



Institutions, indigenous peoples, and climate change adaptation in the Canadian Arctic

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Published online: 11 May 2020
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Abstract Climate change impacts on Indigenous peoples in remote regions pose unique institutional challenges and opportunities for governments. Reducing vulnerability and enabling collaborative knowledge creation through the inclusive consideration of Indigenous peoples' perspectives in government and institutional efforts can help to advance adaptation to environmental change. In Northern Canada, Indigenous communities and multiple levels of the Canadian government and its institutions, including the Canadian Armed Forces, share the commensurate task and responsibility of responding to, tracking, monitoring and adapting to rapid climatic changes and impacts associated with climate change in the Arctic. In this review paper, we explore how Canadian governments may effectively work as partners and catalysts for advancing mutually beneficial climate change adaptation efforts with Indigenous peoples and communities affected by climate change in remote Arctic

regions of Northern Canada. We review knowledge and concepts related to Indigenous traditional ecological knowledge in the context of institutional adaptation planning and policy approaches in remote regions. First, we provide a geographical and contextual background that informs the efforts of institutional partners and Indigenous communities seeking to mutually address long-term challenges associated with adapting to climate change, specifically in the remote Canadian Arctic. Second, we unpack knowledge for advancing collaborative adaptation efforts between Indigenous peoples and institutions in the Arctic. We identify relevant gaps and opportunities for enhancing institutional approaches to climate change adaptation involving Indigenous peoples in remote regions like the Arctic. We conclude with a summary of policy relevant insights for future research.

Keywords Northern Canada · Indigenous knowledge · Climate adaptation · Arctic

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Introduction

Planning for climate change impacts and adaptation in remote regions such as the Canadian Arctic presents both challenges and opportunities for engaging Indigenous peoples in adaptation planning (Flynn et al. 2018; Prowse and Furgal 2009). It is now well-

established that adaptation planning efforts require inclusive social processes aimed at identifying key climate change impacts and risks with larger goals towards advancing strategic plans and activities that can prioritize opportunities for addressing contextual risks and promoting co-beneficial opportunities for reducing vulnerability to climate change impacts (Moser and Boykoff 2013; Mehdi 2006). Adaptation planning involves the inclusion of a wide range of diverse perspectives, including those of Indigenous peoples, often through the co-production of climate change risk scenarios as well as through iterative vulnerability and impact assessment processes that explore and assess exposure, sensitivity and adaptive capacities to adapt to climate risks, as well as to evaluate and prioritize contextual risks and actionable opportunities related to advancing climate resiliency on local and regional scales (Leith et al. 2018; Brondizio 2016; Berrang-Ford et al. 2015; Burton et al. 2007).

Adaptation planning can also inform the development of broader, longer-term strategic climate change and resiliency plans, at various temporal and geographic scales and across a diversity socio-ecological policy and planning contexts; all generally aimed at promoting adaptation and resiliency to the current and future potential of environmental risks associated with climate change (Cameron 2012). Since climate change is a long-term issue, driven by the industrial age legacy of greenhouse gas emissions and capitalist economic growth paradigms, it is expected that climatic change will exacerbate contextual environmental risks and hazards for the foreseeable future, requiring the development of continual adaptation approaches to build resilience to cumulative climate change impacts (Ford and Smit 2004; Smit et al. 2000).

Extant research suggests that effective adaptation planning begins at the local and regional scale, requiring multi-stakeholder collaborations among the various and multi-level institutions of federal, provincial and municipal governments tasked with risk reduction and climate adaptation policy development and enactment (Henstra 2017). To be effective and inclusive, adaptation planning also requires collaboration with a diversity of stakeholders, including but not limited to non-governmental organizations and academia, to support and build capacity on issues of shared interest of climate risk. Long-term and slow onset climate change adaptation challenges, such as

polar ice melt and sea-level rise, also require collaborative approaches that include Indigenous voices in efforts towards assessing and monitoring cumulative environmental risk conditions in remote regions like the Canadian Arctic (Ford et al. 2012). In this review paper, we identify both conceptual and contextual aspects that may be relevant to advancing effective adaptation planning with the traditional Inuit and Inuvialuit cultures of Northern Canada.

The geographic context of this article specifically focuses on and discusses issues that are pertinent mainly to adaptation efforts in remote Northern Arctic regions and communities in Canada. Based on a review of extant literature, throughout this article we provide a broad, contemporary analysis based on adaptation concepts and contextual evidence, with the goal of contributing to scholarly literature and policy discussions of relevant planning approaches for conducting adaptation collaborations with Indigenous peoples in the Canadian Arctic. Throughout, we highlight the key issues and aspects that are related to conducting effective institutional collaborations on climate change adaptation planning with Northern Indigenous peoples in the Arctic context (Black et al. 2009).

Geographical and contextual background: the need for Indigenous collaboration in climate change adaptation planning in the Canadian North

Collaborations between Indigenous communities and government institutions in the assessment and monitoring of, as well as responses to, climate related environmental risks and impacts are critical and important aspects of supporting effective and culturally appropriate climate adaptation and adaptive capacity building efforts in the Arctic (Ford et al. 2018), while promoting peace and reconciliation efforts between the historically marginalized Inuit and the Canadian government (Karetak et al. 2017). In this section, we review geographical and contextual Indigenous cultural perspectives related to the challenges and opportunities for improving adaptation planning collaborations through the co-production of knowledge with Inuit and Inuvialuit communities. We begin by reviewing and outlining the long-term environmental challenges posed by climate change impacts in the Canadian Arctic. Then, we review

knowledge concepts of Indigenous resiliency in the Arctic as a conceptual platform for further exploring opportunities for advancing more effective institutional adaptation efforts through co-produced knowledge and collaborations on climate adaptation planning. Throughout this article, we advocate for greater consideration and incorporation of Indigenous cultural worldviews and traditional knowledge as critical aspects of advancing durable, effective institutional collaborations on adaptation with Indigenous peoples, with the ideal shared aims of co-produced knowledge for reducing vulnerability and promoting adaptive capacity and resiliency to climate change in one of the regions of the world that is most dramatically being affected by climate change impacts.

Taking stock of environmental change and adaptation efforts in the Canadian Arctic

General knowledge and awareness about climate change adaptation has transitioned to the specific development of adaptation strategies and plans, with national governments playing key roles in adaptation planning and policy implementation (e.g. WGAR 2016). Diverse and variable subnational and local level adaptation responses and outcomes have been observed (Vogel et al. 2018; Larsen et al. 2014; Biesbroek et al. 2013). There is evidence of public support for government agencies pursuing adaptation planning and policies to reduce the impacts of current and future climate change on communities and the organizational activities of institutions (Ray et al. 2017). This is true in the northern regions of Canada where Indigenous communities are witnessing significant changes brought about by the alarming rates and nature of climate change (Hassol 2004).

Nationally in Canada, there are now several broad thematic areas for mutual collaboration between Indigenous and institutional partners, recognizing that key domestic priorities in the Canadian Arctic in a warming climate include issues associated with (1) national border security and defence (Byers 2010; Heininen 2016; Smith 2010; Furgal and Prowse 2009; Prowse 2009a); (2) a range of related adaptation issues associated with slow-onset climate change impacts such melting sea-ice, permafrost loss and sea-level rise (Larsen et al. 2014; Hassol 2004), and; (3) adaptation to acute climatic changes such as exposure to extreme weather conditions and cold temperature related

health and safety concerns (Ray et al. 2017; Thompson and Calkin 2011; Blesson et al. 2018; Haigh 2013). Investigations into the risks and hazards that climate change and extreme weather impacts pose to transportation networks and the built environment in the Arctic constitutes another adaptation planning opportunity (Champalle et al. 2013). Consequential risks associated with increasing shipping traffic in the Arctic and the socio-ecological impacts and effects that natural resource economic development projects (e.g. oil and gas exploration, mining) have on traditional Indigenous livelihoods in the Arctic, also present key issues in need of further investigation that properly recognizes and includes Indigenous knowledge (Dawson et al. 2020; Karetak et al. 2017; WGAR 2016; Prowse 2009b).

In describing collaborative institutional adaptation approaches, Flynn et al. (2018) identify six stages for utilizing participatory approaches to adaptation effective scenario planning with local stakeholders. The first four stages include stock taking of sorts: (1) ensuring community participation and engagement when gathering information on the local context; (2) identifying key trends and drivers; (3) creating scenarios, and; (4) reviewing projections. The final two stages set out actions, including: (5) identifying and (6) prioritizing adaptation options. In Flynn et al.'s review of 43 Arctic impacts, adaptation and vulnerability studies, they report that community level participation and consideration of local culture, values, and belief systems has been *variable*, while climate scenarios and projections have *not been uniformly considered* in community scale adaptation planning efforts involving scenario building, development and analysis.

These policy and planning gaps indicate a need and an opportunity for advancing future institutional climate change adaptation planning efforts to promote the inclusion of Indigenous knowledge. The finding also seems counter-intuitive since the inclusion of local perspectives is a contextually important consideration, particularly for institutions and agencies tasked with developing adaptation options that require place-based knowledge of local environmental conditions and hazards.

A key attribute of the iterative adaptation planning process is to incrementally advance organizational learning (Corfee-Morlot et al. 2009). This is done by enhancing institutional adaptive capacities through the

creation of strategic knowledge sharing opportunities and coordinated governance efforts that involve multi-party collaborations, including with Indigenous populations (Cunningham et al. 2014). Such adaptation planning initiatives take advantage of the diversity of qualitative and quantitative data and information provided by diverse stakeholders to formulate strategic climate change priorities and plans. Relatedly, Knapp and Trainor (2013) found that the creation of local stakeholder networks and/or multi-scalar boundary organization(s) can help to promote the improved inclusion and integration of local knowledge and place-based community monitoring partnerships to advance long-term research collaborations that support climate adaptation in the Arctic.

Participatory approaches to adaptation planning can encourage multi-stakeholder evaluations of the various options for adaptation, while also promoting and encouraging shared development of multiple forms of understanding. This can be done through broader consideration of multiple ways of knowing, including Indigenous knowledge, as applied to developing disaster risk reduction scenarios for advancing effective and strategic adaptation planning efforts that collaboratively link government institutions and Indigenous groups as equal partners. Public engagement in adaptation efforts, provides a tool for better informed decision making, in efforts to manage expected future risks as well as take advantage of new opportunities associated with climate change. Before further examining and offering insights related to Indigenous knowledge inclusion in adaptation efforts in the Canadian Arctic, we will first review some of the contextual climate related and social aspects of environmental change occurring in this region of the world.

Climate change impacts

The Canadian Expert Panel on Climate Change Adaptation and Resilience has highlighted the disproportionate vulnerability of northern, remote and coastal regions in Canada to climate change impacts—with the longest coastline in the world at 243,042 km, Canada is significantly exposed to climate change impacts on the expansive Northern Arctic coast (EP-CCAR 2018). Annual average temperatures in the Arctic have increased at *twice to three times the global average*, with significant changes to

Arctic ecosystems, annual sea-ice formations and shifts in seasonality resulting in changing weather patterns reflected in observable new species of trees, plants and animals shifting their habitat northwards (ACIA 2004; EP-CCAR 2018). Warming in the Canadian Sub-Arctic and Arctic includes impacts such as greater incidence of flooding, erosion, changes to traditional subsistence hunting practices dependent on sea-ice; as well as changes in forest fire regimes, and critical issues of food security; all of which directly influence the resiliency of Indigenous peoples cultural practices, as well as the resiliency of the practices of industry and public sector actors operating at high latitudes (Lemmen et al. 2016).

Unique to Arctic ecology are slower-onset climate impacts that can cumulatively lead to acute disasters and catastrophes, for example the potential for unpredictable landslides occurring from incremental permafrost melt in the Arctic as a result of climate change (ACIA 2004). Acute conditions of extreme weather, unpredictable temperature variations and/or unusual precipitation patterns can trigger landslides as permafrost thaws. Another slow-onset climate impact—sea-level rise—is incrementally decreasing the livability of coastal settlements through observable coastal erosion and flooding of coastal communities, particularly when associated with extreme weather events and/or changing ice and tidal conditions in coastal settlement areas (Ford et al. 2018).

Changing sea ice dynamics, sea-level rise and climatic changes in storm activities exacerbate ongoing issues of coastal erosion and land loss for coastal communities. Permafrost thaw and loss of sea-ice disrupts transportation routes, roads, airports and building foundations—destabilizing infrastructure, including those such as industrial facilities and pipelines, exemplifying the susceptibility of Northern infrastructure to climate vulnerabilities. (ACIA 2004). Such environmental hazards, losses and damages present substantial challenges and costs associated with investments in adaptive maintenance, defence, retreat and/or rebuilding of permanent settlements of Indigenous communities and governments operating in Northern latitudes.

Traditional Practices, Food Security, Infrastructure & Transportation Networks

Remote and Indigenous settlements traditionally dependent on wildlife harvesting activities for sustenance (e.g. seal, caribou, muskox, fish & fowl) are particularly impacted by irreversible chronic climate change impacts and issues associated with thawing permafrost, rising sea-levels, warming temperatures, melting sea-ice, as well as ocean acidification (Larsen et al. 2014). This evidence of climate impacts suggests that climate change is disproportionately impacting the traditional livelihoods and Indigenous communities of Canada's northern boreal and Arctic ecosystems, dependent on subsistence hunting and gathering activities. Changing species migration patterns and unpredictable weather conditions significantly disrupt resource dependent economies and the food security of Indigenous communities practicing traditional livelihoods and harvesting activities (Ford et al. 2019; AMAP 2017; Larsen et al. 2014). For example, less predictable or even spontaneous ice break-up, causes significant risks and the potential for loss of human life for Indigenous cultures traditionally dependent on the formation of sea-ice for transportation and capability to harvest 'country' food from the land. Relatedly, warming temperatures and melting sea-ice are reducing the habitat available for many traditionally valued species—further affecting traditional hunting and gathering activities (Pearce et al. 2015a, b).

Changing seasonal sea-ice dynamics and a commensurate increase in natural resource development and shipping activities in the Arctic (Pizzolato et al. 2014, 2016) also poses potential threats to the traditional livelihoods of the Inuit and Inuvialuit who depend on sea-ice for wildlife sustenance harvesting activities, reiterating the incumbent need for inclusive consideration of northern actors in the formulation of Arctic shipping strategies and governance decisions (Dawson et al. 2016, 2020).

Changing seasonal norms are also increasing risks and decreasing the reliability of opportunities for overland transportation via winter ice roads to southern latitudes. While imported food in Northern communities can provide a short-term answer to food insecurity from loss of cultural foods and sustenance supply-chains, it is also an expensive and non-traditional, non-sustainable solution to decreased

access or reliable availability of traditional food sources deemed culturally and economically important to Inuit and Inuvialuit communities, as a result of the high transportation costs associated importing goods (Ford et al. 2019). Food insecurity is further exacerbated by lack of transportation infrastructure and the challenging logistics associated with servicing and transporting goods to remote geographies prone to increasingly unreliable weather and environmental conditions, both overland and by sea.

The rapidity of climate change impacts occurring in the Arctic underlines the need for advancing Indigenous collaborations through institutional approaches to support adaptation policy and planning in the Arctic (Pearce et al. 2015a, b). For Indigenous peoples and governments functioning in the North, increasing frequency and intensity of extreme weather variability and unpredictability, as well as [removed] thawing permafrost and melting of sea-ice, significantly influences and impacts how people meet their basic needs in daily life, work and outdoor activities (Furgal and Prowse 2009; Prowse and Furgal 2009).

Contrary to the nomadic histories of the Inuit and Inuvialuit, the settlement infrastructure needed to sustain permanent communities in the Arctic must be durable, resilient and capable of withstanding a wide range of temperature changes and environmental conditions (Arctic Council 2016; ACIA 2004). Notably, resiliency to environmental changes includes capacities to withstand the impacts that warmer temperatures has on Northern infrastructure, transportation networks and resource supply chains critical to ensuring that Northern peoples' basic needs of food and shelter are met. Furthermore, a changing physical environment also includes disease vector changes brought on by melting permafrost and ice; while extreme weather and rising seas creates additional health risks for northern communities, and government personnel operating there (Seguin 2008).

We summarize that there are substantial climate risks in the Arctic, necessitating a growing need for climate adaptation research and action in the Arctic to holistically address further risks associated with impacts on the quality of freshwater ecosystems, multiple socio-ecological dynamics of changing terrestrial and marine ecosystems, and importantly, the impacts that these changes have on the traditional economies of diverse Indigenous cultures and populations in the North including Inuit, Inuvialuit as well

as Northern Innu, Metis and other First Nations cultures and communities that have depended on these increasingly threatened natural resources since time immemorial (Larsen et al. 2014).

Weather and seasonal variations

The ability of Indigenous peoples in the Arctic to gather food and sustain traditional cultures and lifestyles is under threat from climate change. Bates (2007) concretely identifies the complexities associated with predicting and planning for volatile weather conditions in the Arctic environment as a substantial challenge. For example, in the Inuit settlement of Cambridge Bay (Nunavut, Canada), weather “...can change completely in a matter of hours, catching the unwary and unprepared in thick fog, torrential rain, gathering waves, blowing snow, or plummeting temperatures... blizzards sweep in off the tundra, disrupting community schedules for days, as offices and schools are closed and planes are grounded or prevented from landing. At any time of the year fog or snow could similarly disrupt airplanes” (Bates 2007: 89). Such extreme weather conditions pose significant challenges to day-to-day Northern life.

In the Arctic, extreme weather conditions also co-exist alongside high latitude annual fluctuations in light patterns and dramatic variations in seasonal changes. Bates also reports the significant impact that the twenty-four-hour fluctuations between daylight and darkness occurring on the annual basis has on daily rhythms of work and life (2007). Unpredictable and extreme weather conditions and annual light variations also pose challenges for shipping and air transportation, exemplifying the precarious nature of outside reliance on imported goods and food supplies for survival (Dawson et al. 2020).

Indigenous cultural assets

While climate change is increasing the unpredictability and severity of already extreme weather conditions in the North, at the same time, northern Indigenous populations may be more prepared to adapt to such changes, given cultural worldviews informed by geographical histories and socio-ecological relationships developed through generations of lived experience adapting to the realities of harsh Arctic weather and extreme living conditions. Amidst the bio-

physical backdrop associated with Arctic climate change impacts, Indigenous communities possess and have maintained traditional cultures and worldviews based in place-based ecological knowledge that has given rise to adaptation and coping strategies based on local ecology, as reflected in cultural practices and lived experiences in dealing with extreme weather through adaptations to environmental change. Yet, Indigenous people are disproportionately (both by the geo-political context of State-Indigenous relations and related socio-historical legacies of Canadian settler-colonialism) vulnerable to the impacts of climate change.

While advancing collaborative engagements with Indigenous peoples is needed, complex and contentious social and political issues underlie the potential for advancing collaborative efforts for shared governance regimes of natural resources and territory (i.e., adaptive co-management) in remote Arctic regions (Pearce et al. 2015a, b; Plummer et al. 2013; Downing and Currier 2011; Ford et al. 2012). Institutional service to advance adaptation planning through collaborative activities and multi-stakeholder research partnerships, including through knowledge co-production with Indigenous peoples, may provide opportunities for learning and developing innovative approaches for formulating and advancing mutually beneficial strategic climate adaptation plans and policies. These types of co-designed initiatives could also support better integrated disaster risk reduction and reconciliation efforts that can also advance mutual capacities to address contextual climate change risks (Hassol 2004).

For institutional actors operating at high latitudes (such as governmental and community agencies), climate change related issues present real and strategic challenges and key opportunities for engaging Indigenous perspectives and knowledge related to the development of adaptation and resiliency policies, plans and operations of various activities conducted in Canada’s northern regions. Local knowledge of environmental and social changes remains a crucial aspect of monitoring and navigating rapid climate changes in northern environs, and successfully adapting to climate change, and the institutional opportunities for serving the adaptation needs of Indigenous communities through co-design and cross-cultural learning are ripe.

Social vulnerability and Indigenous resiliency in the Arctic

Social vulnerability to environmental hazards (Cutter 1996) presents climate related logistical hazards and adaptive capacity challenges for Indigenous communities in the Arctic. Addressing these issues requires including the perspectives of historically marginalized Indigenous peoples, as they represent a unique, “vulnerable” and often under-represented voice in Canadian climate change adaptation policy discourses (WGAR 2016). Social vulnerability of Indigenous Arctic communities has been exacerbated due to the historical legacies of European and Canadian colonialism that have contributed to strained cultural relations and feelings of distrust, stemming from historical differences and contrasting cultural realities of Canadian settler-colonial institutions, mainly based in the South, with the Indigenous cultural traditions and ways of life in the North (Karetak et al. 2017; Cameron 2012; Cornut 2010). Cameron and others (e.g. Pfeifer 2018) point out that many Arctic regions have been neglected in vulnerability and adaptation research and Indigenous knowledge and traditional practices of adaptation have been under emphasized in climate change planning and policy efforts (2012).

The remote geography of permanent settlements in the Arctic increases social vulnerability through costly transportation economics to maintain the resources supply chain that sustains daily life (i.e. the added expenses of relying on imported food and basic household supplies). As previously discussed, climate change impacts can and do disrupt transportation networks and infrastructure as permafrost shifts, extreme weather conditions prevail, sea-level rise and sea-ice melt present imminent dangers to those living and working in the Arctic environment. This has direct implications for the shipments of food, fuel, infrastructure, medical supplies to Northern communities that are critical for sustaining populations (EPCCAR 2018). For example, the recent experience of Churchill, Manitoba’s dysfunctional rail corridor provides a stark illustration of how climate change impacts are disrupting Northern life. According to the Canadian Broadcasting Corporation, “...record flooding washed out portions of the approximately 400-km track leading to Hudson Bay in 20 different places,” transforming the community of 800 people into a fly-in or port-access only community (CBC 2019).

Transportation constraints affected by historical flooding plausibly relates to climate impacts. As a result in Churchill, the price of food, bottled water and household supplies *tripled*, exacerbating existing social vulnerabilities associated with the already exorbitant costs of living in the North, compared with those in southern Canada. This exemplifies how transportation networks can be disrupted by changing seasonalities and climate change impacts which in turn also complicates day-to-day planning and managing the daily logistics needed for sustainable prosperity in Northern settlements.

Social vulnerability also relates to sub-standard infrastructure (e.g. roads, water), inadequate housing and limited access to basic services in remote Indigenous communities of the Arctic. As a result, remote resource-dependent and traditional economies on Canada’s Northern coast are differentially vulnerable to harm due to the shifting climate. Yet, Indigenous peoples’ intimate local knowledge of Arctic environmental conditions persists, providing an irreplaceable and essential aspect for advancing situated and culturally appropriate adaptation planning efforts in the North (Flynn et al. 2018). We acknowledge that providing adaptation supports to increase remote settlements’ resiliency requires first ensuring the adequacy of basic services such as transportation, safe water, infrastructure and adequate shelter are met. This is consistent with research and policymaking efforts towards supporting Indigenous reconciliation through capacity-building in the North (Pfeifer 2018; Karetak et al. 2017).

While a market economy exists in the North, the Inuit of the Canadian Arctic have maintained their subsistence-based hunter gatherer society. Since remote Indigenous settlements in the Arctic are marked by a lack of opportunity for participation in the modern economy with high unemployment or precarious employment, reliance on expensive imported food is not tenable for many, necessitating a continued reliance on traditional harvesting practices of ‘country food’ as an essential aspect of affordably nourishing Inuit and Inuvialuit people while sustaining traditional cultural practices, therefore countering social vulnerability while promoting and sustaining Indigenous cultural resilience. An appreciation for traditional cultural access to local food, as well as respecting the rights of freedom of expression for Indigenous cultural practices and traditions, are also

elements of Arctic resilience (Armitage et al. 2011). Many depend on gathering food and resources from the [removed] Arctic environment, with their culture and traditions deeply tied to Arctic wildlife and natural resource cycles for sustenance. Hicks and White (2000) have identified the multiple importances of traditionally harvested sources of protein such as Arctic Char and Caribou for Indigenous peoples of Nunavut. In juxtaposition, several traditional food species are now vulnerable to climate change impacts, affecting wildlife population dynamics and migration patterns, illustrating the challenges of adaptation planning for Indigenous communities (Lovecraft and Meek 2011).

Previous researchers (Cameron 2012; Bates 2007; Adam 2002) have also discussed how the Inuit maintain cultural values and traditional beliefs about environmental adaptability and flexibility that are informed by continuous interaction with the local ecology, the land and sustenance relationships with Arctic wildlife, all of which shapes cultural perceptions about managing time and economic opportunities—including food procurement. Perhaps in part related to cultural hunter-gatherer traditions, the extant literature suggests that, at least historically, the Inuit have tended to eschew reductionistic philosophies about risk, prediction and uncertainty in a traditional worldview that steeply contrasts with non-Indigenous scientific beliefs about the predictive power of risk forecasting & quantification of uncertainty probabilities. From this adaptive perspective, formulating rigid plans and strategies based on a worst-case scenarios can be perceived as a ‘taboo’ among Inuit; whereas maintaining a broader set of skills, abilities and knowledge to adapt spontaneously to situations as they emerge is valued more, at least in the historical (and present) context of hunter-gather traditions and Indigenous worldviews.

At the risk of grossly oversimplifying and mischaracterizing the relationship between traditional Inuit worldviews and the value placed on modern climate science to inform decision-making, based on literature review alone, we suggest there is a greater need for critical inquiry and field studies that probe and conduct exploration into the conceptual power and the utility of the predictive capacities of science to anticipate the future as a means of effectively adapting to environmental change in the Arctic, particularly for actors

working to advance and support adaptation and resiliency efforts among the Inuit.

Towards these ends, we postulate that perhaps in the Arctic environment, where weather conditions are highly variable, extreme and uncertain, Indigenous cultural traditions and worldviews have evolved that have allowed for sustaining resilient, socio-ecological adaptations to harsh environmental conditions for millennia (Riedlsperger et al. 2017). This notion call into question the power of predictive forecasting and non-Indigenous and reductionistic scientific research efforts to holistically inform longer-term, adaptation planning and static management strategies and efforts meant to support Indigenous peoples facing sustained impacts from climate change. Adjacent to this observation, we raise the spectacle for cross-collaborative institutional learning and adaptive capacity building approaches for those non-Indigenous institutions seeking to better promote adaptation and resiliency efforts in the North. Based on these notional reflections, we suggest there is a greater need for conducting co-designed and collaborative inquiries about the Arctic impacts of climate change to inform indigenous-led adaptation policy formulation, focusing specifically on effective process co-designs for jointly identifying and assessing the value of Inuit knowledge in forecasting climate uncertainties as a strategy for producing culturally appropriate adaptation policies and plans to deal with highly variable environmental changes, climatic shifts and impacts.

Inuit perceptions of resiliency to environmental change, as well as historical resiliency to other social challenges such as the imposition of non-Indigenous values, languages and cultural practices, have been enabled by maintaining cultural flexibilities to strategically adapt through an in-depth knowledge of the environment and an acculturation and social priority placed on improvisational abilities to respond to situations as they present themselves on the land, sea-ice and in other environmental contexts, rather than trying to anticipate and prepare for future risks (Karetak et al. 2017; Wolf et al. 2015; Cameron 2012).

However, when ensuring adequate access to food and water supplies and sustaining infrastructure and transportation networks in remote Arctic geographies, spontaneous adaptation does not always suffice as a response to the nature of problems arising in key areas of northern life impacted by climate change (Lemmen et al. 2016). For some remote Northern Indigenous

populations historically (and currently) dependent on natural resources harvesting for sustenance, there are substantial risks of vulnerability and susceptibilities to food insecurity due to climate impacts, should wildlife dynamics collapse and undermine traditional harvesting activities. More immediately, disrupted transportation networks and infrastructure affected by permafrost melt and sea-ice uncertainties currently affects subsistence hunting activities and endangers hunters and operators travelling on sea ice or overland by ice-roads in the North.

There is a paradoxical contrast between Indigenous culture and the institutional governance of climate change in the Arctic, highlighting how southern solutions, such as scientifically based adaptation planning and policy, face many unique challenges and opportunities for learning in Arctic regions. We advance the idea that effectively responding to environmental change in the Arctic requires salient and credible information to advance both Indigenous and institutional decision-making and policies and programs geared towards promoting adaptive approaches to hazard management, in a manner that is culturally appropriate.

Herein lies the crucible for legitimate appreciation and inclusion of Traditional Ecological Knowledge (TEK), and specific to the Arctic, Inuit Qaujima-jatuqangit (IQ), to ensure the co-production of knowledge and effective policy and planning engagement and inclusion of Indigenous voices in developing climate adaptation strategies (Karetak et al. 2017; Berkes 1999). It is known that effective advancement of adaptation theory, policy and planning should include greater emphasis on building institutional research partnerships with local Indigenous groups as a means towards advancing collaborations that support scientific goals and help to meet local needs for risk reduction in a culturally appropriate ways (Cash et al. 2002). We posit that the continuation of progressive institutional collaborations involves advancing shared opportunities for integrating traditional knowledge into regional institutional approaches for adaptation to climatic conditions to help improve adaptive capacities in remote regions like the Arctic, and perhaps to also help to evolve and advance adaptation efforts by institutions more broadly.

Adaptive capacity in the Canadian Arctic: incorporating Indigenous TEK & IQ perspectives

Institutional research and policy actions related to climate change adaptation seeks to explain and advance understandings of the dynamics of governance (Cashmore and Wejs 2014) and the variability of policy and decision-making processes that underlie stakeholders' efforts to anticipate, manage and adapt to climatic changes (Vogel and Henstra 2015; Dowd and Howden 2014). In conceptually addressing institutional capacity gaps, several researchers (e.g., Plummer et al. 2013; Lockwood et al. 2010; Lemos and Agrawal 2006) have observed shifting environmental governance patterns in institutions. These include the cessation of centralized control over environmental resource management in favour of alternative or hybrid forms of adaptive co-management and environmental governance that hinge on the direct involvement of local citizens and groups in sustainability planning and management. Through decentralization, it is assumed, opportunities for strategic integrated multi-scalar approaches involving the public and key stakeholders can help to advance climate change adaptation knowledge creation and sharing through multi-stakeholder collaborations in resource planning, ecosystem monitoring and management regimes, with a broader view towards supporting adaptation to climate change. Although, we also note that 'how and why' adaptation policy-making and planning activities occur is still largely variable in Canada (and elsewhere), subjectively determined by the social dynamics of institutional actors operating within the strictures of hierarchal governance structures and regional or local contexts related to capacity building opportunities and constraints (Vogel et al. 2018). In the case of Arctic adaptation, Watt Cloutier (2016) has directly called for the inclusion of Indigenous Peoples' TEK and IQ perspectives in climate change policy dialogues regarding the future of the Arctic, recognizing there is inherent value and knowledge to be gained from Indigenous peoples whose cultures are directly and historically connected to the land. Adaptation issue framing also shapes, and is shaped by, the research agendas and dynamic (and sometimes competing) institutional factors such as the variabilities in the institutional and cultural values and principles that underlie the formation of broader governance goals

and regional objectives related to climate change research programs, adaptation planning and capacity building initiatives.

For example, in a review of Arctic climate change adaptation planning studies, Flynn et al. (2018) found that user-centred research about climate impacts tended to predominate the field, with research focusing on the impacts of climate change on Northern tourism, community planning, resource management, traditional livelihoods and health and wellness. It was also observed that social science research activities tended to be more inclusive of local participation of Indigenous peoples than the more technical studies on Arctic transportation and shipping. Flynn et al. also found that northern adaptation planning studies utilizing back-casting techniques to envision “ideal futures” through scenario development with local people had higher rates of community participation. However, the same study also reported ongoing barriers and institutional difficulties with sustaining the integration of traditional and local knowledge into Arctic adaptation governance processes, and effective inclusion of Indigenous peoples in decision making processes—despite legislative requirements to do so under regional governance approaches, national treaties and international agreements.

Generally speaking, climate adaptation and building adaptive capacity relates to supporting human capabilities to resiliently adjust to climatic shifts, while recognizing and building on existing cultural knowledge and approaches (e.g. TEK & IQ in the Arctic), in order to help to collectively advance societies and build the necessary societal adaptive capacities required for resiliently dealing environmental changes, in culturally appropriate fashions. As such, Indigenous knowledge forms a vast repository of cultural knowledge capable of informing holistic planning approaches to climate adaptation and more broadly notions of land stewardship, and collaborative natural resource management.

We share the belief that Indigenous knowledge is sorely needed within broader epistemological approaches of global, national and regional efforts to combat climate change via adaptation interventions, holistically including consideration of the roots of the cultural causes of the rise in greenhouse gas emissions driving global temperature change and ecological shifts (e.g. Western social, cultural and economically utilitarian environmental values, legacies of

colonialism and the impacts capitalism, neoliberal globalization etc.). While this area of philosophical inquiry is beyond the scope of this article, it is important for readers to recognize that Indigenous cultural traditions such as IQ contribute a radically different view of the world on the issues of climate change by treating it more holistically—in essence arguing that treating the symptoms (climate impacts), without addressing the root causes (cultural values), can not and will not tangibly lead towards environmental sustainability and socio-ecological resiliency, in the long-run.

We turn our attention now to the contributions that IQ & TEK may have towards broadening adaptation dialogues in the North. While the geography and physical landscape of Northern Canada may be similar in that is [removed] sparsely populated, there are also unique regional governance differences in the cultural fabrics, political organization and demographics of the people who live there. Wenzel (2004:239) reports that the “principal difference between Nunavut and either the Northwest Territories or Yukon... is that the majority of Nunavut’s citizenry (approximately 85%) are aboriginal, almost all of whom are Inuit”. Nunavut was created in 1999 as a sovereign sub-national territory of Canada governed by Inuit. In Nunavut, governance approaches give a priority to IQ—a philosophical worldview encompassing “all aspects of traditional Inuit culture including values, worldview, language, social organization, knowledge, life skills, perceptions and expectations” (Wenzel: 240; See also Karetak et al. 2017; Berkes 2008).

Karetak et al. (2017), observes further that IQ historically, and currently, provides a holistic and ethical framework guiding all aspects of Inuit life, consisting of four main cultural ‘maligarjuat’, or guiding ‘laws’ or principles, that include: (1) working for the common good, as opposed to personal interest; (2) living in respectful relations with people and living things; (3) maintaining harmony and balance; and, (4) planning and preparing for the future.

In full disclosure, we acknowledge that as ‘Qallunaat’ (non-Inuit Southerners) engaged in desk-based literature review activities only, our capacities to fully comprehend and accurately communicate about IQ are limited. What follows is our interpretation of IQ, based on extant literature, with a view towards advancing the ontological objective of broadening the scope of communication about adaptation policy approaches

and raising the importance of IQ and holistic thinking for other ‘Qallunaat’, with regards to institutional approaches to adaptation and adaptive capacity building in the Arctic and elsewhere.

Historically, in Inuit hunter-gatherer ways of living, IQ served as a means of social ordering for the subsistence nomadic lifestyles of the Inuit through oral traditions in Inuit culture. Today, IQ has potential applications for informing 21st century governance models, particularly for climate change adaptation and resiliency. IQ presents a holistic and different approach to thinking about adaptation; providing a well-spring of innovative knowledge that could better help and serve to informing the continuation of Inuit culture and particularly the development of holistic planning approaches that include and recognize the importance of cultural knowledge and social capital as components of the adaptive capacities necessary for advancing effective approaches for dealing with and adapting to perilous and ever-changing environmental conditions in the harsh Northern landscape, and in other locales confronted and faced with rapid climatic change (Sabo and Sabo 1985).

In contrast, TEK recognizes that there are various human systems of knowledge acquisition, including the innate cultural knowledge that exists in Indigenous cultures through lived, direct experience with the environment and human-animal and human-plant relations. Over time, these types of direct TEK experiences leads to the successive accumulation of environmental and ecological knowledge, which then become integrated into daily practices via cultural and spiritual beliefs that are orally transmitted among community members successively over generations (ACIA 2004; see also Berkes 2008; Inuit Circumpolar Council 2012).

The broader and all-encompassing term IQ extends beyond TEK, which tends to focus more on the utility values of plants and animals, often in the context of sustainable natural resource management. Whereas IQ holistically includes the ‘Ancient Knowledge of the Inuit’—itself a ‘complete body of knowledge and experience passed from generation to generation’(Karetak et al. 2017) that recognizes there are multiple inter-dependencies and importances of Inuit language, cultural values and beliefs, that in turn inform and influence Inuit culture and in modern day—Nunavut governance structures, policy developments and institutional environments.

Some of the other key principles and precepts of IQ (as translated into English) include: *servicing others; building consensus; respecting differences; acquiring and improving knowledge and skills through practice; cooperation in working together harmonious with a common purpose; acting as environmental stewards with a holistic understanding of the consequences of actions and intentions; problem-solving through creative-innovation and improvisation; acting as guardians of shared resources; respecting others knowledge and experience; taking only what is necessary and not wasting resources, such as food; avoiding causing unnecessary harm to animals; accepting the myth of private property through grounded acknowledgement that no one can truly own animals or lands so as to avoid conflicts, and, as previously noted; treating all beings with respect* (Wenzel 2004: 241, *emphasis added*).

While IQ is a unique Inuit cultural trait, we suggest that the precepts and principles of IQ are universally applicable, particularly with regards to advancing the ontology of climate adaptation. Wenzel (2004) notes that IQ can serve to “temper the more logical-positivist tendencies” that may not serve sustainability planners and adaptation managers seeking to address changes associated with the fundamental and long-term uncertainties of dealing with climate change through institutional means of policy and planning. In more practical terms, IQ has been recognized in the Government of Nunavut’s ‘Incorporating Inuit Societal Values’ (2013), which summarizes the following key principles of IQ and seeks to demonstrate the application of these values in governance activities and legislation:

- *Inuuqatigiitsiarniq*: Respecting others, relationships and caring for people;
- *Tunnganarniq*: Fostering good spirits by being open, welcoming and inclusive;
- *Pijitsirniq*: Serving and providing for family or community, or both;
- *Aajiiqatigiinni*: Decision making through discussion and consensus;
- *Pilimmaksarniq or Pijariuqsarniq*: Development of skills through practice, effort and action;
- *Piliriqatigiinni or Ikajuqtiigiinni*: Working together for a common cause;
- *Qanuqtuurniq*: Being innovative and resourceful, and;

- *Avatittinnik Kamatsiarniq*: Respect and care for the land, animals and the environment.

Institutionally, the Government of Nunavut (2013) has reported that the Nunavut Department of Environment has pragmatically incorporated IQ via programming initiatives by including a social science researcher in the wildlife management division to help to holistically incorporate IQ into management initiatives, while a digital documentation project of Elders IQ about climate change impacts on Baffin Island has provided a valuable historical record of oral and observational data about environmental changes occurring in the North, to help to better inform climate change planning (Government of Nunavut 2013). Other Nunavut IQ programming initiatives include the ongoing incorporation of the knowledge of local Elders and hunters in coastal and marine decision-making; conducting inter-departmental workshops to better integrate IQ into governance initiatives, and forwarding the integration of IQ into environmental protection initiatives such as the creation of new parks and protected areas. Operationally, the Nunavut Wildlife Act historically established an Elder Advisory Committee composed of 9 members, with 3 representatives from each of Nunavut's regions. The Elder Advisory Committee provides guidance and helps to facilitate the application of IQ into wildlife and environmental management activities in Nunavut, by providing advice and recommendations to the territorial Minister of Environment with respect to the operations of the Department of Environment. Additionally, Hunters and Trappers Organizations and Regional Wildlife Organizations are regularly engaged and consulted with on a broad range of decisions and policy issues.

As governments and societies the world over grapple with adapting to rapidly changing environments, these few examples from Nunavut of how incorporating IQ can help to inform adaptation efforts through institutional adaptive capacity building, offer a leading example for collaborative environmental programming and operations that incorporates Indigenous perspectives; offering the potential of broader insights and applications of the IQ approach for institutional adaptation planning, and approaches to climate change resilience more broadly.

Institutional adaptation opportunities in the Canadian Arctic and beyond

At the global scale, the IPCC has reported that adaptation planning, and its implementation, involves dynamic social processes that can utilize iterative vulnerability and risk assessments and associated planning tools and mechanisms to construct flexible and adaptive planning strategies to deal with environmental uncertainty on local and regional scales (Larsen et al. 2014). Such strategies based on iterative and ongoing assessments of climate risks can help with the prioritization of planning and policy actions based on stakeholder interests. Institutional adaptation efforts involve creating or modifying regulations, professional codes, laws, protocols, and governmental agreements; as well as modifying the day-to-day operational habits, conventions and traditions of social organizations (including institutional governance practices, *and the cultural values that underlie them*).

Based on our review in this article, we suggest that evolutions in adaptation research are needed to further advance greater collaboration on policy and planning efforts with ongoing and integrated resiliency applications for both institutions and Indigenous partners alike (Table 1).

Making such thematic and collaborative changes through research, policy and practice efforts may help to better account for the iterative and evolving opportunities to moderate the harm or exploiting advantages related to actual or expected impacts of climate change (Adger et al. 2009; Smit et al. 2000). A key attribute of the iterative adaptation planning process is to incrementally advance organizational learning by enhancing institutional adaptive capacities. This is done through engaging in the creation of strategic knowledge and building capacity by sharing opportunities and coordinated governance efforts to take advantage of diverse information from diverse stakeholders when formulating strategic climate change priorities and plans (Corfee-Morlot et al. 2009). As the example of IQ incorporation in Nunavut, illustrates—cultural values have the potential to inform and help to evolve adaptation efforts by institutions.

Bisaro et al. (2018) have defined institutional adaptation as changing and adapting the collectively held social practices through which individuals address mutual interdependency to consider the

Table 1 Opportunities for Improving Institutional/Indigenous Collaboration on Climate Adaptation

Thematic areas for institutional/Indigenous collaborations	Issues addressed	Planning and management policy development opportunity
Iterative processes	Risk and vulnerability	Prioritization of adaptation issues
Flexible tools	Harm moderation; situational change	Alternatives for managing climate uncertainty
Organizational learning	Inclusive of diverse knowledge and Indigenous worldviews; capacity building including appreciation for local culture, values, and beliefs	Engagement of stakeholders on shared priorities
Research partnerships	Knowledge creation and application, Community participation	Understanding environmental change trends and drivers
Sectoral alliances	Borders, defence, shipping, climate impact monitoring	Partnership building on shared issues of interest

impacts of climatic changes. In a systematic review of the adaptation literature related to institutions, Bisaro and Villamayor-Tomas found that advancing understanding of the barriers and opportunities for institutions to work effectively with external stakeholders requires greater interpretative research into ‘how’ and ‘why’ questions, including through co-designed research with stakeholder groups. Research partnerships that include the participation of diverse stakeholders in knowledge creation and application activities can help to advance understandings of the environmental and social dimensions that can contribute to effective institutional approaches to climate change adaptation. Since institutions play a pivotal role in shaping individual and collective behaviour in social settings, Bisaro et al. (2018) suggest there is a need for research about how and why socio-ecological considerations related to adaptation can be integrated into institutional designs and practices. They suggest such research can promote harm aversion in policy and management approaches for dealing with climatic changes. We suggest that longitudinal monitoring and research evaluation of the barriers and opportunities for advancing adaptation efforts in Nunavut, through a focus on the inclusion of IQ, may reveal key findings related to inclusive approaches to adaptation policy and practice.

Bisaro et al. (2018) recommend research attention be paid to the “soft” institutional and capacity measures that can help to solve collective action problems around shared resources, a particularly

salient notion in geographically remote regions like the Arctic. Practically, this relates to conducting collaboratively designed vulnerability assessments and developing adaptation planning tools, techniques and incentives for advancing applied research that incorporate Indigenous knowledge, as well as supportive policy and planning efforts that harness the potential for advanced design of larger scale research and institutional learning in response to climate adaptation and resiliency imperatives.

Conclusion

This paper identifies geographical and contextual factors in Northern Canada that create unique issues of mutual concern to be addressed through Indigenous and institutional collaborations on climate change adaptation. Based on previous research, we have identified how remote Northern Arctic communities in Canada are particularly vulnerable to slow-onset, chronic climate change impacts and issues associated with thawing permafrost, rising sea-levels, warming temperatures, ocean acidification and melting sea-ice. This review also reminds us that climate change may increase the severity of already extreme weather events in the North, but at the same time northern populations may be more prepared to adapt to such changes, given historical and lived experience with adapting to the realities of harsh Arctic weather and extreme living conditions, and traditional worldviews

that promote holistic problem-solving through social capital, collaboration and capacity-building.

When it comes to climate change, local communities and institutional actors face significant challenges that are common in nature. However, we have also illustrated some of the ways that different actors are linked to separate prognostic options and preferences (i.e., central bureaucratic authority versus local or regional cultural protocols). Based on our limited review and analysis, we suggest that effective institutional collaborations can assist northern communities and governments in addressing known and emerging adaptation needs, through inclusive design approaches to policy and planning. It is also important to recognize that available adaptation policy options intersect with culturally contingent worldviews and divergent concepts that subjectively can frame adaptive responses, for example perceptions of vulnerability and resilience, dichotomous views on the politics of Arctic climate security and Indigenous knowledge, and institutional adaptation approaches that manifest in the creation of governance priorities. In reality, several effective policy and planning approaches are needed for advancing climate adaptation which could be achieved through collaborative adaptation planning and inclusive research initiatives with Indigenous peoples in Canada's remote Arctic northern regions.

Specifically, better explanations of the ways and means for linking divergent worldviews and perceptions of social vulnerability, as informed by traditional knowledge and holistic practices, are needed. Northern peoples have adapted to northern environments since time immemorial. Their suggestions for strategies that support the needs of people locally must inform land use and infrastructure choices based on local, context specific knowledge of places (i.e. what strategies and practices can work given the day to day processes that occur locally). Arctic institutions used to manage lands and become involved in partnerships (i.e. Hunters and Trappers Organizations, Renewable Resource Councils, regional-level management boards, Canadian Rangers) are sources of adaptive capacity (Armitage 2005; Lackenbauer 2013) and will play an increasingly important role in knowledge transfer and decision making, if meaningfully engaged in, and resourced for, adaptation planning and resiliency efforts.

Collaborations that emphasize flexibility, inclusive collaborations and adaptability would be most suited

to northern settings, where ongoing change is expected and accepted, alongside a long-term view of human–environment relationships that shape, and are shaped, by the dynamics environmental change. There are fundamental cultural differences regarding how to live in Arctic environs that influence local and government institutions. These differences also structure adaptation perceptions and actions. As pointed out here, different groups can hold contrasting views of what makes a community vulnerable and resilient. This is in line with international comparative research on flood governance and stakeholder internal representations of ecosystem resilience and preferences for institutional responses, which also illustrate this variability (see Baird et al. 2016), thus challenging the universality of resilience as a concept for understanding hazards and risk.

Other research (see Lindell and Hwang 2008) has documented that personal risk perceptions and tolerance can vary depending on factors such as hazard experience, gender, income, as well as hazard proximity, availability of risk information, and ethnicity. Perceptions and influencing factors can also vary depending on the hazard in question. Therefore, designing acceptable and effective institutional collaborations with northern communities for Arctic adaptation solutions will need to address local and cultural differences, as well as preferences for institutional process design and adaptation actions. The suitability and credibility of such institutional collaborations are important to successful implementation, thus, planners and community leaders must also pay regard to the fact that expectations for institutional credibility can vary significantly among remote Indigenous populations involved in natural resource governance (Pero and Smith 2008).

Institutional collaboration and new partnerships that involve sharing traditional knowledge about Arctic adaptation to climatic conditions with institutional actors and broader society may help improve adaptive capacities in remote regions. Both northern communities and government institutions operate on the sparsely populated, remote, changing and sometimes extreme Arctic frontier. Thus, adaptation planning for improving the means for collaboratively sharing environmental information and knowledge, and ideally developing shared goals for addressing climatic impacts, could be an essential ingredient for advancing effective northern planning and policy

initiatives, regardless of the long-term strategic interests or divergent worldviews, and different political or cultural perspectives.

Lastly, government and local concerns for sovereignty differ along geopolitical and cultural lines. Canadian Arctic communities and institutions are diverse. Senior government concerns are different than local Indigenous concerns regarding the kinds of sovereignty issues at play in a warming Arctic (i.e., those related to national security and those related to local livelihoods and cultural autonomy). Somewhat ironically, foreign trade and transportation improvements that one day may question national control by intruding in Arctic waterways are taking attention away from the more immediate concerns for basic northern living requirements (e.g. housing, food security, energy security, transportation safety etc.). Senior levels of the Canadian government today can support and protect local northern residents against environmental dispossession through adaptation and resiliency support, and thereby also advance support for national sovereignty goals by addressing local adaptation and development needs. A government discourse of environmental security focused on the clash of external geopolitics driven by the southern interests of ‘Qallunaat’ diverts political attention away from government social responsibilities to work towards reconciliation with Indigenous peoples by advancing holistic plans and programs that can dually cut greenhouse gas emissions while better supporting institutional development and the local actions required for climate resiliency. Continued governance approaches that maintain the influence of centralized, southern governments and give priority to extractive industries in shaping the future of the North, rather than supporting Indigenous-led adaptation and development in the Arctic, will fail to meet the major challenges or take advantage of the opportunities that climate change presents for ‘Qallunaat’ learning and institutional evolutions spurred by IQ values and practices.

Acknowledgements This research was undertaken with funding from the Canada Research Chair program, Social Sciences and Humanities Research Council of Canada (SSHRC) and Department of National Defence (CA). We appreciate the helpful comments from the anonymous reviewers and editors.

Compliance with ethical standards

Conflict of interest This research does not involve human participants or animals, nor does it hold any potential conflicts of interest.

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