in Nunavik (Lévesque et al. 2012; Bokhorst et al. 2008).

Current state of adaptation and future adaptation needs and priorities

A relatively small number (8%, n=51) of adaptation initiatives were documented within the Hunting and Subsistence Harvesting sector. Initiatives, as illustrated in Figure 3.14, were predominantly being implemented at the individual/family/household (33%, n=16), community (24%, n=12), and regional (20%, n=10) scales. Initiatives were primarily adaptation actions (63%, n=32), consisting mostly of practice and behavioural responses (41%, n=21). Research and monitoring (27%, n=14) and resource transfers including financial transfers (10%, n=5) initiatives were also common. As shown in Figure 3.14, there were an equal number of initiatives at the recommended stage as there were at the completed or complete and ongoing stages. A large proportion (73%, n=37) of initiatives included Inuit knowledge; many involved using knowledge gained from past experiences to reduce the risks associated with Hunting and subsistence harvesting.

The low number of initiatives reported for this sector may be a function of the data collection technique employed for the systematic review, which relied heavily on online reporting. These findings were complemented with input from the Climate Change and Clean Energy workshop held in Kuujjuaq that included community representatives and provided insight on autonomous adaptation (defined as initiatives that are not formal and planned). However, a future update to this report can benefit from community visits that would enable a more extensive evaluation of autonomous initiatives.

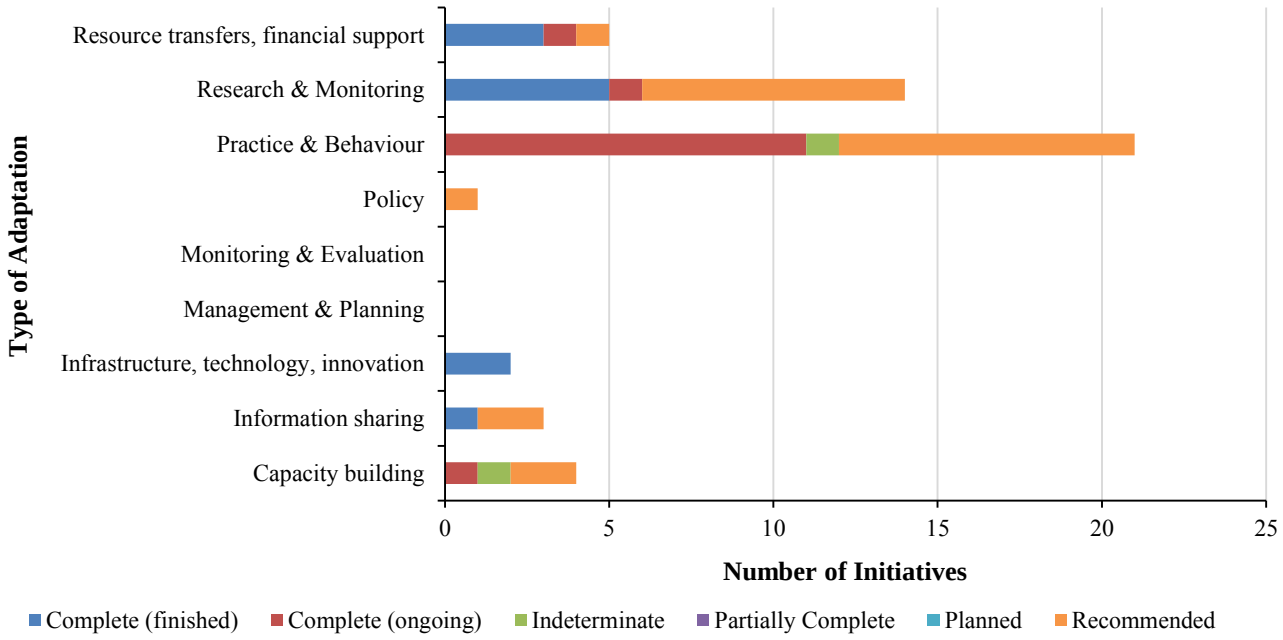


Figure 3.14: Adaptation type by status of action for Hunting and subsistence harvesting initiatives (n=51)

Unlike the majority of other sectors, many initiatives (33%, n=16) documented within the Hunting and subsistence sector were autonomous, wherein individuals or families were undertaking changes in their own lives to adapt to changing climatic conditions. Examples included changing the timing of subsistence activities to correlate with safe ice conditions, finding new and safely accessible hunting grounds, and switching to fishing or using boats to avoid travel on ice. As documented in many studies and in the 2011 gap analysis study, such autonomous adaptations reflect the inherent adaptability of Inuit, which is based largely on land skills and traditional knowledge of the local environment (Furgal et al. 2008; Bolton et al. 2011; Ford et al. 2012).

In 1979, a hunter support program established under the James Bay and Northern Québec Agreement was started among the Nunavik Inuit. The aim of the program is to encourage and support the hunting, fishing and trapping activities as a way of life, and to guarantee the communities a supply of produce from such activities (KRG, 2015a). Each of the 14 villages administers the program; it enables the village council to obtain several resources and services, including harvesting equipment such as a community hunting boat, a communal cold storage house, and the ability to buy meat and fish from local hunters with the program's funds and provide these to villagers without charge (KRG, 2013). Importantly, however, the Nunavik hunter support program has created a larger umbrella for mutual help above the level of the family and has also contributed significantly to a broader community identity. This program is therefore critical in assisting communities increase their adaptive capacity to the many pressures a changing climate brings: a major one being the prohibitive costs associated with obtaining the appropriate hunting and safety gear, and also with transitioning to newly needed equipment (e.g. from snowmobiles to boats) (Bolton et al., 2011; Ford et al., 2012; KRG, 2015a).

As discussed in the 2011 study, there is also continued need for increased information sharing within Nunavik (Bolton et al., 2011). The project Access to Territory and Resources in Nunavik has implemented an integrated community-based monitoring network (ICBM) for Umiujaq, Akulivik, Ivujivik, Kangiqsujuaq, and Kangiqsualujjuaq, to facilitate greater sharing of information between communities regarding travel conditions (Tremblay et al., 2008). This project's main goal was to enhance the adaptive capacity of northern people by integrating them into community-based monitoring, as well as provide them with better information concerning trail conditions. Local researchers collect data on snow and ice thickness at chosen sites, and relay that information to others via a central researcher. The private sector has also contributed to advancing ICBM initiatives in Nunavik. The Makivik Corporation in collaboration with satellite-monitoring and cartographic companies, developed the Nunavik Lake Ice service; a monitoring platform that combines Traditional Ecological Knowledge (TEK), remote sensing data, and local climate and atmospheric data, with the aim of better understanding how climate change affects ice cover and Arctic charrr dynamics in Kuujjuaq, Kangirsuk, and Kangiqsualujjuaq (Box 1) ("Nunavik Lake Ice Service").

Box 1: Nunavik Lake Ice Service and the Arctic Charr Database

Key to any adaptive management approach is a good information base. The Nunavik Research Centre of Makivik Corporation has been collecting Inuit knowledge as of the mid 1970's; this information is stored in a geospatial database, containing more than 86,000 records from over 400 interviews with community members. Complemented with remote sensing data, and local climate atmospheric data from weather stations, the information has been integrated into a digitized web-based portal that can be accessed by local community Hunting, Fishing and Trapping organizations. It enables real-time updates and incorporates Inuit knowledge collected as early as the 1970's. The database serves as a relevant management tool in several ways. First, it is used for a comprehensive mapping service where routes and fishing grounds can be queried. Second, the database helps improve understanding of which environmental factors have the greatest influence on Arctic charr distribution and success in Nunavik. With continued use and updating, the database helps improve understanding of temporal trends in the distribution and abundance of Arctic charr, thereby helping to offset the lack of consistent studies in the past which has hampered abilities to accurately predict the consequences of the large-scale environmental changes implied by climate change.

Whilst the 2011 study acknowledged the presence of such initiatives to disseminate useful travel information, it highlighted the uncertainty of both their effectiveness, as well as the mode of communication most useful to Inuit. Given these uncertainties, several initiatives have since been undertaken in Nunavik. First, the Civil Security Section of the KRG, the Kativik Regional Police Force and its Cadet Program, and the Nunavik Hunting, Fishing and Trapping Association (NHFTA) jointly launched the Out on the Land seasonal prevention campaign that airs audio clips, interviews, and testimonials regarding safety when travelling on land, and protocols to be followed in case of emergency on local and regional FM radio stations (KRG, 2015).

Second, an initiative titled Real-time Monitoring for Travel Safety and Food Security was initiated in 2010-12 by Makivik's Nunavik Research Centre in Salluit and Akulivik, to evaluate travel safety conditions as they relate to local weather patterns, through a web portal in real time. The project was grounded in Inuit knowledge and identified the following: the most frequently used winter hunting and fishing grounds; travel routes to critical subsistence areas and how they have been changing in recent times; the current method used by community members to determine which travel routes are safe to take; and usefulness of visual aids and real time weather data in choosing safer travel routes and most appropriate mechanism for delivering real-time data (Allard and Lemay, 2012). The monitoring tool implemented through this project provided real time access to weather conditions along key travel routes and assisted subsistence hunters in making safer decisions with respect to travel safety, thereby reducing the number of travel-related accidents in Nunavik (Peace & Myers, 2012; Inuit Tapiriit Kanatami, 2016). Third, Tamaani, Nunavik's Internet service provider has received finances from all levels of government to replace the local wireless distribution network with a local fibre optic network (Government of Québec, 2015). As such, web-based dissemination of trail information and other web-based tools that are not yet fully embraced, will likely grow in importance.

As discussed in the 2011 gap analysis study, weakening land skills and traditional knowledge continue to present a major adaptive capacity barrier. It increases the vulnerability of younger generations due to a lower level of preparedness when presented with unforeseen climatic circumstances (Bolton et al., 2011). Traditional knowledge underpins Inuit adaptive capacity as residents manage risks by taking precautions based on understanding the dangers of the land, knowing precursors to hazardous conditions and specific survival strategies, such as packing appropriate equipment, and understanding traditional navigation methods (Ford et al., 2012; Nickels et al., 2006; Pearce et al., 2015). The adoption of new technologies such as snowmobiles and GPS, while also representative of adaptation actions, reduce the requirement for young hunters to learn certain travel and navigational skills. Programs designed to encourage the transmission of traditional knowledge and land skills between generations would help to increase the adaptive capacity of the younger generation (See Section 3.7.4). Community members at the Kuujjuaq workshop also highlighted the need for capacity building programs on the establishment of emergency prevention and preparedness measures, as well as disaster recovery measures for local and aboriginal residents.

In response to altered species abundance, health, and distribution, studies suggest that species substitution is a viable adaptation option (Pearce et al., 2011). However, little research into species substitution has been conducted. One adaptation initiative suggested that community members need to be engaged in public education around species substitution to better inform residents about viable and sustainable adaptation strategies. As reported in the 2011 gap analysis study, further biophysical research to better predict and model the range shifts of key species would help to inform species substitution strategies (Bolton et al., 2011). Initiatives like Nunavik's Arctic Charr Database, that includes information on several population variables, travel routes and hazards to fishing sites, is a prime example that could be replicated for other key species (Box 1). Caribou Ungava, presently in its second phase of programming (2015-2020), is another extensive research program that focusses on the ecology of migratory caribou and predators in the Quebec-Labrador peninsula. In addition to promoting the sound management of caribou, this initiative aids in promoting adaptive capacity by enabling a better understanding of the impacts of climate change, human disturbances and the role of predators on the ecology of this species. Results are disseminated on a website for use by various stakeholders including community residents, private, public and academic institutions (Caribou-Ungava, n.d.).

Additional community-based monitoring initiatives for a wider number of communities, climatic, and environmental factors would build community-scale adaptive capacity and facilitate improved travel condition information gathering and sharing. Such fine-scale information could also be integrated into broader weather and environmental condition monitoring efforts, thus providing an additional benefit. Information could then be broadcast on regional Internet sites to allow access to all community members. During the regional workshop in 2016, residents recommended improving cell service and communications technology so that hunters can call for help in case of emergency (Stratos Inc, 2017). Research into expanding broadband or cellular service access across communities may therefore be needed to explore information dissemination platforms.

Table 3.11: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation needs and priorities in the Hunting and Subsistence Harvesting sector

Climatic sensitivities and exposures	• Increased temperatures are leading to more hazardous and less predictable ice conditions, thus increasing subsistence harvesting activity risks • Changing snow conditions are making land-based travel routes more difficult to use • More unpredictable weather conditions are increasing the risks of being stranded or involved in an accident while on the land • Higher wind speeds and storm frequency are increasing summer boating dangers • Novel climatic risks, such as rain in the winter, may further increase the dangers of subsistence harvesting activities • Changing climatic factors are impacting the abundance, migration, and range of important species for subsistence harvesting, such as Arctic charr and caribou • Longer and warmer growing seasons may benefit some berry species and disadvantage others. Increased winds and extreme events are expected to decrease berry productivity
Current state of adaptation	• Many autonomous adaptations, such as changing the timing of subsistence activities to match safe ice conditions, were documented • No monitoring and evaluation or management and planning initiatives were documented • Hunter Support Programs in all communities have assisted in increasing the adaptive capacity and also help in overcoming prohibitive adaptation costs associated with subsistence activities • Nunavik Lake Ice Portal (Nunavik Research Centre) is an integrated, community-based sea ice information gathering and dissemination system that provides observations and local knowledge of sea ice thickness and surface features relevant to local travel safety in Kuujjuaq, Kangirsuk, and Kangiqsualujjuaq • Real-time Monitoring for Travel Safety and Food Security was initiated by Makivik's Nunavik Research Centre in Salluit, Akulivik and Kuujjuarapik, to evaluate travel safety conditions as they relate to local weather patterns, through a web portal in real time • Kativik School board and Avataq Cultural Institute have initiated the Avativut Project that entails the monitoring of ice cover and berry productivity in all communities (see section 3.5.4). This provides a valuable source of information to inform studies on climate change impacts on berry productivity. • Out on the land seasonal prevention campaign airs audio clips, interviews, and testimonials regarding safety when travelling on land, and protocols to be followed in case of emergency on local and regional FM radio stations • Nunavik Arctic Charr Database, an evolving repository of TEK, serves as an important adaptive management tool providing information on population location, presence/absence, abundance, spawning and over-wintering habitat, exploited lakes, related travel routes and hazards to fishing sites. • The region will benefit from greater connectivity as, Tamaani, Nunavik's Internet service provider has received finances from all levels of government to replace the local wireless distribution network with a local fibre optic network. • No initiatives addressed increased dangers associated with summer boating
Gaps and Future needs	• Inuit adaptive capacity is threatened by prohibitive costs associated with adaptation, and weakening land skills, traditional knowledge, and traditional sharing networks • Hunting support programs could provide entry points for effective policy to strengthen community relations and adaptive capacity • Programs designed to encourage the transmission of traditional knowledge and land skills

	between generations would help to increase the adaptive capacity of the younger generation (See Section 3.5.4). ICBM initiatives have worked well to achieve these goals and can be replicated in communities with no such programs • Adaptation initiatives suggested the need for capacity building programs based on the establishment of emergency prevention and preparedness measures, as well as disaster recovery measures for local and aboriginal residents • Increased weather and environmental conditions information and dissemination would assist residents in assessing risks prior to engaging in subsistence activities—formal community-based observer programs may be a viable option • Broadband or cellular service access expansion within communities may be needed to facilitate information dissemination • Increased research into effective adaptation strategies that integrate traditional knowledge with technology could assist in promoting further adaptation uptake • Additional research into climate change impacts on species, and adaptive species substitution, would help to inform species substitution strategies • Initiatives addressing increased summer boating dangers would help individuals adapt

3.7.6 Institutional and Resource Management

Given the complexity and interconnectedness of climate change impacts on multiple sectors, effective efforts to adapt to climate change require a sustained transdisciplinary approach in creating coherence, coordination, long term planning, and integration of adaptation into climate-sensitive decision making (Ford and King, 2015). In this regard, institutions provide the political and administrative structure that can either enable or restrict adaptation. Conducive institutional organization also depends on the ability of institutions to mobilize leadership and resources, develop legal and regulatory frameworks for adaptation, and plan for short and long time horizons (Bauer et al., 2012; Biesbroek et al., 2010; Dickinson and Burton, 2011; Moser and Ekstrom, 2010). In this regard, the following section explores the current state of adaptation and potential future directions for the Institutional and resource management sector.

Climatic sensitivities and exposures

Institutions are humanly created formal and informal mechanisms that shape social and individual expectations, interactions, and behavior. They can be classified as falling into public (bureaucratic administrative units, and elected local governments), civic (membership and cooperative organizations), and private sectors (service and business organizations) (Uphoff & Buck, 2007). Climate change will have several implications for institutional structures and subsequently adaptive capacity for several reasons. Firstly, formal and informal institutional arrangements are crucial in determining the success of adaptation interventions as vulnerability is a function of the way macro and micro-level institutions in a variety of domains affect distribution of risks related to climate changes (Agrawal & Perrin, 2009). Secondly, by constituting and organizing incentive structures for household and community level adaptation responses, institutional management is key in determining whether adaptation responses will be organized individually or collectively. Thirdly, regional and local institutional structures shape the acquisition and distribution of external interventions aimed at enhancing adaptive capacity such as finances, knowledge and information, skills training, new institutional inputs, and technological support, thereby affecting the degree of success of such interventions changes (Gosselin et al., 2011; Agrawal & Perrin, 2009). Although integration of climate change adaptation planning into policy and institutional processes is emerging, it continues to be a

sidelined focus (Budreau et al., 2007; Ford, 2009). In light of this, a changing climate will not only influence the effectiveness, efficiency, and longevity of institutional processes (e.g. policies) but will create new needs which will further challenge institutions that are already grappling with a host of other developmental objectives.

Climate change is projected to impact key animal species in Nunavik, such as caribou and Arctic charr, through a series of complex interactions including food availability, water temperature, and disease transmission patterns (Prowse et al. 2009; Sharma et al. 2009; Allard and Lemay 2012; Lemmen et al. 2016). While climate change may result in some positive outcomes for species, research suggests that native species will be negatively affected overall (Prowse et al. 2009; Lemmen et al. 2016). For example, caribou herd numbers in the Québec-Labrador peninsula have reportedly decreased from over one million during the 1990s to less than half this number in 2010, which is in part attributed to climatic change (Sharma et al. 2009; Allard and Lemay 2012; Le Corre et al. 2014). Due to Inuit populations' dependence on these animals for sustenance and cultural practices, such impacts will substantially affect Inuit food security, health and well-being (see Section 3.7.2), participation in subsistence harvesting activities (see Section 3.7.5), and subsistence economy (see Section 3.7.3) (Allard and Lemay 2012; Ford et al. 2012; Lemmen et al. 2016). In response to these changes, adaptive co-management efforts focusing on managing subsistence harvesting activities in a sustainable manner have been established in several Inuit regions (Armitage et al. 2010; Bolton et al. 2011). Adaptive co-management combines the dynamic learning of adaptive management with the partnerships of cooperative management thus providing flexible management strategies wherein networks of collaborators share management power and responsibility (Armitage et al. 2010). Given that research states that the most successful long-term sustainable resource strategies combine global perspectives and scientific knowledge with a local understanding of cultural and environmental factors, adaptive co-management regimes have been widely adopted worldwide, and in northern Canada in particular (Dowsley 2009; Armitage et al. 2010, 2011; Allard and Lemay 2012; Wilson et al. 2014)

In addition to stressing natural resource systems, climate change is indirectly pressuring adaptive co-management systems (Armitage et al. 2010; Bolton et al. 2011). Most importantly, climatic and environmental conditions are changing more rapidly than traditional scientific monitoring can accommodate; as such, resource management strategies may lack considerations of local environmental understandings, which is a key determinant of a strategy's success (Dowsley 2009). This is further exacerbated by a wider institutional context of Inuit knowledge devaluation in wildlife resource management (Bolton et al. 2011; Ford et al. 2012). Broader social trends influenced by climate change are also impacting the ability of co-management systems to adequately accommodate social and environmental change (Armitage et al. 2010; Bolton et al. 2011). Of note, as the monetary economy continues to develop, and participation in the subsistence economy declines, individual harvest incentives may increasingly conflict with collective decision-making in resource co-management, thus hampering adaptive capacity (Armitage et al. 2010; Bolton et al. 2011; Ford et al. 2012).

Effective adaptation throughout all sectors and jurisdictions will require strong institutional leadership promoting collaborative and coherent action (Dickinson and Burton 2011; Ford et al. 2012). Institutional frameworks at any scales that are ill suited to rapidly changing environmental conditions may compound climatic exposure sensitivities discussed in prior sections (Bolton et

al., 2011). Nevertheless, while climatic impacts present complex challenges for this sector, they also pose some of the greatest opportunities for decision-makers to act on increasing adaptive capacity (Ford et al. 2012).

Current state of adaptation and future adaptation directions

A significant proportion (20%, n=135) of documented adaptation initiatives were captured by this sector. Initiatives were predominantly implemented at the national (53%, n=72), northern Canadian (20%, n=27) and provincial (12%, n=16) scales. The distribution of adaptations was almost equal between groundwork (53%, n=72) and action (46%, n=63) initiatives, with a higher percentage of action (60%, n=47) versus groundwork (50%, n=37) initiatives remaining at the recommended or planned stage. Capacity building (29%, n=39) and research and monitoring (17%, n=23) initiatives were the most common adaptation types of initiatives as depicted in Figure 3.15. Approximately 15%, (n=21) initiatives included Inuit knowledge, primarily in the form of Inuit consultation during the development of adaptation plans, frameworks, or guidebooks.

> Note: Federally administered initiatives that applied to Inuit Nunangat and provincially administered initiatives that applied to Quebec were included in the analysis due to the direct, indirect or potential impacts they may have on Nunavik. This justifies the comparatively higher number of initiatives documented at the federal and provincial compared to the regional jurisdiction. Caution should therefore be applied when interpreting results about stakeholder contribution to and scale of adaptation planning. Moreover, these results provide a baseline to contextualize and guide future research that should aim to understand which higher or broader scale initiatives and programs have Nunavik focused components.

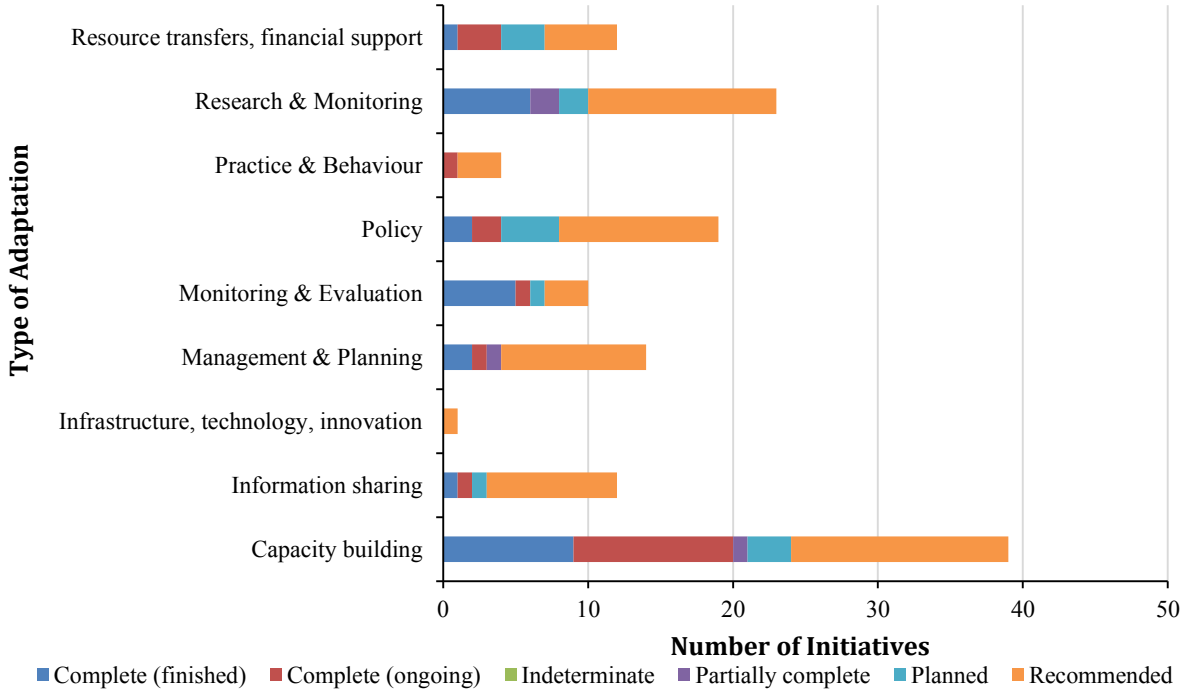


Figure 3.15: Adaptation type by status of action for Institution and Resource Management (n=135)

With respect to resource management, two co-management boards exist in Nunavik, the Nunavik Marine Region Wildlife Board [9] (NMRWB), and the Hunting, Fishing and Trapping Coordinating Committee (HFTCC)[10]. Membership[11] to the boards is based on appointments by Makivik Corporation and the federal, provincial and regional governments, enabling the formulation of collaborative resource conservation and management measures in Nunavik (Nunavik Marine Region Wildlife Board, n.d.).

While top-down management regimes lacking local consultation can have devastating effects for Inuit, the multi-scalar nature of existing co-management boards enables adaptive capacity by reducing conflict between institutional scales and ensuring that all stakeholder needs and viewpoints are considered during policy development (Ford et al. 2007; Wenzel 2009; Armitage et al. 2010). In this regard, following the creation of the NMRWB, efforts have been taken to ensure greater integration of Inuit knowledge through community consultations and added flexibility to wildlife management plans. The draft Polar Bear Management plan (Makivik Corporation, 2016b) and the Adjacent Beluga Management Plan (NRWB, 2010) represent two such examples wherein the Boards' responsibilities include establishing, modifying or removing levels of Total Allowable Take and non-quota limitations for the Nunavik Marine Region (NMR), as well as approval of this management plan before it is implemented. In order to inform recommendations and decisions to inform such plans, which have intimate impacts on the Business and Economy (Section 3.7.3) and Hunting and Subsistence Harvesting sectors (Section 3.7.5), these boards have supported several wildlife studies incorporating Inuit knowledge to examine the health and population dynamics of caribou, beluga and polar bear amongst other species. In addition to meaningful consultations with local communities and integration of Inuit knowledge, these newly developed plans and systems have attempted to provide more flexibility and decision-making powers to the regional Hunting, Fishing, Trapping Association. This is especially important in the face of a changing climate, and as co-management regimes face greater cultural and environmental change, new and flexible management approaches will be required to effectively adapt (Armitage et al. 2010, 2011). It is important to note that whilst newly established management systems under co-management boards are better integrating Inuit knowledge compared to previous ones, uptake and implementation of these systems depend on higher levels of government. As such, efforts to ensure the continued prioritization of management systems that integrate western and Inuit knowledge will be needed for successful, culturally-appropriate, and sustainable wildlife and resource management (Arctic Council, 2013).

Although co-management boards exist in Nunavik, basic baseline population information and trends for many species, are lacking; long-term data sets for specific species collected through community-based monitoring programs such as the Arctic charr initiative (see section 3.7.5)

[9] The NMRWB, established under the Nunavik Inuit Land Claims Agreement, has primary responsibility with regards to wildlife management and the regulation of access to wildlife within the NMR. All decisions of the NMRWB are subject to approval by the responsible Minister(s), and must limit Nunavik Inuit harvesting only to the extent necessary to affect a conservation purpose, to give effect to a Total Allowable Take (TAT), or for public health/safety reasons.

[10] The HFTCC is a consultative body created as part of the JBNQA. Its authority therefore is restricted to the mainland – the James Bay and Northern Quebec Territory as defined in the Agreement. It has been given the responsibility to review, manage, and in certain cases, supervise and regulate the hunting, fishing and trapping regimes established pursuant to the JBNQA. It also acts as a privileged consultative body for governments wishing to implement measures related to wildlife management, but can also initiate, discuss, review, and propose all such measures.

[11] An important distinction between the HFTCC and NMRWB exists by way of the appointments to each board; whereas members of the HFTCC represent the agencies that appoint them members of the NMRWB are completely independent of these agencies and therefore represent their own opinions and expertise.

would help communities to track environmental changes and therefore inform effective adaptive management strategies (Armitage et al. 2011; Bolton et al. 2011; Allard and Lemay 2012; Wilson et al. 2014). Efforts to continue prioritizing resource co-management research would therefore contribute to increasing adaptive capacity within Nunavik.

There are several examples of how adaptive capacities are being reinforced within institutions at different and combined scales. With respect to climate change adaptation at the federal level, the government is responsible for building adaptive capacity through increasing awareness of climate impacts, encouraging economic growth, establishing legislative frameworks conducive to national adaptation, and communicating climate change information (Austin et al., 2015; Dickinson and Burton, 2011; Government of Canada, 2011). Federally, the departments who received funding under the Clean Air Agenda were highlighted as the main coordinating bodies for adaptation (Labbé et al., 2017). Table 3.12 summarizes the federal government's climate change adaptation programming (supported by the Clean Air Agenda from 2008-2016) relevant to Northern Canada. Capacity building initiatives (34%, n=23), were the most common type of initiative implemented at the federal scale, the 'Federal Adaptation Policy Framework' (2011) and the 'Pan-Canadian Framework on Clean Growth and Climate Change' (2016) being two such examples. The Federal Adaptation Policy Framework was released to guide the adaptation efforts across federal departments. It is a high level policy document, with the broader goal of enabling federal departments to tailor interpretations according to needs (Labbé et al., 2017). Equally, because the Federal Adaptation Policy Framework is not prescriptive, there is no mandate or requirement for departments to do adaptation plans or risk assessments, nor is there any outlined strategy with steps towards concrete adaptation efforts.

Table 3.12: Government of Canada financed adaptation programs relevant to Northern Canada

Government of Canada Department	Federal Program	Description of program	Funding Received
Health Canada (HC)	Climate Change and Health Adaptation Program for Northern First Nations and Inuit Communities	Funding for 47 community-led research projects addressing the health impacts of climate change in Inuit regions (4 in Nunavik). Funds went to community organizations collaborating with various partners to achieve project goals.	$17 million from 2008-2016 ~$5.6million went towards 47 projects in Inuit Nunangat
Transport Canada (TC)	Northern Transportation Adaptation Initiative	Program that supported adaptation research and collaborative initiatives with regional governments and not-for-profit private sector companies	Received $11 million from 2011-2016. *Lack of information for amount financing projects in Inuit Nunangat.*
Indigenous and Northern Affairs	Climate Change Adaptation Program	Funded northern community and regional government work focused on infrastructure	$14 million from 2008-2011 and $20.2 million from 2011-

Canada (INAC)		vulnerability; coastal erosion; sea level rise and ice dynamics; drinking water quality and availability/ waste water management; extreme weather events; winter roads; and permafrost degradation.	16. ~$3.3 million went to projects in Inuit Nunangat between 2008-2011 and ~4.8million between 2011-2016
Public Health Agency of Canada (PHAC)	Preventative Public Health Systems and Adaptation to a Changing Climate Program	Inuit-relevant projects funded through this program included an assessment if the burden of acute gastrointestinal illness (AGI) and adaptation to climate change in the Canadian North in selected Inuit communities (e.g. Iqaluit, Rigolet) to aid development of adaptation strategies.	Received $12 million between 2011-2016. *Lack of information for amount financing projects in Inuit Nunangat*
Natural Resources Canada (NRCan)	Does not have northern specific standalone climate change adaptation program, but supports adaptation efforts in Inuit Nunangat through the Climate Change Geosciences and Adaptation Program (CCGP) (2005-2016), the Adaptation Platform's Northern Working Group (ongoing), and through Regional Adaptation Collaboratives (RAC) (ongoing)	CCGP focuses on providing scientific research to help land-use planners, industry, and regulators decrease risk and adapt northern resource development and does not report inclusion of traditional knowledge. Northern Working Group brings together northern stakeholders to identify adaptation priorities and work to mainstream adaptation needs. RACs are a cost-sharing programs between the federal and provincial/territorial governments, which supports adaptation planning, mainstreaming adaptation into decision- making, and promoting collaboration across stakeholders from regional to local levels.	Received $35 million for adaptation related work through the *Enhancing Competitiveness in a Changing Climate* from 2011-2016. *Lack of information for amount financing projects in Inuit Nunangat.*
Fisheries and Oceans Canada (DFO)	Aquatic Climate Change Adaptation Services Program (ACCASP)	The ACCASP included an assessment of climate change risks and vulnerabilities in the Canadian Arctic Ocean Basin, and research that support	Received $16.55 million in funding for 2011-2016. *Lack of information*

		applied adaptation Tools to help mainstream climate change into departmental programs and policies in the north.	*for amount financing projects in Inuit Nunangat.*

At the provincial level, the Government of Québec has the longest history of climate change and adaptation planning. In 2013, an update to the 2006 provincial climate change strategy was released, as well as a strategy for Climate Change Adaptation (2013-2020). A key theme throughout these strategies was the need to mainstream climate change adaptation into public administration including into new legislative instruments and policies (Government of Québec, 2012). Although these documents include actions relevant to the north, such as "Objective 17: Strengthen the resilience of infrastructures" and highlights three specific projects relevant to Nunavik, there is not an explicit focus or section dedicated to Nunavik or the importance of adaptation for Inuit.

Ouranos is the body coordinating much of the adaptation research happening in Nunavik, supporting authorities in decision-making, and encouraging mainstreaming by working closely with the Kativik Regional Government (KRG), the Makivik Corporation, various ministries in the Québec provincial government, and the Société du Plan Nord. Much work done through their Northern Environment Program engages with key stakeholders throughout project processes. In addition to this, Centre d'études nordiques (CEN), housed in Université Laval, Université du Québec à Rimouski, and Institut national de la recherche scientifique (INRS), continues to be a leading climate change research institute partnering with governments, industry, and communities in the north broadly and Nunavik specifically. At the regional level, the KRG has been most involved with climate change adaptation planning and programming, mainly through initiating collaborations with government departments and research institutions.

Given these institutional structures, adaptation efforts in Nunavik are taking place; however, they are often ad hoc, lack long term commitments, and are not being integrated into higher level decision making. In other instances, interviewees at the knowledge transfer workshops in Kuujjuaq, reported that adaptation is sometimes occurring in response to broader changes and needs, without climate change being the main driver. Additionally, there is no legislated requirement for government departments (federal, provincial, or regional) to formally consider climate change risks, let alone report on adaptation responses. A starting point could be a multi-scalar collaboration for the development of a regional adaptation plan and/or community plans which specifically note(s) the importance of adaptation, highlight priorities, and define recommendations specific to the local context. Further, a close integration of different institutional arrangements is also likely critical for enhancing the effectiveness of adaptation practices. Without greater attention to local institutions and their role in adaptation efforts of different kinds, and the ways in which local and external institutions can be articulated in the context of adaptation, it is difficult for adaptation interventions and investments to achieve maximum success.

Institutional organization around adaptation faces numerous challenges at the regional scale. A recurring theme during the Kuujjuaq workshop in 2017 was the limited capacity of departments in terms of staffing, limited funding and time given to projects, as well as the high turnover rates.

Recommendations suggested that adaptation planning in Nunavik could benefit from the creation of a resource hub, person, or group within the region dedicated to climate change, and to help local groups work together and exchange knowledge related to adaptation. Nunavut's Climate Change Adaptation Secretariat is an example where an institutional entity charged with the coordinating role for adaptation has improved adaptive capacity, the identification, and implementation of tangible adaptation measures (Labbé et al., 2017). In the interim, existing programs and the institutional configurations that facilitate individual and collective adaptation strategies is a fruitful area of inquiry and policy analysis for generating effective coordination with external interventions to enhance adaptive capacity.

Finally, as discussed in Section 3.6, the importance of incorporating traditional knowledge, a key determinant of Inuit resilience and adaptive capacity, into climate change adaptation is being increasingly recognized at all scales (Furgal et al. 2008; Ford et al. 2012; Arctic Council 2013; IPCC 2014; Pearce et al. 2015; Government of Canada 2016). However, research suggests that although traditional knowledge can provide useful and cost-effective information for resource management, it is rarely used to the same degree as scientific knowledge in conservation and management decision-making (Wilson et al. 2014). Moreover, many management decisions and monitoring techniques are developed purely using scientific knowledge (Kendrick and Manseau 2008). Since the effectiveness of resource management strategies relies on Inuit harvesters agreeing with the information used to support resource management decisions, equitable integration of traditional knowledge and scientific knowledge should be prioritized to enhance the adaptive capacity of resource management regimes (Tyrell, 2008; Wilson et al. 2014).

In comparison, Inuit perspectives are increasingly being integrated into broader institutional adaptation initiatives. This is crucial since cultural relevancy of adaptation plans will help to improve initiative uptake and implementation, thus increasing adaptive capacity particularly at the local scale (Ford et al. 2012; Labbé et al. 2017). The Pan-Canadian Framework for Clean Growth and Climate Change posits that the consideration of both scientific and Traditional Knowledge will guide all government decision-making (Government of Canada 2016). Accordingly, Inuit organizations, such as Inuit Tapiriit Kanatami, are becoming increasingly engaged and involved in Canada's future plans for addressing climate change. For example, Inuit Tapiriit Kanatami recently published a report detailing adaptation and mitigation priorities and recommendations specific to Inuit Nunangat, intended to inform the development of the Pan-Canadian Framework for Clean Growth and Climate Change (Inuit Tapiriit Kanatami 2016). The report is also intended to serve as the basis for a National Inuit Climate Strategy that will detail specific climate actions needed to support Inuit communities (Inuit Tapiriit Kanatami 2016). Continued collaborations of these types will be critical to building adaptive capacity in Nunavik.

Table 3.13: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions for Institutional and Resource Management initiatives

Climatic sensitivities and exposures	• Institutional frameworks that are ill suited to rapidly changing environmental conditions, from the community to the national scale, compound the socio-economic exposure sensitivities discussed in prior sections. • Devaluation of traditional knowledge relative to scientific knowledge in resource management decisions undermine steps towards building adaptive capacity. • Environmental change is stressing co-management systems because parameters are

	changing more rapidly than traditional scientific monitoring can accommodate. • Climate change will affect the effectiveness and sustainability of policies in diverse sectors unless they are climate proofed; it will also create new needs for policies which will strain institutions simultaneously grappling with other developmental objectives and challenges • Climate change will impact key animal species through a series of complex interactions; native species are projected to be negatively impacted overall • While science has substantially increased its focus on climate change adaptation in recent years, adaptation generally continues to be sidelined in policy discussions. • Climatic impacts also present some of the greatest opportunities for decision-makers to act on increasing adaptive capacity
Current state of adaptation	• Initiatives were predominantly implemented at the national, provincial, and northern Canadian scales. • Capacity building and policy initiatives were most common adaptation types. • No infrastructure, technology and innovation initiatives were documented. • Approximately 20% of initiatives included Inuit knowledge. • Federal departments who received funding under the Clean Air Agenda were highlighted as the main coordinating bodies for adaptation (HC, TC, INAC, PHAC, NRCan, DFO). • No legislated requirement for government departments federal, provincial, or regional, to formally consider climate change risks, let alone report on adaptation responses • Provincially, Québec has the longest history of climate change and adaptation planning having both a Climate change action plan and adaptation strategy which place a heavy emphasis on mainstreaming adaptation into public administration. • Although these documents include actions/ projects for Nunavik, there is no explicit focus or section dedicated to Nunavik or the importance of adaptation for Inuit. • Ouranos collaborates with all levels of government and coordinates much of the adaptation research happening in Nunavik. • Centre d'études nordiques (CEN) continues to be a leading climate change research institute partnering with governments, industry, and communities to advance adaptation research and projects in Nunavik. • Regionally, KRG has been most involved with climate change adaptation planning and programming. • Inuit organizations, such as ITK and the Inuit Circumpolar Council are contributing to and pushing forward the adaptation agenda. • Adaptation efforts continue to be ad hoc, lack long term commitments, and are not being integrated into higher level decision making. • High institutional turnover, existence of other pressing issues besides climate change, lack of resources represent significant barriers to adaptation for the region
Gaps and Future needs	• Initiating a multi-scalar collaboration for the development of a regional adaptation plan and/or community plans which specifically note the importance of adaptation, highlight priorities, and define recommendations specific to the local context. • Adaptation planning in Nunavik could benefit from the creation of a resource hub, person, or group within the region dedicated to climate change, and to help local groups work together and exchange knowledge related to adaptation. • A coordinating body or committee responsible for climate change adaptation at the regional level could enhance adaptive capacity. • At the regional and local scales, there are existing programs that could be built upon to enhance adaptive capacity to climate change.

	• A co-management agency involving all Inuit regions would assist in creating coherent management solutions across the Inuit Nunangat • Reflexive and inclusive discussions among stakeholders, particularly Inuit stakeholders, should be continued to improve adaptation coordination and efficiency • Further integration of Indigenous knowledge into resource management regimes and adaptation plans/policies may help to improve adaptation uptake and implementation • As adaptation plans and policies are created, ensuring their cultural relevancy will help improve uptake and implementation ability, all of which will work together to increase readiness to adapt, especially at the local level.

3.7.7 Intersectoral

As described in Sections 3.7.1 to 3.7.6, climate change is expected to have wide ranging impacts on a variety of sectors. The human dimensions of climate change involve complex interactions within and between social and natural systems; as such, while some impacts can be addressed by a single sector (e.g. Health and well-being sector addressing increased exposure to UV radiation), many climatic factors affect several sectors and therefore require a coordinated intersectoral adaptation response. Figure 3.16 provides examples of the interconnectivity of impacts across sectors and illustrates the overlap of adaptive responses to different impacts.

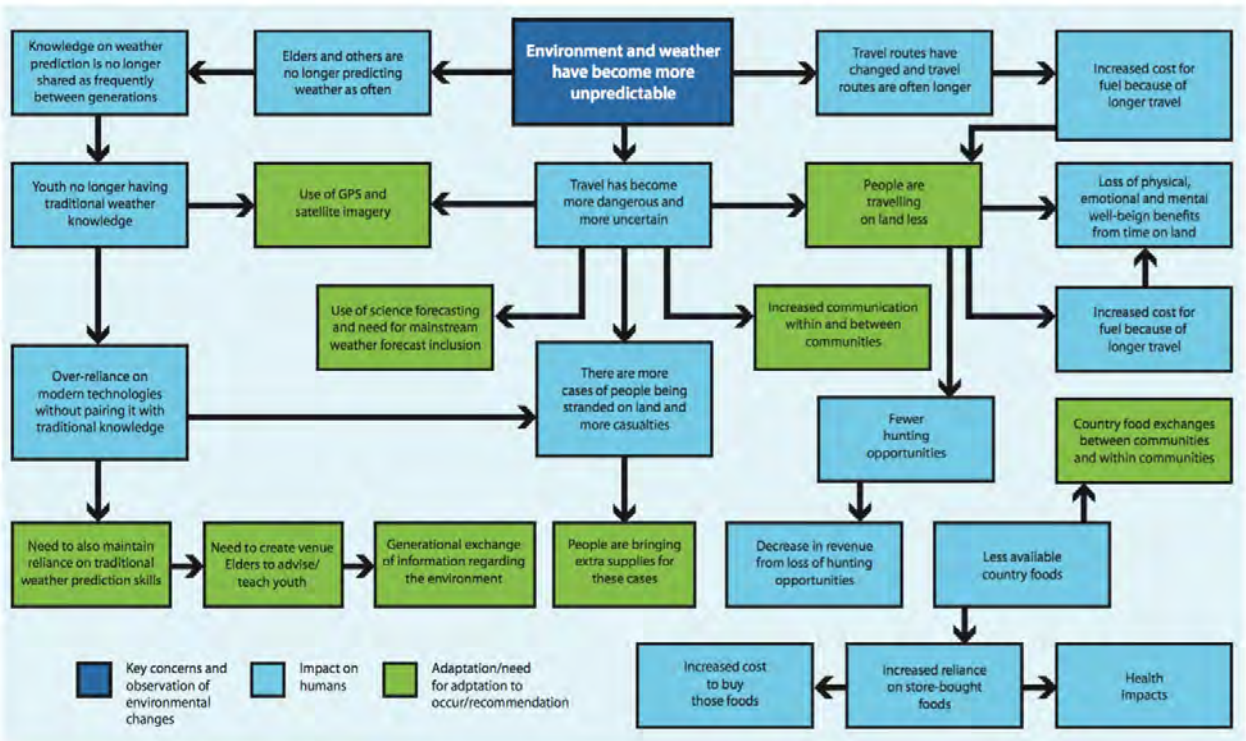


Figure 3.16: Interconnectivity of impacts and adaptive responses across sectors (Nickels and Furgal, 2005, as cited in Inuit Tapiriit Kanatami, 2016)

The following section describes the current state of Intersectoral adaptation initiatives and future adaptation needs. Initiatives were classified as Intersectoral if a coordinated response among two or more sectors was required to address the climatic or non-climatic motivating factor.

Current state of adaptation and future adaptation directions

A large proportion (16%, n=105) of documented adaptation initiatives were Intersectoral efforts. Initiatives were primarily implemented at the national (54%, n=57) scale. Groundwork initiatives (64%, n=66) dominated the Intersectoral sector. As illustrated in Figure 3.17, capacity building (33%, n=35) and research and monitoring (25%, n=26) initiatives were the most common adaptation types whereas no infrastructure, technology and innovation initiatives were documented. Approximately one quarter (27%, n=28) of initiatives included Inuit knowledge, primarily in the form of Inuit consultation during the development of adaptation plans, frameworks, or guidebooks.

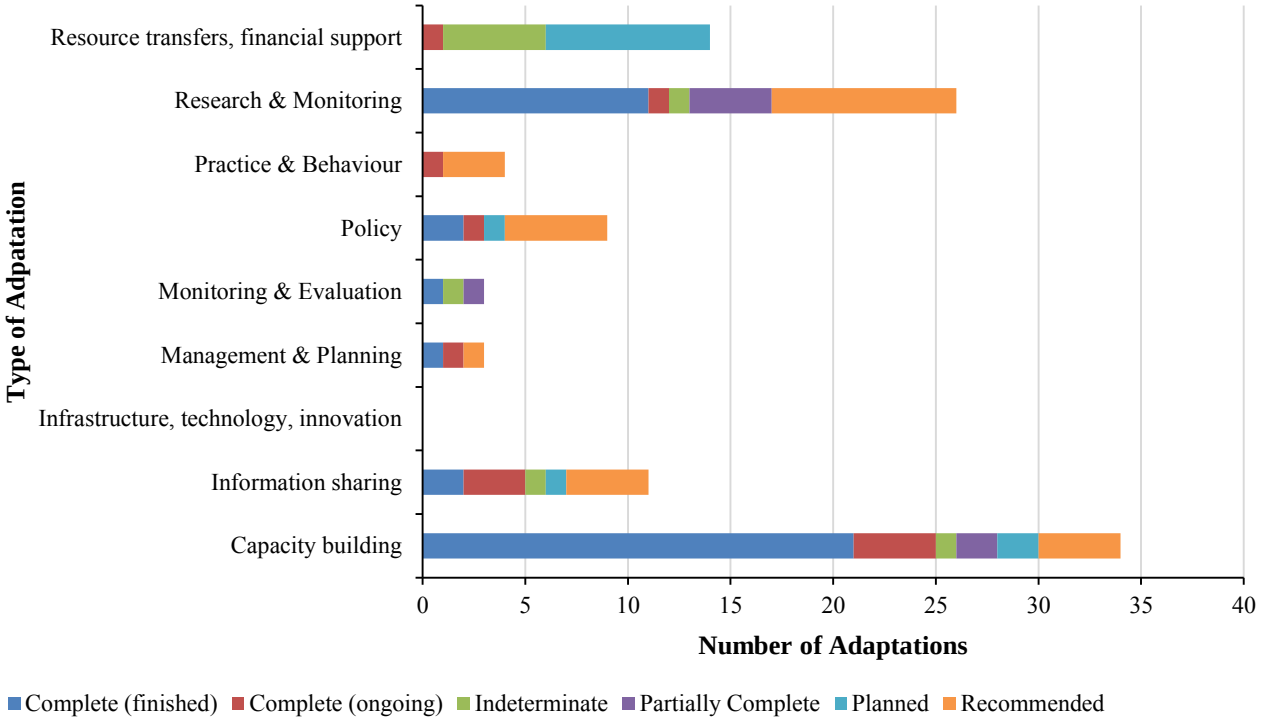


Figure 3.17: Adaptation type by status of action for Intersectoral initiatives (n=105)

Multiple documented intersectoral initiatives, some of which are presented in Table 3.14, were comprehensive adaptation plans or frameworks intended to inform and coordinate adaptation initiatives across a variety of jurisdictional levels or sectors. Of note, the Government of Canada's 'Pan-Canadian Framework on Clean Growth and Climate Change' (2016), Inuit Tapiriit Kanatami's 'Inuit Priorities for Canada's Climate Strategy: A Canadian Inuit Vision for our Common Future in our Homelands' (2016), and the Québec Government's '2013-2020 Climate Change Action Plan' (2012) and '2013-2020 Government Strategy for Climate Change Adaptation' (2012) were key intersectoral initiatives. Ouranos' Northern Environment Program, currently in its 2014-2019 phase of operation, is another prominent example of an intersectoral initiative that aims at enhancing adaptive capacity in Nunavik. The program promotes the acquisition of knowledge pertaining to climate change impacts and adaptation, and supports key stakeholders in the region to account for these considerations in their decision-making. Parnasimautik/Plan Nunavik, developed in response to Québec's Plan Nord, outlines sustainable development priorities of Inuit in Nunavik in relation to housing, health, education, access to

land, environmental and wildlife protection, culture, tourism, bio-food, non-renewable energy, energy transportation, communications, and community development. Climate change considerations have been included in the five and 25 year priorities identified with particular emphasis on impacts related to transportation and access to communities (through effects on airport infrastructure and land based travel), country food accessibility and availability, as well as increasing need for search and rescue capacity.

These initiatives highlight the need for collaboration and partnerships in adaptation, determine roles of collaborators in adaptation, and set priorities for adaptive actions. Given that some adaptations will require careful planning and the collective action of more than one organization or jurisdictional level, such broad initiatives are crucial for ensuring an efficient and coherent adaptation response in the face of climate change. Such initiatives existed at the national, provincial, and northern Canadian scales, however no adaptation plans or frameworks were documented at the regional or community scales. Of note, the Pan-Canadian Framework on Clean Growth and Climate Change recommended the development and implementation of a comprehensive Northern Adaptation Strategy to strengthen northern capacity for climate change adaptation. This study is intended to inform this strategy.

In addition to adaptation plans, multiple collaborators published adaptation tools, including guidebooks, risk assessment frameworks, and best practices documents. Such initiatives are crucial elements to the adaptive process, as they assist stakeholders in understanding climate change information, prioritizing adaptive actions, and creating adaptation plans that address relevant climate change impacts. As previously mentioned, regional and community adaptation plans could be developed using these tools to help build community adaptive capacity. Policy recommendations included additional development and dissemination of adaptation tools.

Table 3.14: Examples of Intersectoral climate change adaptation tools

Year	Climate change adaptation tool	Agencies/Institutions/Author
2010	Managing the Risks of Climate Change: A Guide for Arctic and Northern Communities	Centre for Indigenous Environmental Resources, Indigenous and Northern Affairs Canada, MTMDET
2010	Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation	ICLEI Canada, Natural Resources Canada
2010	Developing a Climate Change Adaptation Plan: Guide for the Québec Municipal Sector	Ouranos
2013	Best Practices in surveying for the measurement of climate change adaptation	Natural Resources Canada, Engineer Canada PIEVC
2013	Climate data guide book	Natural Resources Canada
2013	Community-related adaptation resources compendium	Natural Resources Canada, ICLEI-Canada
2014	A Guidebook on Climate Scenarios: Using Climate Information to Guide Adaptation Research and Decisions	Ouranos, Natural Resources Canada

2015	Synthesis on Climate Change Knowledge in Québec	Ouranos

As illustrated in Table 3.15, in addition to adaptation tools, several information portals and databases were established to help track and store information relevant to climate change and adaptation. Information portals are important tools for adaptation stakeholders as they synthesize relevant information and render the information easily accessible. However, as mentioned above, the systematic review was unable to determine if stakeholders are using or benefiting from these resources.

Table 3.15: Examples of Intersectoral information portals and databases relevant to climate change adaptation

Year	Information portals/databases	Agencies/Institutions/Author
2010	'Mon climat et moi' & 'Mon climat et ma santé' websites http://www.monclimatetmoi.com/ http://www.monclimatmasante.qc.ca/	National Institute for Public Health Québec
2013	Arctic Council Information Portal http://arcticportal.org/	Natural Resources Canada, Yukon Government, University of Alaska Fairbanks
2013	Policy recommendation: Develop a database of adaptation activities	Arctic Council, Risk Sciences International
2015	'Let's do it for them' website https://www.letsdoitforthem.gouv.qc.ca	Government of Québec
2016	Ouranos website https://www.ouranos.ca	Ouranos

Lastly, multiple collaborators recommended the need to work with communities to implement adaptation initiatives at the community level. As described throughout Sections 3.7.1 to 3.7.6, with the exception of the Culture and Education and the Hunting and Subsistence Harvesting sectors, community-scale initiatives were relatively uncommon. Given that communities have varying exposure sensitivities and adaptive capacities, community-level initiatives that are tailored to local contexts are critical to effectively building resilience and promoting adaptation (Pearce et al. 2011a; Bours and Pringle 2014; Loboda 2014). This adaptation gap is expanded upon further in Section 3.4.

Table 3.16: Summary of current climatic sensitivities and exposures, the current state of adaptation, and future adaptation directions for Intersectoral initiatives

Climatic sensitivities and exposures	• Climate change is expected to have a wide variety of impacts on various sectors • While some impacts can be addressed by a single sector, many climatic forcings affect several sectors meaning and therefore require a coordinated intersectoral adaptation response
Current state of adaptation	• Initiatives were primarily implemented at national and provincial scales • Capacity building and research and monitoring initiatives were most common adaptation types • No infrastructure, technology and innovation initiatives were documented • Approximately one quarter of initiatives included Inuit knowledge

	• Multiple comprehensive adaptation plans or frameworks intended to inform and coordinate adaptation initiatives were documented, including the Government of Canada's 'Pan-Canadian Framework on Clean Growth and Climate Change' (2016), Inuit Tapiriit Kanatami's 'Inuit Priorities for Canada's Climate Strategy: A Canadian Inuit Vision for our Common Future in our Homelands' (2016), and the Québec Government's '2013-2020 Climate Change Action Plan' (2012) and '2013-2020 Government Strategy for Climate Change Adaptation' (2012) No adaptation plans or frameworks were documented at the regional or community scales • Multiple published adaptation tools, including guidebooks, risk assessment frameworks, and best practices documents were documented • Several information portals/databases were established to help track and store information relevant to climate change and adaptation • By working at a regional scale and enabling links between various researchers and decision-makers, Ouranos' Northern Environment Program, provides an example of a platform that can be leveraged to encourage innovative multidisciplinary, multi-organisational dialogue that can promote adaptation initiatives at the local level.
Gaps and Future needs	• Pan-Canadian Framework on Clean Growth and Climate Change recommended the development and implementation of a comprehensive Northern Adaptation Strategy to strengthen northern capacity for climate change adaptation; this study is intended to inform this strategy • Creation of regional- or community-scale adaptation plans or frameworks would serve to increase the adaptive capacity of Nunavik's communities • Further research to assess which federal and provincial initiatives are being applied to Nunavik and if not why? • Policy recommendations included the development and dissemination of additional tools • Multiple collaborators recommended the need to work with communities to implement adaptation initiatives at the community level; community-level initiatives would help to build community resilience and adaptive capacity

Chapter 4: Summary Conclusions

This study examines and characterizes the current state of climate change adaptation in Nunavik. It is the first in-depth study of its kind for this region, characterizing the current state of adaptation by sector, identifying future adaptation needs, and involving policy makers and northern organizations in the review process and the recommendation of future needs. To gain a better understanding of adaptation occurring in all spheres, future research should emphasize identifying private-sector adaptation initiatives through stakeholder consultations and autonomous adaptation initiatives through community member interviews or focus groups. Furthermore, given Nunavik's dominant youth population and the rapidly changing environment, engaging youth in adaptation research and implementation could help to effectively build adaptive capacity in Nunavik. This chapter concludes the report with a presentation of overarching findings and recommendations from the analysis.

4.1 Predominance of groundwork (adaptation-enabling) initiatives

A total of 566 discrete climate change adaptation initiatives relevant to the Nunavik region, published since 2010, were captured by this systematic literature review. Despite this large number of initiatives, climate change adaptation in Nunavik remains in its early stages. The majority of adaptations were groundwork initiatives (see definition in section 2.6) and almost half of adaptation initiatives remained at the stage of recommendation. Groundwork initiatives are necessary for building readiness to adapt to climate change, and this study identifies proactive efforts to characterize climate risks and vulnerability, and the creation of cross-sectoral working groups on adaptation that span levels of government and engage the private sector. Continued translation of these initiatives into actions, including changes in land-use planning and disaster planning and emergency preparedness, would help to concretely prepare communities for a changing climate (Government of Canada 2011, 2016; Lesnikowski et al. 2011; Araos et al. 2016).

4.2 Few community-level initiatives documented

The majority of adaptation initiatives were implemented at the national and provincial scales, while comparatively fewer were implemented at the community level. Given that communities have varying exposure sensitivities and adaptive capacities, community-level initiatives that are tailored to community-specific contexts would help to effectively build resilience and promote adaptation in Nunavik (Pearce et al. 2011a; Bours and Pringle 2014; Loboda 2014). Additionally, geographic discrepancies among community-level initiatives were documented, in which some communities hosted markedly more adaptation initiatives as compared to others. Further research evaluating the drivers behind these discrepancies would be useful in engaging those communities that are currently benefiting from fewer adaptation activities.

4.3 Absence of comprehensive regional- and community-level climate change adaptation plans documented

Cross-scale coordination and leadership from the federal (primarily through funding), provincial and regional governments (primarily through strategy planning and programming) is driving the

majority of adaptation efforts in Nunavik. Such institutional coordination of adaptation across sectors and scales has been identified in the general scholarship as important in bringing adaptation onto government agendas, and catalyzing coherence, coordination, and long-term planning (Biesbroek et al. 2010; Dickinson and Burton 2011; Smith et al. 2011). While comprehensive adaptation frameworks or plans exist at the federal and provincial scales, none were documented at the regional or community scales. Across levels of government, legislative and regulatory requirements for adaptation are essential to ensure that climate change considerations are integrated into decision-making processes (Smith et al. 2009; Preston et al. 2011; Ford and King 2015). Formal adaptation planning can highlight that adaptation is a priority for government action and funding, can help provide strategic direction for government decision-making, and when combined with a strong implementation plan can be an important first step in moving towards adaptation action (Ford and King 2015; Preston et al. 2010; Smith et al. 2009). Whilst the provincial government's 2013-2020 climate change adaptation strategy outlines priorities and objectives for adaptation, a regional climate change adaptation action plan would further prioritize Nunavik's needs and enhance the communities' ability to efficiently adapt to climate change. The readiness-focused assessment that is currently underway for Nunavik aims to identify institutional factors constraining and enabling adaptation in the region. By providing decision-oriented knowledge explicitly designed to inform policy and practice, this assessment can be used to inform and advance planned adaptation and the development of adaptation plans.

4.4 Limited evidence of monitoring and evaluation adaptation initiatives documented

There was limited evidence of monitoring and evaluation initiatives documented across all scales; this is not unique to Nunavik and has been widely noted in adaptation literature elsewhere in the Arctic and beyond (Lesnikowski et al. 2011; Ford et al. 2014; Loboda 2014; Araos et al. 2016; Labbé et al. 2017). Monitoring and evaluation initiatives are a core component of adaptation planning, and are needed to track and assess initiative outcomes, target and justify adaptation funding, inform and improve initiatives, and reduce the risk of maladaptation (Lesnikowski et al. 2011; Preston et al. 2011; Bours and Pringle 2014; Ford et al. 2014; Araos et al. 2016). Additional monitoring and evaluation initiatives would therefore help to improve the effectiveness and efficiency of climate change adaptation in Nunavik.

4.5 Limited integration of Inuit knowledge into initiatives documented

Approximately one third of adaptation initiatives explicitly included Inuit knowledge, with integration being much more common at the community and regional scales as compared to the federal and provincial scales. Further integration of Inuit knowledge with broader-scale scientific research is needed to provide a foundation for successful, cost-effective, and culturally-appropriate adaptation strategies (INAC 2010; Nakashima et al. 2012; Arctic Council 2013). Integration of Inuit knowledge into adaptation initiatives could also help to improve initiative uptake and effectiveness (Bolton et al. 2011). Adaptation programs that have successfully integrated Inuit knowledge in Nunavik have been documented and could be used as models for future adaptation initiatives. Successful integration of Inuit knowledge into adaptation initiatives will also require continued discussions and collaboration with Inuit stakeholders.

4.6 Widespread benefits of intersectoral adaptation initiatives

A significant proportion of documented adaptation initiatives represented intersectoral efforts. Intersectoral initiatives are able to translate limited resources and capacities into crosscutting benefits and increases in adaptive capacity. As such, prioritizing the implementation of intersectoral adaptation initiatives could efficiently and effectively support climate change adaptation in Nunavik.

The *Unaaq Men's Association* in Inukjuak is a long-term land-based initiative designed to build youth resiliency, create jobs and promote Inuit culture. The program connects youth and Elders to foster land-based learning, through activities including country food harvesting, manufacturing and repairing traditional equipment, and teaching marketable and survival skills such as building construction and emergency management. Establishing similar initiatives elsewhere in Nunavik would have the potential to facilitate intergenerational knowledge transfer, income generation, improve psychosocial outcomes, and enhance intracommunity relations. Expanding existing land-based programs, such as the 'Integrated Community Based Monitoring Program, could also achieve similar results as the replication of the Unaaq Men's Association. Within these programs, promoting two-way skills transfer among youth and hunters, wherein hunters teach youth traditional land-based knowledge, while youth offer new technical skills such as efficient GPS navigation could further increase community adaptive capacity.

In addition to expanding the programs currently underway, establishing a network for sharing climate change adaptation information and expertise across Inuit regions would allow stakeholders to learn and benefit from others' experiences in climate change adaptation. This network could take shape as a web-based platform or portal that provides access to adaptation initiative information, tools, and links to other resources.

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Appendix I: All source documents organized by document type

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Appendix II: Data extraction codebook

Objectives:
This purpose of this systematic review was to understand the current state of climate change adaptation in Nunavik, Québec. In order to do so, an analysis of grey and peer-reviewed literature was conducted to identify all adaptation initiatives relevant to Nunavik since 2010.

Drawing on adaptation scholarship (Lesnikowski et al. 2015, Labbe et al. 2016), the analysis aimed to address the following questions:

a. *Who is adapting to climate change impacts in Nunavik, and who is initiating these adaptations (e.g. private sector, households, federal government)?*
b. *Where are adaptation initiatives taking place (geographic focus e.g., Kuujjuaq, Nunavik, Northern Canada)?*
c. *What factors (climatic and non-climatic) are motivating adaptation strategies (e.g. extreme weather events, economic stress)?*
d. *Which sectors report adaptation initiatives (e.g. business and economy, transport and infrastructure)?*
e. *What types of adaptation initiatives are being reported (e.g. research and monitoring, policy)?*
f. *At what stage of the adaptation process*[12] *is Nunavik at (e.g. groundwork or action)?*
g. *What is the status of adaptation initiatives (e.g. recommended, ongoing, complete)?*
h. *Are adaptation initiatives including Inuit knowledge?*

Individual adaptation initiatives were classified according to the following indicators: document title, stakeholder category, publishing year, type of document, initiative title, jurisdiction, geographical focus, scale, sectors involved in adaptation, climatic and non-climatic factors or vulnerabilities motivating adaptation, level of action, adaptation typology, inclusion of traditional knowledge in adaptation, and status of adaptation.

This study will provide a baseline for qualitative and quantitative adaptation tracking and for an evaluation of selected adaptation initiatives.

Key terms and concepts:

Climate change:
In order to be included in the analysis, initiatives must be concerned with climate change impacts, rather than the impacts of general climate processes. The United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change will be used for this study: *"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods"* (UNFCCC 1992). Initiatives may address any type of vulnerability associated with climate change, or any system (physical, biological, human) impacted by climate change. Initiatives addressing both positive and negative impacts of climate

[12] Refer to Figure 2.2 (page 20) for a description of the adaptation process

change will be analysed. Where climate change is not explicitly identified as a risk factor, an initiative will only be included if it can be reasonably inferred that the initiative accounts for climate change. As such, initiatives concerned with the general monitoring of temperature, precipitation, extreme events (as well as all other climatic factors included in variable 11 & 12 below) will be excluded unless climate change is clearly related to the initiative's purpose.

Adaptation:
In order to be included in the analysis, actions must be concerned with climate change adaptation, and not climate change mitigation, greenhouse gas emission reduction, energy efficiency techniques, or any intervention related to increasing carbon sinks and/or reducing carbon emissions. This study will use the IPCC definition of planned adaptation: *"the result of a deliberate policy decision, based on awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state"* (IPCC 2014).

Vulnerability:
The IPCC definition of vulnerability will be used: *"The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity"* (IPCC 2014).

Data sources:
Grey literature documents were collected through a web search and download of a website's material, reports and other documents; peer-reviewed documents were collected through five database searches. Adaptation initiatives that were not relevant to Nunavik were excluded from analysis.

Data organization and analysis:
Collected data will be contained in a Microsoft Excel spreadsheet and in an online and desktop Zotero™ library. Each spreadsheet row will denote a discrete adaptation initiative; each spreadsheet column will denote an analysis indicator. Individually inputting each discrete adaptation initiative will effectively capture the breadth of actions occurring across Nunatsiavut. The indicators used were adapted from Austin et al. (2015), Labbé et al. (2017), and Lesnikowski et al. (2015), and included: 1) document title, 2) stakeholders, 3) publishing year, 4) type of document 5) initiative title or description, 6) stakeholder collaboration, 7) stakeholder type(s), 8) geographic focus, 9) scale of adaptation, 10) most important scale of adaptation, 11) sector involved in adaptation, 12) climatic factor(s) or vulnerability(ies) motivating adaptation, 13) most important climatic factor or vulnerability motivating adaption, 14) importance of climatic factors in motivating adaptation, 15) non-climatic factor(s) or vulnerability(ies) motivating adaptation, 16) most important non-climatic factor or vulnerability motivating adaptation, 17) level(s) of adaptation, 18) most important level of adaptation, 19) adaptation typology(ies), 20) most important adaptation typology, 21) inclusion of Inuit knowledge in adaptation and 22) status of adaptation.

The data analysis was completed using Stata Corp. 14, and figures were created in Microsoft Excel 2016.

Inclusion and exclusion search criteria

Inclusion criteria	Exclusion criteria
Substantial focus on Nunavik	No substantial focus on Nunavik
Peer-reviewed article, government/non-governmental organization/private company/professional association document or webpage, document by government-established research organization/network or government-hired consultant, technical documents, adaptation plans, national/regional/provincial/community reports, or adaptation assessments.	Documents outlining vulnerability, resilience or adaptive capacity assessments; editorials; meeting or conference proceedings; or abstracts.
Climate change as the overarching adaptation focus	Does not explicitly address or mention climate change as the overarching adaptation focus
Focus on human adaptation initiatives to experienced or anticipated effects of climate change	Focus on non-human adaptation efforts (i.e. adaptations in natural systems), climate change mitigation efforts, or future climate projections
Consideration of changing future hazards and vulnerabilities	Addresses current or past climate risk without a consideration of how risk will change in the medium- and long-term future
Practical focus (i.e. provides details on a discrete adaptation initiative)	Conceptual focus (i.e. description of the problem and potential hazards)
English or French	Neither English nor French
Published in and after 2010 until March 2017	Published before 2010
Indexed by Google, Web of Knowledge, Scopus, PubMed, Geobase	Not indexed by Google, Web of Knowledge, Scopus, PubMed, Geobase

Codebook Indicators

Indicators 1 to 5 provide basic identifying information.

1. Document title	Full document title
2. Stakeholders	List all parties affiliated with adaptation initiative design, funding, implementation, or research based on author affiliations, acknowledgements, and logos included within the document.
3. Publishing year	Year document was published
4. Type of document	Grey literature or academic peer-reviewed
5. Entry title	A descriptive entry title should be used; include the name of the program, document, report, regulation, project, tool, training session etc. When titling policy recommendations, use the following format: "Policy recommendation: Type of action recommended."

(Lesnikowski et al. 2015)

Indicators 6 and 7 provide information regarding who is involved in adaptation by coding stakeholder collaboration and stakeholder type. Stakeholders are all parties affiliated with adaptation initiative design, funding, implementation, or research, determined based on author affiliations, acknowledgements, and logos included within the document.

6. Stakeholder collaboration	Yes	Multiple stakeholder groups from differing jurisdictions (federal, provincial, regional), NGO's, private sector actors, research institutions involved in adaptation design,

		funding, implementation, or research.
(Mutually exclusive)	No	Single stakeholder category involved in adaptation design, funding, implementation, or research.

7. Stakeholder Type (Not mutually exclusive)	International	Adaptation initiated by an international governing body (e.g. United Nations)
	Federal (Government)	Adaptation initiated by the Government of Canada or a federal department (e.g. Health Canada)
	Provincial (Government)	Adaptation initiated by the Government of Québec or a provincial department (e.g. Ministry of Transport)
	Regional (Government)	Adaptation initiated by the Kativik Regional Government or a regional department (e.g. Department of Renewable Resources, Environment, Lands and Parks)
	Community	Adaptation initiated by a community entity (e.g. Nayumivik Landholding Corporation)
	Private sector	Adaptation initiated by the private sector (e.g. Makivik Corproation)
	Non-Governmental Organization	Adaptation initiated by a Non-Governmental Organization (e.g. Inuit Tapiriit Kanatami)
	Research/Academic Institutions/Think Tanks	Adaptation initiated by the research community, an academic institution, or a think tank (e.g. McGill University)
	Individuals/ Families/ Community Residents (Autonomous)	Adaptation initiated autonomously by individuals/families/community residents

Indicator 8 provides information regarding where adaptation is occurring by coding for the geographic focus of the adaptation. Geographic focus represents the location where the adaptation initiative is occurring.

8. Geographic focus (Not Mutually exclusive)	National	Adaptation is focused at the national level.
	Pan-Arctic	Adaptation is focused at the Pan-Arctic level (e.g. all Circumpolar regions).
	Northern Canada	Adaptation is focused on all of Northern Canada.
	Québec	Adaptation is focused at the provincial level
	Nunavik	Adaptation is focused at the regional level.
	Community	Adaptation is focused at the community level (Akulivik, Aupaluk, Inukjuak, Ivujivik, Kangiqsualujjuaq, Kangiqsujuaq, Kangirsuk, Kuujjuaq, Kuujjuaraapik/ Whapmagootsui, Puvirnituq, Quaqtaq, Salluit, Tasiujaq, Umiujaq); specify which community.

Indicators 9 and 10 provide information on the extent of adaptation initiative implementation by coding for what scale the adaptation is occurring at. Indicator 9 is not mutually exclusive; however, the most important scale of adaptation was selected in Indicator 10. For the purpose of this study, importance is given to the scale most applicable to the region of Nunavik (ex. if the scale of the initiative was documented to be province-wide with additional information to suggest the inclusion of Nunavik, while indicator 9 would read 'provincial and regional', indicator 10 would read 'regional').

9 & 10. Scale	International	Adaptation is being implemented at the international scale.

(9. Not mutually exclusive; 10 mutually exclusive)		If only circumpolar countries are included then classify as Pan-Arctic, not International. Typically, in partnership between two or more nations by government or non-government organizations that will affect the well-being of all citizens or a subset of vulnerable groups within one or more of the participating nations. Actions include adaptations organized by international NGO's, the United Nations or private companies. Also included are adaptations undertaken or led by one nation, but that affects citizens of two or more nations.
	National	Adaptation is being implemented at the national scale. Includes actions undertaken by stakeholders in order to maximize well-being of all citizens or select vulnerable groups within a nation.
	Pan-Arctic	Adaptation is being implemented at the Pan-Arctic scale (e.g. all Circumpolar regions). Includes actions undertaken by stakeholders in order to maximize well-being of all citizens or select vulnerable groups in the Pan-Arctic.
	Northern Canada	Adaptation is being implemented in Sub Arctic and Arctic regions of Canada. Includes three Territories (Yukon, Nunavut, Northwest Territories), Nunavik, and Nunatsiavut.
	Provincial	Adaptation is being implemented at the provincial scale. Includes actions undertaken by stakeholders in order to improve conditions within the boundaries of a province or involving many provinces. Adaptations could be undertaken by two or more provinces within a nation; however, actions were not meant to influence all citizens at the national scale.
	Regional	Adaptation is being implemented at the regional scale. Includes actions undertaken by stakeholders in order to improve conditions at a regional scale that encapsulated two or more municipalities/communities within provincial boundaries.
	Community	Adaptation is being implemented at the community scale. Collective action is undertaken by stakeholders to deal with stimuli that affect the community as a whole.
	Individual/family/ household	Adaptation is being implemented at the individual/family/household scale influencing one or more people but not enough to constitute a community level adaptation. Household is defined as individuals living together as a unit under one roof or relatives that live in a common area.
	Indeterminate	Insufficient information to determine scale

(Berrang-Ford et al. 2011)

Indicator 11 provides information on what sector is adapting by identifying the sector that has been most involved in the adaptation initiative.

11. Sectors	Business and Economy	Costs associated with climate change (e.g. finance, labour, trade, business, industry, livelihoods, tourism, insurance);

(Mutually exclusive)		includes the business associated with mines and fisheries, forestry, hydroelectric power companies.
	Culture and Education	Includes all school system levels and other cultural education programs or opportunities (i.e. traditional knowledge mentorship programs).
	Health and Well-being	Includes public health planning, clinical services, and medical interventions.
	Hunting and Subsistence Harvesting	Hunting and traditional subsistence activities
	Infrastructure and Transportation	Includes land-use planning, housing, utilities, and public works. Includes road/highway maintenance, air traffic, and shipping.
	Institutional and Resource Management	Includes creation of new institutional structures (e.g. new department for climate change), as well as policies and regulations that govern natural resources.
	Intersectoral	Multiple sectors cooperating

(McDowell et al. 2014, Lesnikowski et al. 2015)

Indicators 12 to 16 provide information on what factors are being adapted to by documenting the climatic and non-climatic factors motivating adaptation. The lists of factors are sourced from the Intergovernmental Panel on Climate Change (IPCC) in the Fourth and Fifth Assessment Reports and adapted from Lesnikowski et al. (2015). Given that adaptations may be motivated by a variety of factors, Indicators 11 and 14 are not mutually exclusive. However, the most important climatic and non-climatic factor motivating adaptation was documented in indicators 12 and 15, respectively; these indicators were mutually exclusive. Indicator 13 assesses the importance of climatic versus non-climatic factors as motivating factors for adaptation initiatives.

12&13. Climatic factors motivating adaptation (12. Not mutually exclusive; 13. Mutually exclusive)	Air pollution	Air pollution, including higher levels of ground-level ozone, airborne dust, particulates, increased production of pollens and spores by plants
	Changes in lake/river bodies and/or their ice	Changes in lake/river bodies and their ice, including decreased ice cover and changing water levels or temperatures
	Changing ocean conditions	Changing general ocean conditions, including ocean temperatures, sea level, ocean hypoxia, acidification, and ecosystems. Does not include changing sea ice, which would be captured under "Sea ice extent/stability/duration decline"
	Extreme events	Increased frequency and intensity of extreme events (e.g. flooding, avalanche)
	Permafrost change	Permafrost changes and degradation
	Precipitation decrease	Decreased precipitation (annual or seasonal)
	Precipitation increase	Increased precipitation (annual or seasonal)
	Sea ice extent/stability/ duration decline	Reductions in sea ice extent, stability, and/or duration
	Sea level rise/coastal impacts	Sea-level rise, including coastal inundation, coastal erosion, and saline intrusion. Not defined as a single, extreme event (e.g. flooding or storms), but rather a creeping effect of climate change along coastal areas.

	Temperature decrease	Decreased atmospheric temperatures (annual or seasonal), more frequent and severe cold conditions.
	Temperature increase	Increased atmospheric temperatures (annual or seasonal), more frequent and severe heat waves.
	Water supply and/or quality concerns	Decreased water supply access and/or quality; affected by changes in precipitation, extreme weather; increased contamination in drinking and recreational water supply
	Weather and environmental conditions uncertainty	Greater unpredictability of weather or environmental conditions (e.g. travel route conditions)
	Wildlife changes	Marine, freshwater, and terrestrial wildlife changes (e.g. location, population dynamics)
	General effects/impacts	Initiatives addressing general climatic factors without specifying a specific climatic vulnerability
	Indeterminate	Insufficient information to determine the climatic factor(s) motivating adaptation

(Lesnikowski et al. 2015, Labbe et al. 2016)

14. Importance of climate-related factors in motivating adaptation Mutually exclusive	Sole reason for adapting	Only climatic factors were motivating adaptation
	Primary reason combined with non-climatic factors	Climate-related factors indicated as the main driver of adaptation in addition to other non-climatic factors.
	Equal or secondary role combined with non-climatic factors	Both climatic and non-climatic factors were influential in driving the adaptive response. Climate change was either of equal or secondary importance to non-climatic factors in motivating the adaptation.
	Indeterminate	Insufficient information to determine the importance of climatic factors in motivating adaption.

(McDowell et al. 2014)

15 & 16. Non-climatic factors motivating adaptation (If relevant) (15. Not mutually exclusive; 16. Mutually exclusive)	Cultural change and traditional lifestyles	Loss of cultural traditions (i.e. heritage, arts, methods of acquiring and using natural resources)
	Economic stress/development	Loss of profitability or viability, or increased costs in part due to climate change. Also includes economic development opportunities (e.g. increased access to mines).
	Food quality and/or quantity	Decreased country food quality and/or quantity, increased food-borne contamination, decreased food availability.
	Human health (physical)	Physical health and well-being vulnerabilities
	Infrastructure	Infrastructure vulnerabilities or requirements
	Mental health	Psychological impacts resulting from climate change stress
	Resource development	Altered resource development opportunities/abilities
	Transportation	Transportation vulnerabilities or requirements

	General factors	Initiatives addressing general non-climatic factors without specifying a non-climatic vulnerability
	N/A	Non-climatic factors not discussed as motivating factors
	Indeterminate	Insufficient information to determine the non-climatic factor(s) motivating adaption

(McDowell et al. 2014, Labbe et al. 2016)

Indicators 17 and 18 provide information about how adaptation is taking place by classifying adaptation initiatives into groundwork or action initiatives. According to Lesnikowski et al. (2011), adaptation groundwork can be understood as: *"steps taken to prepare for and inform adaptation responses."* Groundwork initiatives are meant to enable the conditions necessary for adaptation by building a context conducive to adaptation, but do not directly reduce vulnerability. Lesnikowski et al. (2011) defines adaptation action as: *"actions taken to help communities and ecosystems cope with changing climate conditions, such as the construction of flood walls to protect property from stronger storms and heavier precipitation."* Adaptation actions directly reduce vulnerability or build resilience to climate change. Since a single adaptation initiative may include both groundwork and action components, Indicator 17 is not mutually exclusive; however, the most important level of action was selected in Indicator 18.

Policy recommendations were categorized according to the level of the suggested action. For example, if a report suggested developing new storm warning technology, the initiative was classified as "Action" to better reflect the variety of suggested initiatives.

17 & 18. Level(s) of Action (17. Not mutually exclusive; 18. Mutually exclusive)	Groundwork	Steps taken to prepare for, and inform adaptation responses. Includes climate impact/vulnerability/ adaptation research, adaptation planning, stakeholder organization/networking/decision-making, strategic planning, determination of goals and priorities, evaluations assessing adaptation effectiveness, conceptual tool, etc.
	Action	Steps taken to directly increase resilience to climate change vulnerabilities. Includes legislative or policy action, infrastructure or technological development, adoption of adaptation practices, financial support provision, implementation etc.

(Lesnikowski et al. 2015)

Indicators 19 and 20 indicate how adaptation is taking place by classifying initiatives according to adaptation typology. The typology classification system used was adapted from published adaptation action assessments (Lesnikowski et al. 2011, 2015), which were adapted from a typology of possible adaptation measures identified by the IPCC AR4, and a literature review of peer-reviewed literature on adaptation assessments and tracking (Biagini et al. 2014). Given that multiple types of adaptation may be encompassed in a single initiative, Indicator 19 is not mutually exclusive; however, the most important level of action was selected in Indicator 20.

19 & 20. Type(s) of action	Capacity building (Groundwork)	• Developing human resources, institutions, departments, or working groups, and equipping them with the capacity to adapt to climate change.

(19. Not mutually exclusive; 20. Mutually exclusive)		• Includes increasing capacity of existing groups to address climate change through the identification of best practices and tool development. • Conceptual tools are also included such as modeling programs (including data sets, tools created for other purposes but applied to adaptation studies), databases of information, strategic guidelines, plans, frameworks, policy documents that guide adaptation policy. • Not legally binding- sets goals, objectives, and priorities. Including vague statements and concepts (e.g. flood risk management, drought strategy). • Networking and idea sharing among decision-makers, such as meetings, workshops and conferences also included in this category.
	Research and monitoring (Groundwork)	• Study of response options based on vulnerability context. • Includes research and development for adaptation, impact/vulnerability assessments, and tracking environmental or atmospheric conditions. • This includes surveillance and monitoring systems that inform authorities about when the public should be notified about elevated risk (e.g. weather stations that monitor and predict temperatures, used in heat warning systems).
	Monitoring and evaluation (Groundwork)	• Monitoring of the performance of implemented adaptation initiatives. • Evaluation of the integration of climate change perspectives in existing programs and measures. • Includes evaluations of the extent to which adaptation interventions are decreasing climate change risks.
	Information sharing (Action)	• Systems for communicating climate information to help build resilience, such as information databases and campaigns to educate communities about the climate change impacts and sources of vulnerability. • Includes early warning systems that inform communities of extreme events and provide information on proper individual or household response. E.g. heat wave warning systems, storm warning systems.
	Infrastructure, technology, and innovation (Action)	• New or improved physical infrastructure or technology (e.g. buildings, construction, climate-resilient technologies) aimed at providing direct or indirect protection from climate change risks.
	Management and planning (Action)	• Incorporating understanding of climate science, impacts and vulnerability into government planning and management. • Includes organizational developments such as the

		creation of government agencies, departments, working groups, or ministries with mandates that address climate change issues. • Includes increasing capacity of existing groups to address climate change. Implies allocation of government funding.
	Policy (Action)	• Creation of new policies or revisions of existing policies or regulations to allow flexibility to adapt to climate change. • Includes binding regulations, rules, guidelines, laws or statutes.
	Practice and behaviour (Action)	• Revisions or expansions of practices and on the ground behaviour that are directly related to building resilience to climate change impacts.
	Resource, transfers, and financial support (Action)	• New financing or insurance strategies to prepare for future climate impacts. • Funding for adaptation research and actions at different jurisdictional levels and stakeholder groups.

(Biagini et al. 2014, Lesnikowski et al. 2015, Labbe et al. 2016)

Indicator 21 addresses the inclusion of Inuit knowledge and cultural values in the adaptation planning, development, and implementation. For the purpose of this report, the term 'Inuit knowledge' is used to include understandings of indigenous knowledge, aboriginal knowledge, traditional knowledge, Traditional Ecological Knowledge (TEK), and Inuit Qaujimajatuqangit (IQ). Inuit knowledge encompasses knowledge (e.g. cultural knowledge, hunting skills, food preparation, environmental knowledge, etc.) gained through collective experiences passed down through generations. This variable is mutually exclusive.

21. Inclusion of Inuit knowledge Mutually exclusive	Yes	Inuit knowledge and cultural values were incorporated into adaptation planning, development, and/or implementation
	No	Inuit knowledge and cultural values were not incorporated into the adaptation
	Indeterminate	Insufficient information to determine the inclusion of Inuit knowledge and cultural values

Indicator 22 provides information on how adaptation is occurring by coding for the status of adaptation implementation. This variable is mutually exclusive.

22. Status of action Mutually exclusive	Recommended	A statement denoting that an action is important without any indication that implementation is underway and/or no timeline for implementation is discussed. Primarily includes policy recommendations.
	Planned	A statement denoting that an action is important with a clear indication that action or steps towards action are being designed (e.g. resource allocation, assigning personnel, etc.). Could be described in the form of a timeline for action implementation.

	Partially complete	Action implementation is very clearly underway/steps in action have been operationalized. Usually denotes initiative where multiple steps are in different stages of progress (e.g. some components in planning stage, some underway, some completed).
	Complete (ongoing)	All stages of action are underway and will continue to function beyond reported project completion date or indefinitely (i.e. surveillance system, legislation passed, infrastructure built).
	Complete (finished)	Action was implemented and completed prior to or at reported project end date.
	Indeterminate	Status is unclear based on information provided.

(Lesnikowski et al. 2015)

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