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Climate change resilience in the Canadian Arctic: The need for collaboration in the face of a changing landscape

SHORT TITLE: Climate change resilience

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Human-induced changes to global climate have become increasingly difficult to ignore in recent years. As the frequency and severity of extreme weather events increases, the impacts on both natural and human systems are becoming difficult to manage with the current policies. In Canada, one of the most vulnerable regions to climate change is the Arctic, where temperatures are rising at a rate two to three times that of the global average. Warmer seasonal temperatures have led to melting permafrost and increased variability in sea ice conditions, which has contributed to a rise in coastal erosion. The ongoing resilience of Arctic communities will depend heavily on their ability to implement successful long-term adaptation policies. The development and implementation of any action on climate change adaptation should involve collaboration with local stakeholders in order to reflect the views and experience of those living in the Arctic.

Keywords: climate change impacts, climate adaptation, community planning, local stakeholder engagement

Key Messages:

- Climate change impacts affect core infrastructure and resources in the Arctic. Resilience of northern communities depends heavily on proper government leadership and successful implementation of long-term adaptation policies.
- Determining adaptive capacity of Arctic communities and developing appropriate policies requires collaboration with local stakeholders who can speak to vulnerability in the context of climate and non-climate related factors.
- Mainstreaming climate change policies so that they are integrated into existing procedures and policy-goals allows local governments to manage present-day issues while enhancing long-term community resilience to climate change.

Introduction

The realities of human-induced changes to global climate have become increasingly difficult to ignore in recent years. Newly published reports such as the Intergovernmental Panel on Climate Change (IPCC) special report, *Global warming of 1.5°C* (IPCC 2018), and *Canada's changing climate report* (Bush and Lemmen 2019), have publicized the dire future we can look forward to if nothing is done to mitigate our contribution to greenhouse gases in the atmosphere. Indeed, in 2018 residents of British Columbia experienced the worst fire season on record, due largely to changing weather patterns (BC Flood and Wildfire Review 2018; BC Wildfire Service 2019). At the same time in the east, communities along the St. John River experienced historic flooding due in part to the combination of heavy snowfalls, rapid spring melt, and intense precipitation (Tutton 2018; Birchall 2019). As extreme weather events around the world become increasingly common, impacts on both natural and human systems will increase.

In Canada, one of the most vulnerable areas to climate change is also one of the easiest to ignore due to its geographic isolation and low population density. The Arctic's fragile ecosystem is especially vulnerable to rising seasonal temperatures and, in 2018, the IPCC reported that Arctic regions are warming at a rate two to three times that of the global average (IPCC 2018). The resulting impacts are causing unique challenges for Arctic communities, including placing strain on infrastructure, for instance. (Ford et al. 2017; Birchall and Bonnett 2019).

Arctic communities are looking to build resilience to climate change and are starting to take action. A critical component of successful long-term adaptation action is collaboration or engagement with local stakeholders and community members.

Setting

The Canadian North, often defined as the area north of the 60th parallel, has a population of over 113,000, with much of the population living outside of the capital cities, spread along the northern coast in small, isolated communities (Lemmen et al. 2016; Statistics Canada 2019). Canada's northern coastline, stretching from the Yukon in the west to Labrador in the east, extends more than 176,000 km, with most of this area located north of the Arctic Circle (Lemmen et al. 2016). This northern coastal region is home to 58 communities and more than 70,000 people (Lemmen et al. 2016). The climate in the Canadian Arctic is characterized by long, cold winters and short, cool summers with sparse precipitation that occurs primarily in the summer months (Lemmen et al. 2016).

Climate change impacts

As climate change progresses, seasons in the Arctic are becoming less consistent, with increasing daily temperature variation and shorter spans of extremely low temperatures (ACIA 2005). Warmer seasonal temperatures have led to melting permafrost and increased variability in sea ice conditions (Birchall and Bonnett 2019). As a result, and exacerbated by sea level rise and increased storm surge activity, Arctic communities are experiencing increased rates of coastal erosion (Ford et al. 2008).

Tuktoyaktuk, like many communities in the Arctic, is underlain by permafrost, made vulnerable by increasing temperatures and storm surge activity (Lemmen et al. 2008; Lemmen et al. 2016). Here, decision makers have implemented measures to address vulnerabilities in local infrastructure. The community stockpiles gravel aggregate from winter roads in order to maintain and repair building foundations during the warmer months; boulders and concrete slabs are used to help protect vulnerable shorelines (Andrachuk and Smit 2012). In areas where shoreline

stability is extremely degraded, buildings at imminent risk are removed or relocated (Andrachuck and Smit 2012). Prior to establishing such control measures, Tuktoyaktuk was experiencing coastal retreat at a long-term rate of roughly 2 m per year (Lemmen et al. 2016).

In the past, sea ice protected coastal communities by creating a barrier to storm-related waves and surges. However, as sea ice becomes more variable and permafrost continues to thaw, coastal erosion rates increase and the lifespan of engineered defences significantly decreases. This forces local government decision makers to allocate greater resources to infrastructure maintenance and shoreline defences (ACIA 2005; Bonnett and Birchall 2019). As climate impacts continue to affect core community infrastructure and resources, the resilience of Arctic communities will depend heavily on their ability to implement successful long-term adaptation policies.

Current government leadership

Government leadership is crucial for successful implementation of climate adaptation initiatives. In Canada, federal and territorial governments have acknowledged the importance of adaptation to climate change and have made funding available for northern communities to facilitate adaptation planning (Pearce et al. 2012). Each Territory is approaching climate change adaptation in a different way, with additional support and oversight from the federal government:

- The Northwest Territories recently released the 2030 NWT *Climate Change Strategic Framework*, which lays out the Territory's approach to climate change impacts and prioritizes a goal of building resilience and adapting to climate change (Government of Northwest Territories, n.d.).
- The Government of Nunavut has developed the Climate Change Centre, which provides information on climate change and local resources for impacted populations. In 2011, the Government of Nunavut released *Upagiaqtavut*, a strategic planning document on climate change impacts and adaptation in the Territory (Government of Nunavut 2011). This document outlines the Government's responsibilities and goals relating to adaptation initiatives.
- The Yukon Government released a climate change action plan in 2009 and is currently developing a new strategy on climate change with a focus on energy and the economy (Yukon Government 2019).

In 2016 the federal government, in partnership with the provincial and territorial governments, created the *Pan-Canadian framework on clean growth and climate change* (PCF) (Government of Canada 2019). The PCF addresses the importance of climate change resilience through adaptation and lays out action items highlighting the need to develop climate-resilient codes and standards and to invest in infrastructure projects that strengthen climate resilience.

Many federal and territorial programs target adaptation to climate change, yet meaningful action can often be ad hoc with limited long-term commitments (Labbé et al. 2017). As climate change impacts increase in magnitude, adaptation actions in Arctic communities need to be implemented with more urgency and efficiency. A key approach to facilitate immediate and impactful change involves engaging local stakeholders, who are often most aware of vulnerabilities unique to their community.

Taking action

Developing resilience to climate change in the Arctic means increasing the inherent capacity of communities to manage stresses and shocks (IPCC 2014b). However, local government entities, with limited resources, tend to focus on short-term issues with more immediate results (Hamin et al. 2014); planning for future and uncertain risks can be overwhelming. When it comes to infrastructure, this can mean taking a more reactive approach to maintenance and repairs rather than anticipatory action. Determining appropriate adaptive actions requires on-going assessment of a community's vulnerability and its capacity to adapt. Mainstreaming climate change policies so that they are integrated into existing procedures and strategic community planning goals can help to implement adaptation action and enhance resilience to climate change impacts long-term, while still addressing present-day issues (Wallace 2017).

As a result of the remote nature of many Arctic communities, local stakeholder engagement is key when identifying climate change risks that are relevant, and developing adaptation plans that are realistic (Pearce et al. 2012). Collaboration with community members, local government, and Indigenous groups throughout the planning process allows the most vulnerable individuals to have a voice. Policymakers should engage local stakeholders throughout the planning and development process to ensure policies appropriately address vulnerabilities and consider cultural values (Ford et al. 2007).

In Arctic communities, often the impacts of climate change are already being felt. In this scenario, planning for long-term resilience is not enough. Immediate action is needed and the resources to execute adaptation responses require collaboration and support across all levels of government. Territorial and federal government plans, such as the PCF, can help communities faced with impacts access funding or technical assistance to support adaptation. It should then be left up to local entities to coordinate and implement adaptation actions in line with the social and cultural beliefs, and the stressors specific to the community (Labbé et al. 2017; Albert et al. 2018; Down and Birchall 2019).

Conclusion

Earth's climate is currently changing at a rate greater than at any point in the history of modern human civilization (USGCRP 2018). Isolated communities in the Canadian Arctic are uniquely vulnerable given the accelerated rate of change in the north. Support across government levels is necessary for successful resilience-building. Moreover, it is vital that development and implementation of any action on climate change adaptation involve local stakeholder engagement in order to reflect the views and experience of those living in the Arctic.

Future studies

Indigenous populations, making up the majority of Canada's Arctic communities, are uniquely sensitive to climate change impacts. With strong cultural ties to the environment and a heavy reliance on hunting and fishing to support their way of life, climate change in the Arctic has impacted many Indigenous groups' traditional daily activities and, in some cases, put livelihoods at risk (Ford et al. 2008; IPCC 2014a). Adaptation action in the Arctic must consider Indigenous cultural values in order to be successful. While this viewpoint focuses primarily on government action and the impacts of climate change on Arctic communities as a whole, much more can be explored and discussed on Indigenous experience and culture in the Arctic.

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