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“Blue-ice”: framing climate change and reframing climate change adaptation from the indigenous peoples’ perspective in the northern boreal forest of Ontario, Canada

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The northern boreal forest in Ontario, Canada, in the sub-Arctic above the 51st parallel, is the territorial homeland of the Cree, Ojibwe, and Ojicree Nations. These Nations are represented by the political organization Nishnawbe Aski Nation (NAN). January 6–March 31, 2011 the researchers and NAN collaborated in a study to record observations of changes in the forest environment attributed to climate change and share and exchange information and perspectives about climate change. Data were collected from 10 First Nation communities across a geographic area of ∼110,800 km² (43,000 mi²).

We explore climate change impacts through the lens of “blue-ice”, a term embedded in their languages across the fieldwork area and reframe adaptation in the First Nations’ perspective and worldview. Changes in blue-ice on the landscape are affecting transportation in traditional activities such as hunting and fishing, as well as the delivery of essential community supplies. The word “adaptation” linked to climate change does not exist in their languages and the term is associated with European colonization. We propose the term “continuity” to reflect the First Nation worldview.

Our recommendation is giving First Nations’ perspectives and knowledge of their territorial landscape a foundational role in the development of climate change policy for Ontario’s northern boreal forest.

Keywords: adaptation; climate change; cultural continuity; energy security; First Nations; food security; participatory action research; sub-Arctic; traditional activities; worldviews

Introduction

The indigenous peoples of the boreal forest north of the 51st parallel in Ontario, Canada, are Cree, Ojibwe, and Ojicree people who reside in 32 First Nation communities. First Nations are recognized within Canada as “Aboriginal peoples” having Aboriginal and treaty rights, affirmed by Section 35 of Canada’s Constitution Act, 1982. These 32 northern communities, as well as an additional 17 others, are represented by Nishnawbe Aski Nation (NAN), a Provincial-Territorial Organization. Their homeland covers two-thirds of the province of Ontario, spanning approximately 544,000 km² (∼210,000 mi²) (NAN, 2011).

In 2010, Ontario passed the Far North Act. The Act enables land use planning for resource development (e.g. mining and hydroelectricity) and includes the goal of 50% protection of the land base to support biological diversity and maintain ecological processes and functions, “including the storage and sequestration of carbon from the atmosphere” (OMNR, 2011). The land area covered by the Act (∼450,000 km² or ∼174,000 mi²) is land within the traditional territory of NAN member First Nations. While First Nation involvement and approval of land use plans are enabled by the Act, NAN raised strong objections to the legislation, stating that as worded the Act gives the Minister (in the Ministry of Natural Resources overseeing the Act) the final decision-making authority, and as such impedes their rights to decide how, where, and when their lands and natural resources would be developed or conserved.

Policy decisions to address climate that affect NAN First Nations and are made without their full engagement and input will fail to fully consider their rights, perspectives, or values. First Nations within NAN have direct ties to the land and recognize the importance of addressing climate change impacts in their territories. The rapidly occurring changes related to climate change are influencing how they interact with, and respond to, a changing environment. Threats from floods and forest fires, and changes on the land are affecting community safety, food, and energy security.

In 2010, NAN and the researchers (hereafter referred to as the research team) developed a research proposal and entered into a research contract defining each party’s roles and responsibilities. The objectives of the research...
included: (i) documenting community members’ observations of climate-related changes occurring in the forest, (ii) examining First Nation perspectives and engagement in policy development on climate change, and (iii) examining the potential for northern boreal forests to mitigate climate change. This paper presents the first objective with discussion of First Nation observations in changes to the forest environment, and one aspect in the second objective – their perspectives on adaptation related to their worldview and relevance in climate change policy.

We begin our discussion with the concepts of adaptation, resilience, adaptive capacity, and the growing literature on joint scientific and indigenous knowledge research in climate change. Presented in the discussion is an overview of the research method – Participatory Action Research (PAR) and combining scientific and indigenous peoples’ worldviews. We continue with a brief description of the geography of the study area and the homeland of the First Nations collaborating in the research. Next, we present fieldwork observations from the First Nation participants on the rapidly occurring and unpredictable changing conditions on their land through the lens of “blue-ice”.

Blue-ice is more than “ice”. “Blue-ice” is a term embedded in their indigenous languages. It refers to a specific environmental condition in its formation that is both a familiar frame of reference in seasonal cycles and in activities carried out on the land, and constant in its importance as an element of life. Our analysis on the disappearance of blue-ice observed by First Nations is an indicator of warming temperatures on the planet (see Mueller & Vincent, 2003; NASA, n.d.), and is significant to these people affected by its disappearance. Changes in blue-ice are a climate change impact on transportation, which affects food security, energy security, and traditional activities. Discussion includes participants’ responses to the term “adaptation” based on their worldview and historical context. We propose the word “continuity” to reflect the First Nation view of adapting to the landscape – a process that has been perpetual over millennia (not restricted only to more recent anthropogenic climatic changes). We recommend giving First Nations perspectives and ecological knowledge of their changing landscape a foundational role in the development of climate change policy for Ontario’s northern boreal forest.

Adaptation, climate change, and indigenous peoples

Impacts from climate change will not be distributed equally around the world (Fischlin et al., 2007) and attention is now shifting from climate change mitigation to climate change adaptation3 (Folke, Pritchard, Berkes, Colding, & Svedin, 2007; Huntjens et al., 2012). Mitigation efforts towards climate change intend to reduce the severity of impacts, while adaptation assumes there will be significant changes and therefore adjustments will be required in activities, thinking, and decision-making (Kwiatkowski, 2011). Adaptation in relation to climate change has several definitions and related concepts found in the academic and grey literature (Levina & Tipton, 2006). Different interpretations and definitions of the term have been adopted by different fields, such as anthropology, biology, and business management, and the more recent social development and justice arenas, to align with their particular disciplinary foci (Engle, 2011; Walker, Holling, Carpenter, & Kinzig, 2004).

The shift in focus to address climate change from mitigation to adaptation is reflected in, and connects, two schools of thought – socio-economic development and social-ecological interactions. The sustainability and socio-economic development literature discusses vulnerability and risk (Walker et al., 2004), with a focus on changing human activities to prevent or mitigate climate change (Engle, 2011). In the social-ecological system literature, adaptation discussions centre on the attributes of a system’s resilience, adaptability, and transformation (Walker et al., 2004). Since Holling’s (1973) seminal paper on the concept of resilience, refinements of the concept have emerged (Walker et al., 2004). Holling’s concept was to understand the capacity of ecosystems to persist in the original state subject to “perturbations” (Folke et al., 2010), or simply put, to understand ecosystem responses to change (Adger et al., 2011). Since then concepts from the resilience and vulnerability literature have been applied with sustainable development concepts (Park et al., 2012) to understand the complex systems of human responses to environmental change, particularly adaptation to climate change (Abel, Cumming, & Anderies, 2006; Huntjens et al., 2012; Park et al., 2012). O’Brien, Hayward, and Berkes (2009) argue that resilience research into the interaction of social and ecological subsystems provides insight into complex systems as a whole. Untangling the complexities to develop effective policies is viewed as essential to sustainability for ecological and socio-economic systems (Liu et al., 2007).

Folke et al. (2007) suggest ecological and human dimensions “are not just linked but truly integrated...and the interplay takes place across temporal and spatial scales and institutional and organizational levels in systems that are increasingly being interpreted as complex adaptive systems”. Complex adaptive systems (CASs) theory builds upon and differs from traditional systems theory in that it incorporates the role of adaptation in the dynamics and responses of complex systems. CASs are characterized as self-organizing, a complex whole interacting at a localized scale in non-linear dynamics, and across temporal and spatial scales (Hartvigsen, Kinzig, & Peterson, 1998). The key element is the influence of adaptation. There are three fundamental characteristics in the ability to adapt that contribute to the overall resilience of a system: (1) a system’s susceptibility to change while
still retaining its structure and function, (2) the degree a system is capable of self-organizing, and (3) adaptive capacity to learn and adapt (Abel et al., 2006; Carpenter, Walker, Anderies, & Abel, 2001).

Vulnerability is the degree to which a system is likely to experience harm, as in the extent and occurrence of a disturbance from internal and external variables, which can be from global, regional, and local forces (Liu et al., 2007). Defined by Walker et al. (2004), resilience is the ease or difficulty of changing a system—that is, how resistant it is to change due to a disturbance, and its ability to retain essentially the same function, structure, identity, and feedback during change. The concept of adaptive capacity has emerged from the sustainability (focused on vulnerability) and social-ecological (focused on resilience) literature. A key element of adaptive capacity is its creation from the production and communication of information and knowledge (Lemos, Boyd, Tompkins, Osbahr, & Liverman, 2007).

Indigenous knowledge, often referred to as Traditional Ecological Knowledge (TEK), has led to the development of elaborate coping strategies and valuable knowledge that plays a role in adaptation to and mitigation of climate change (Macchi et al., 2008). Indigenous knowledge is a cumulative body of knowledge and beliefs, evolving by adaptive processes and handed down through generations (Davidson-Hunt & Berkes, 2003). Studies on the knowledge of indigenous peoples in adapting to and mitigating climate change (Devkota, Bajracharya, Mareseni, Cockfield, & Upashyak, 2011; Macchi et al., 2008), the adaptive capacities of indigenous peoples to climate change (Galloway McLean, Ramos-Castillo, & Rubis, 2011), and the co-production of knowledge on climate change (Berkes, 2009) have brought indigenous perspectives on adaptation and the application of traditional knowledge to modern climate change problems (Berkes, Colding, & Folke, 2000; Galloway McLean et al., 2011). As direct users of the natural environment, indigenous peoples have valuable and experiential knowledge at a regional level on ecosystems and the services they provide (see Davidson et al., 2014). Adger et al. (2011) argue many sources of resilience in the collections of social and institutional memories (i.e., past experiences and successful adaptions to change) are likely to be challenged by climate change and are insufficient in managing resilience unless put to use—at different scales in scope, time horizons, and governance (including regionalizing influence and authority) to frame problems and recombine experiences in order to build adaptive capacity.

In Canada, research with indigenous peoples on climate change has largely focused on the Arctic (Cobb, Kisioglu, & Berkes, 2005; Cruikshank, 2001; Dowsley, 2009; Henry, Meakin, & Mustonen, 2013; Huntington, Callaghan, Fox, & Krupnik, 2004; Nakashima, 1993; Pearce et al., 2009). Our discussion of adaptation reflects a conversation that brings to light perspectives from indigenous peoples in 10 communities living across the sub-Arctic in the boreal forest.

**Study overview**

**Research method and data collection**

The study is a collaboration between NAN (as an umbrella organization and participating communities), the academic researchers, and individual participants, using PAR. Traditional knowledge is “usually described by Aboriginal peoples as holistic, involving body, mind, feelings, and spirit” (TCPS-2 Sect. A., 2010). In western science, there still exists a mindset that it is superior to TEK (Pretty, 2011) in that knowledge that includes “feelings and spirit” or “anecdotal” information cannot be measured or quantified, and is therefore not scientific. Moreover, perspectives from oral traditions have too often been utilized as data in science rather than stand-alone knowledge or theory (Cruikshank, 2001). However, there is an increasing recognition that local and indigenous knowledge, particularly in areas of high environmental priority such as climate change, may provide insight and fill in data gaps on remote or hard-to-access environments (Brook & McLachlan, 2008). Incorporating the depth and breadth of TEK on the historic and current status of the land (e.g., biophysical conditions, flora, and fauna) across large geographic areas of traditional territory is invaluable to fill gaps in scientific knowledge and in forming appropriate policies in rapidly changing environments (Dowsley, 2009). Studies have discovered drawing on indigenous knowledge produces a better understanding than western knowledge and scientific methods alone, despite the challenges with integrating the two knowledge systems (Bohensky & Maru, 2011; Cochran et al., 2008). Moreover, growing literature from indigenous scholars places local experiences in a broader context and is therefore relevant as a knowledge paradigm parallel with western knowledge (Henry et al., 2013).

This study incorporated the main characteristics of PAR: (i) educative (for both parties), (ii) dealing with individuals as members of a social group, (iii) problem-focused with the intent of taking action, (iv) treating all participants as inherently part of the process, and (v) a collaboration where each party contributes and each party benefits from the interaction (Winter & Munn-Giddings, 2001). PAR created the pathway for two-way knowledge exchanges: building capacity on climate change at the community level (i.e., forest science, climate change science, and political dialogue) identified at the onset to be a part of and a strength of the research, and recording observations from community members living in the sub-Arctic boreal forest environment related to climate change.

Our discussion is a collection of responses conducted with careful, systematic audio-recordings during semi-structured interviews with individuals and focus groups,
Table 1. Community roles of interviewees.

<table>
<thead>
<tr>
<th>Community role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Council member</td>
<td>An elected individual by the First Nation community – these individuals can be the Chief, Deputy Chief, or Band Council member</td>
</tr>
<tr>
<td>Elder</td>
<td>An individual recognized in the community for their generational knowledge; not necessarily someone who has lived a long time, though usually (i.e. a grandparent or retired person); a community advisor and a traditional teacher; lives or has lived a traditional lifestyle</td>
</tr>
<tr>
<td>Traditional lifestyle land user</td>
<td>An individual who lives off the land using traditional activities – hunting, fishing, trapping, gathering, fuel, and plants (edible and/or medicinal); makes tools and equipment (e.g. snowshoes, nets, and bowls)</td>
</tr>
<tr>
<td>Seasonal land user</td>
<td>An individual who engages in traditional activities on the land either on weekends (e.g. fishing), when hunting seasons occurs for various species of animals/birds (e.g. moose and goose) or gathering edible and medicinal plants when in season (e.g. blueberries). Seasonal land users are usually employed within the community (e.g. schools, nursing stations, band offices, and airports), employed in an industry near the community, volunteer, or have other roles in the community</td>
</tr>
<tr>
<td>Community land use planning team member</td>
<td>An individual employed by the community to create a land use plan around a community’s reserve land identifying potential development areas (e.g. forestry and mining), traditional and sacred places (e.g. trap lines and burial sites), and ecologically important sites (e.g. wetlands and waterways)</td>
</tr>
<tr>
<td>Winter road staff</td>
<td>An individual employed by the community to build and maintain the roads during winter road seasons</td>
</tr>
</tbody>
</table>

along with field notes and memoing. Forty-three individuals from the visited communities contributed to the research data. The vast majority of the contributors were key informants or knowledgeable people within a community. Huntington (2000) argues that having a community identify and introduce key persons to a researcher is the desired approach to reach individuals having the knowledge and information relevant or useful to the research. A few participants the principal researcher met while walking or shopping in a community (“random” participants). The participants represent Council members, Elders, Land Users (hunters, trappers, fishers, and gatherers), community land use planning members, winter road staff, and other community members. For the purpose of our discussion, descriptions for the role of a community member are found in Table 1. The information provided by these individuals was coded for themes and organized using QSR NVivo 9 software.

Elders represent the largest community group interviewed (30%), Winter road staff made up 16% of the participants, Land use planning members represented 12%, and seasonal/traditional land users 8% of the participants. It should be noted winter road staff, land use planning members, and other community members are usually also “land users”, but their specific role in the community related to their employment is very relevant in the discussion of “blue-ice” and therefore noted accordingly.

**Research area**

From January 6 to March 31, 2011, 10 First Nation communities located in northern Ontario, Canada, at latitudes between 51° and 54°N, from near the Manitoba border in the west to the James Bay coast in the east, a geographic area of approximately 110,800 km² (43,000 mi²), participated in the research (Figure 1). The communities contributing to the data, in order of visits were: Muskrat Dam, Weagamow, Pikangikum, Sandy Lake, Neskantaga, Nibinamik, Attawapiskat, Fort Albany, Kingfisher Lake, and Wunnumin Lake. These communities are in very remote locations only accessible by aircraft with the exception of travel during winter months on winter/ice roads, and for the two communities along the James Bay coast (Attawapiskat and Fort Albany) short-time river barge transportation in the summer. These First Nations are intrinsically connected to the climate, landscape, flora, and fauna. Hunting, fishing, and trapping (e.g. moose (*Alces alces*), walleye (*Sander vitreus*), and marten (*Martes americana*)) are part of their culture in traditional activities and family gatherings (e.g. seasonal hunts of snow goose (*Chen caerulescens*)), as is gathering firewood and wild fruits such as the blueberry (*Vaccinium myrtillus*).

The study area contains two ecozones: the Boreal Shield, Canada’s largest ecozone, and the Hudson Plain (or Lowlands). Advancing and retreating glaciers etched the depressions and shaped the regional landforms creating the thousands of lakes, numerous rivers and streams, vast wetlands, and peatbogs (muskeg). Land elevations (within the study area) vary from 360 m in the west to sea level in the east. The area, as classified by Köppen, has a continental sub-Arctic or boreal climate. The sub-Arctic region experiences the most extreme seasonal temperature variations found on the planet, ranging from −40°C (−40°F) in winter to +30°C (86°F) in the summer. Historically, summers are short lasting no more than three months and winters are severe lasting five to seven months with snowstorms, strong winds, and bitter cold conditions.
due to continental polar and Arctic air masses. Precipitation occurs throughout the year in the forms of rain and snow.

Results and discussion

“Blue-ice”: a lens into climate change

Evidence for climate change and its effects on the lives of millions of indigenous peoples is accumulating in the literature (Downing & Cuerrier, 2011; Galloway McLean et al., 2011). The changes demonstrate a deviation from familiar conditions outside a culture’s traditional knowledge (Sakakibara, 2011). During the course of the fieldwork, similar findings arose in the repeated descriptions of changes in seasonal temperatures and precipitation, vegetation and wildlife, along with comments on the rapid rate and extent of changes observed and experienced, the uncertainty as to why these events were occurring, and the unpredictability of environmental conditions on the landscape. Crate (2008, p. 527) points out that “in the field, we need

Figure 1. Fieldwork map: Indicated are the northern communities visited and travel hub centres from which travel to the communities was possible. Flights north originate below the 50th parallel in Sioux Lookout (in the west) and Timmins (in the east); travel east–west directions to access the northward hubs requires stops in Thunder Bay, Sault Ste. Marie, and Sudbury, ON. Total travel distance to reach the communities was nearly 6300 km (3900 mi). In our discussion, we divide the study area into three regions N of the 51st: the west, at longitudes between 91° and 94°W, central, at longitudes between 87° and 90°W, and the east, at longitudes between 81° and 83°W.
to understand how our research partners frame the local effects of global climate change in order to tease out cultural implications”.

The reference to kah-oh-shah-whah-skoh-siig mii-koom as pronounced in Ojicree, and written in Ojicree syllabics as ᐃᓂᑲᓪᓗᔨ ᓲᓐ ᐃᔅᐳᕕᔅ.Collectors, or “blue-ice”, was a phrase consistently used by First Nations to describe a specific and familiar environmental condition that is rapidly changing, with significant implications and relevance to community members across the study area. The importance of “blue-ice” formation on lakes and rivers (and in general frozen waterbodies and the muskeg) cannot be understated with respect to First Nation recollections and memories, its cultural significance in traditional activities, and the current and future well-being of these communities. The formation and presence of ice influence these First Nation communities throughout the year. Tremblay et al. (2006) had similar findings in their study using traditional knowledge and local observations as well as scientific knowledge to characterize ice conditions relevant to the Aboriginal communities involved. “Blue-ice”, though noting a colour (and is blue-greenish where fresh water meets marine water in the mouth of the rivers at James Bay⁹), is a cultural and community frame of reference to the conditions and attributes of the land, and the activities connected to them. It is fixed in the past, present, and future and climate change observed by these First Nations is discussed through that lens.

Blue-ice in the scientific literature has specific properties and particular meteorological circumstances in its formation (see Yu, Liu, Jezek, & Heo, 2012 on blue-ice in the Antarctic). In the northern boreal, “blue-ice” forms out of water exposed to very cold sub-zero temperatures over an extended period of several weeks.¹⁰ Explained by Gudra and Najwer (2011), “supercooled water and low air temperature are ideal conditions for the formation of frazil ice, small crystals of free-floating ice” (p. 625). Though this may seem to be straightforward, the timing of two environmental conditions must be met in the formation of “blue-ice” – frigid temperatures and the absence of snow. As explained by an Elder, the arrival of snow on open water is beneficial, to quickly chill the water, but not beneficial after the initial ice forms:

When I was a kid … from September to October it used to be cold, really cold … when the lake started to freeze and we used to have blue-ice and this blue-ice lasted like a long time before the snow comes … and when the snow came we didn’t have a snow that was coming down like a slush, because it was so cold. But now every winter, the snow usually comes first. We have snow on the ground first and then we would have slush on the lakes and then … it freezes up. (Elder, central region)

When snow arrives too soon after the initial layer of ice forms, water underneath the ice is insulated from the cold northern air impeding “blue-ice” formation. Snow also has other influences on ice formation. As explained by a community member, during ice formation water naturally floods across the ice surface from open areas or at ice edges, and when water meets snow the formation of slush occurs (a slurry mixture of snow crystals and liquid water). Snow on the ice surface can also cause melting of the existing ice creating a contact zone of water and snow that results in slush. Slush when it freezes is a white-coloured ice, and referred to as “slush” by First Nations even in frozen form (due to its mixture of snow and water and not solely water). Differences in the types of snow are also a factor in ice formation and falling snow is mostly affected by temperature (Table 2). In the scientific literature,

there are various types of ice, differentiated depending on the way it is formed. Snow ice forms when snow falls on water surfaces at a temperature of about 0°C [32°F] – ice does not melt. Sudden temperature drop causes snow ice to change into white ice. (Gudra & Najwer, 2011, p. 625)

The major difference in blue-ice and slush is strength. Recorded from interviews in the study area, “blue-ice is the strong ice that freezes right” (Elder, west region) when “the cold was strong” (Elder, central region). Ice is diverse by nature and blue-ice is dense (in comparison to slush) and considered twice as strong; therefore, “there needs to be twice as much slush ice to equal the strength of blue-ice” (Winter Road staff member, west region). In the scientific literature, there are no established methods for measuring ice parameters; the most common examination of ice is measuring layer thickness in a water body

<table>
<thead>
<tr>
<th>Air temperature</th>
<th>Snow crystal type</th>
<th>Snow crystal characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below -10°C (14°F)</td>
<td>Powder snow</td>
<td>Fluffy, light weight, small in size like dust particles; non-sticking separate crystals; easily moved by the wind; and dissolves quickly in open water</td>
</tr>
<tr>
<td>Between -10°C and 3°C (14°F and 27°F)</td>
<td>Packed snow</td>
<td>Heavier than powder snow; crystals will eventually stick together, forming a dense layer or compacted snow layer on the land; packed snow can be walked on leaving no footprints</td>
</tr>
<tr>
<td>Above 3°C (27°F)</td>
<td>Wet snow</td>
<td>Heavy snow due to its water content; crystals easily merge together forming a group of flakes or clumps; crystals stick well together creating a water-snow mixture; can be the consistency of sloppy “mashed potatoes” and difficult to travel across</td>
</tr>
</tbody>
</table>
The depth of blue-ice described repeatedly across the study area was nearly half the depth (or even less) as in the past.

Along with changes in the formation and depth of blue-ice is the duration of ice on the land from its arrival to breakup. In the past, ice began to form in the fall (September/October) and remained until May (or even into June); its presence on the land lasting six to eight months. In recent years, blue-ice (slush and ice in general) is forming later and disappearing earlier, by nearly two months and even more. Community members remember those conditions in these translations:

On the river systems … on the shores of the rivers ... we were still dragging our boats. A long time ago … the lakes and the river system around June 10 would be the time that they would open up. (Elder, central region)

Now the ice is gone when it is maybe March. (Traditional Lifestyle Land User, central region)

For breaking, for the ice to break, sometimes it happens in April but usually that is in May ... the beginning of May … it happens in the past they say in June ... the ice broke. (Winter Road Maker, east region)

First Nation knowledge on ice formation, strength, thickness, timing, and duration is widespread across the northern boreal because the presence of ice is a critical factor in the activities carried out on the land. First Nations are witnessing changes in both snow (the timing and type) and warmer temperatures in the months in which blue-ice historically formed and stayed on the land.

**Impacts from changes in Blue-ice**

For these First Nations, the significance of disappearing blue-ice is the transportation link to food and energy security, and continuity with traditional activities. Winter road access is a vital lifeline in these remote communities as it is the only time in which the economical transportation of goods and supplies occurs. Each community is responsible for building a section of the winter road system to create transportation corridors from the north to access permanent highways and urban centres south of the 50th parallel. Transported goods include groceries, and in some cases potable water, fuel (gasoline and diesel), modular houses and building supplies, household items (furniture, appliances, computers), equipment and tools (school, medical, electricity generators), and vehicles (cars, trucks, and snowmobiles). At many times during the fieldwork, winter roads were not open. Instances of road-making equipment falling through the ice (Figure 2) or rivers beginning to flow signalled the temporary halt of transport trucks or the end of the winter road season. At times, even access for cars and light trucks was questionable.

Community members in charge of winter road making have had to adjust the type and weight of equipment to the

![Figure 2. Snowplough fallen through the ice. Photo taken January 2011 between Sachigo Lake and Muskrat Dam, Ontario (west region). The absence and/or decreased depth of “blue-ice” formation are attributed to the reduction in the strength of the ice for winter road transportation. Source withheld; printed with permission.](image-url)
strength-bearing capacity of the ice. In the 1980s, heavy snowploughs in excess of 18 tonnes were standard equipment, which changed to 10 tonne equipment 10–12 years ago, to the current use of lighter and smaller ¾ and 1 tonne trucks fitted with ploughing equipment (personal communication, Vernon Morris). This adjustment reflects a compounding dilemma with the disappearance of blue-ice. Smaller road-making equipment increases the time needed to complete and maintain the winter road, and the timeline for reliable winter road conditions is becoming shorter. The following observations emphasize the changes in winter roads across all regions in the study area:

Last winter ... there was hardly any winter. I noticed that. It didn’t freeze up. ... and then the spring, it comes too fast. The reason why I noticed that ... was the winter road. We couldn’t use it after that. It was a really short winter. (Seasonal Land User, west region)

The winter road didn’t last that long ... I think they finished it in January [2011] and they are still good ... so probably this is the last week [last week of March] to use it. (Seasonal Land User, central region)

Last year we were like a month behind schedule because of all the mild days we had ... couldn’t do it [make the road]. (Winter Road Maker, east region)

Diminishing winter road access significantly increases the prices of goods and decreases availability. Without winter roads, goods (though not large heavy items) arrive by costly air cargo. During the fieldwork it was not uncommon to pay ~CAD 5.00 for a dozen eggs. Gasoline was priced at CAD 2.45/litre (~US $9.80/gallon) or more during times of scarcity, and at times shelves in the stores (particularly perishable foods) and fuel tanks at the gas pumps were exceedingly low or empty. Moreover, the further people travel out on the land to obtain traditional foods due to changes in animal and bird habitat and migration, the more expensive it becomes to carry out traditional activities for food. A community member explained the situation: “It is not worthwhile to go moose hunting as it is expensive … the ride is very expensive … it comes out about the same as to buy food from the store than to go hunting.”

With fuel trucks increasingly unable to access communities, not only will cost be an important factor, but also the supply of fuel will be in jeopardy. Less fuel for vehicles may not be as critical as less fuel for electricity. Northern NAN communities rely on diesel-generated electricity with the exception of the few NAN communities along the James Bay coast connected to the province’s electrical grid. Electricity not only powers appliances, but also heating and cooling systems in homes, buildings (schools, nursing stations, and band offices), and the community water treatment plant. While many homes are wood heated, many are not. No heat in the winter at sub-zero temperatures is potentially life threatening. In addition, access to potable water is an issue in every community. It is a minor issue when an electrical generator temporarily fails, shutting down the treatment plant and pumping station, but in some communities, access to potable water can be a major issue when the water quality is so poor that it has to be delivered whether by transport trucks or air cargo.

Some community members and Elders (still physically capable) live off the land in a traditional lifestyle using skills that have been passed down to the next generation mostly through teaching by doing, but there are changes occurring:

In the ‘70s I had the opportunity to work the land with Elders, people who taught me how to trap, hunt and fish and I appreciate what is out there on the land. We learned the language again, and the customs, the way of thought and how to care for the land and for the animals and stuff. … All that is changing really fast. (Council Member, west region)

Many community members, though employed within the community (e.g. schools, band council offices, and winter road making) and not living off the land, are still “land users” travelling across lakes and rivers to reach traditional hunting, trapping, and fishing areas on weekends and during seasonal activities (e.g. goose hunts). Land users are acutely aware of changes in ice conditions affecting traditional activities particularly in terms of personal safety. Changes in ice conditions, sometimes very unpredictable on a day-to-day basis, present potentially life-threatening situations:

There was this one area ... it thawed ... really fast ... and it was this area where I fell through the ice. ... It was just white ice too; there was no blue-ice. It was just like a snow that had frozen there, no ice. But I was all by myself and when I first fell into the ice I got scared wondering how I’m going to get out. (Winter Road Maker, west region)

We trap, and we hunt out this way, like out towards [the] east … there is a river that goes all the way to James Bay … we used to go across by dog team or our skidoos [snow-mobiles]. Now we can’t even go across them in some places. (Traditional Lifestyle Land User, central region)

Regardless of the changing conditions, First Nations’ continuity with the land remains, though how traditional activities are conducted or the timing of when some activities occur is changing.

Like I said, the middle-end of April we [the family] would go set up and then do hunting through till the third of week of May. ... It’s like earlier and earlier that we have to go set up because we have to carry a lot of stuff over. ... I don’t want to take it all by canoe ... when the ice is already all gone; so what we do is we go there prior, set it all up ... leave it there until we go geese hunting. But this year it
Adaptation and reframing the language

Archaeological evidence suggests that indigenous populations have previously adapted to climate change (Applied History Research Group, 2000, 2001). Recently recognized are “culturally appropriate adaptations”14 devised through community participation, which are necessary for indigenous communities to adapt to climatic changes (Downing & Cuerrier, 2011). For researchers to understand the impacts and adaptations to climate change of indigenous peoples requires a different lens. To do so, it is necessary for researchers to reframe their viewpoint through dialogue and engagement with indigenous communities (Pearce et al., 2009). The collaborative nature of this study between NAN, its communities, individual participants, and the research team created the space to explore the language and context of climate change adaptation from a First Nation’s worldview.

NAN representatives and participants in the study reacted to the term “adaptation”. In the Cree, Ojibwe, and Ojicree languages spoken in NAN territory, the word “adaptation” does not exist. First Nations in this area, prior to European contact, lived a nomadic lifestyle for thousands of years, moving with seasonal resources in traditional activities or into more favourable locations with changing circumstances on the land and have long understood the need to act in accordance with the changing landscape because their lives and livelihoods depend on it. Adaptation was inherent, not a term.

In modern times, “adaptation” must be understood in the political context between First Nations and the Canadian state. It is a term coloured by colonization. Canadian state policy with First Nations has had an assimilation goal exercised more clearly at some historical periods than others (Tobias, 1976). Legislation passed in 1857, the Gradual Civilization Act,15 captured this intent, as did a proposed amendment to the Indian Act (1867) in 1920, giving the federal government the power to eliminate (enfranchise) First Nations’ legal status as “Indians” (Salem-Wiseman, 1996). For First Nations, adaptation has meant struggling against assimilation policies to maintain their identity as peoples. While the state consolidated its power, First Nations were forced to adapt by losing theirs. One interviewee captured this sense of loss of control:

Adapting to change … maybe I misunderstand that because adapting to change is changing my thought, my view on life … to something that is imposed on me. And I really have no power to assist in that process. (Seasonal Land User, west region)

Adger, Arnell, and Tompkins (2005) point out that assessing the success of adaptation will involve new and challenging institutional processes that should be judged on the criteria of effectiveness, efficiency, equity, and legitimacy. The last two criteria are particularly relevant to First Nation communities. Consideration needs to be made for the social and human rights implications of climate change (OHCHR, 2009) including the rights to life (food and water), along with free, prior, and informed consent (FPIC16) in the use of their territories to address climate change and in decisions to manage and adapt to the impacts. Dowsley (2009) argues reducing policy barriers that constrain community level decision-making in turn increases community options and adaptive capacity that can help to cope with rapidly changing environments.

Adaptation needs to be understood not only in the political context, but also more importantly, in terms of First Nation values and beliefs about their relationship to the land. The First Nation worldview is rooted in ties to the land with responsibility given to them by the “Creator” to look after that land (NAN, 1977). That responsibility still defines how First Nations see themselves, in spite of changes forced upon them, whether it is state policy or climate change. Indigenous knowledge is interconnected to the individual as part of all living things, the earth, stars, and planets (Botha, 2011; Chinn, 2007) and described as holistic and “different ways of knowing” (Botha, 2011; Pretty, 2011). It could be argued that the interconnected indigenous perspective across temporal and spatial scales (see Davidson-Hunt & Berkes, 2003) reflects the concepts of CASs theory, and perhaps this perspective has a greater scope in understanding a complex issue like climate change. This wealth of knowledge has only begun to be understood, accepted, and applied outside indigenous communities.

While adaptation necessitates change, “adjustments” to climate change should be limited to ecological, social, and economic aspects (Smit & Pilifosova, 2001). First Nations in the study recognize the need to develop anticipatory reactions to rapid climate change and to evolve activities, but remain the same as a people. Continuity in activities on the land occurs as noted from this interview:

I pack the snow and then I have to make sure that I drive across that one certain place the entire winter. That is the only way. Because if I drive or cross it over [the river] in a different area, it’s not as safe. (Seasonal Land User, west region)

The magnitude of changes and the hazards these changes have created (and will continue to create) affecting
First Nations’ subsistence way of life have also provided the impetus to plan appropriately for a changing environment. First Nations’ engagement and perspectives are critical in the planning and policy processes to address climate change on territorial land.

Conclusion

First Nations observations about changes occurring on the land and water were strongly similar across the study area and many discussions and descriptions focused on “blue-ice”. The term is embedded in their languages and is as elementary to life as water (only in a solid state) and is a measuring stick for people’s activities on the land. Blue-ice ties transportation to food and energy security, whether to access modern goods and services or carry out traditional activities. Blue-ice (and ice in general) historically formed in the fall and remained until spring or over a period of six to eight months. Today, blue-ice forms later, disappears earlier, and its depth is less (almost by half as in the past), reducing both the timeline in frozen lakes and rivers, and its strength-bearing capacity. Travel conditions on frozen waterways and winter roads can be extremely hazardous even during months typically considered the middle of winter (e.g. January).

The concept of “adaptation” found in the climate change literature is foreign to First Nations in the northern boreal forest of Ontario. Indigenous peoples (and/or local communities) have for centuries managed and aligned the benefits from the environment with human interests (Hawken & Granoff, 2010). Adaptation is not a word or concept in their culture, yet it is inherent and necessary to living on the land for these remote First Nations. The term adaptation also carries a negative connotation associated with the history and influences from colonization to these indigenous peoples.

The research team was challenged to use terms in keeping with the First Nation worldview framed by their connection to the land. Comments from Elders on interpreting “the sound of the cold” made this relationship remarkably clear. We transformed the term “adaptation” to “continuity” to reflect the indigenous connection to the land. Consistent with theories in complex adaptive systems, First Nations’ understanding of, and interaction with, the landscape takes place across temporal and spatial scales, in generational and first-hand knowledge over a large geographic area and at a local level concerning blue-ice.

First Nations in the study recognized the need to develop anticipatory reactions to rapid climate change and to evolve activities in continuity with the land, while still staying the same as a people and retaining their cultural identity. Changes in blue-ice are requiring adjustments, but the indigenous worldview remains intact. The important distinction we make is that only activities in response to climate change are applicable to the term adaptation (not First Nation people), and that in spite of adaptive changes to climate change, the First Nation worldview has remained perpetual and resilient. Most important to the indigenous peoples in this study is recognition of their right to a homeland from which they cannot be displaced and which is central to their identity.

Policy and decision-making in response to climate change, to mitigate the extent of change and the adaptive undertakings required, are arduous and fraught with uncertainty. A major contributing factor to the difficulties with the decision-making is the integral complexity of ecological and social systems. The value of indigenous knowledge handed down through generations in adapting to and mitigating climate change, the application of traditional knowledge to modern climate change problems, and indigenous perspectives on adaptation have been discussed. However, climate change policy in Ontario is being developed without meaningful and comprehensive consultation with First Nations and does not address the issues highlighted in this paper. This study illustrates the relevance and uniqueness of First Nations knowledge about climate change within their territory in relation to both their perspective of continuity and to the rapidly changing conditions on the land. The importance of First Nations’ involvement in climate change policies that will affect their territories and communities cannot be overstated, both as a constitutional requirement to protect Aboriginal and treaty rights, and in their knowledge in changes occurring in the sub-Arctic.

The absence of indigenous knowledge in the climate change discourse and policy decisions may have a perverse outcome. Excluding meaningful and broad participation by indigenous peoples perpetuates the dominant western approach to climate change adaptation and may limit the knowledge and information needed to identify key indicators in the complications, challenges, or solutions to the impacts. Rather than non-indigenous people building adaptation strategies from a western framework, or using traditional knowledge where policy-makers deem it appropriate, space needs to be provided throughout the entire policy-making processes for First Nations’ perspectives. The new challenge for indigenous communities and western policy-makers is inclusion in the dialogue.

Fundamental to the dialogue is reframing the language, which in this case is from “adaptation” to “continuity”. Reframing the language would create a basis for discussions more meaningful to and respectful of First Nations, and facilitate the opportunity for greater understanding amongst policy-makers of the changes occurring in the northern boreal forest. It will require formulating strategies and protocols in which First Nations are actively involved in the policy process from the onset, and not just the recipients of policy decisions made by others. Policy-makers need to give western and indigenous knowledge mutual
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Notes

1. We use three different terms to cover indigenous peoples: “indigenous”, as spelled out in the UN Declaration on the Rights of Indigenous Peoples, 2007 (and adopted by Canada in 2010), “Aboriginal”, which is defined in Canada’s Constitution Act, 1982 to include “Indians, Métis, and Inuit”; and “First Nations”, which has no legal definition but has become the accepted term for “Indian Bands” under the Indian Act (INAC, 2002); the communities that were part of the study are all “First Nations” and consider themselves to be Ojiwwe, Cree, and Ojicree Nations. We therefore use the term First Nations and indigenous interchangeably.

2. NAN Launches Anti-Bill 191 Campaign News Release, Tuesday, August 31, 2010, Thunder Bay, ON.

3. Climate change mitigation is the reduction, prevention, and removal of greenhouse gases from the atmosphere, whereas adaptation is planning and preparing for climate change impacts to lessen the impact or capitalize on the opportunities.

4. Respectfully acknowledged, unavoidable community circumstances took precedence over the research; many times the winter road opened creating an exodus of community members (both and/or interviewees and translators) to obtain much needed supplies, or sadly a death occurred and all community activities halted, including interviews, except those to mourn.


7. The Köppen Climate Classification information as developed by German geographer Wladimir Köppen (1846–1940) continues to be the authoritative map of the world climates in use today; Retrieved from http://www.elmhurst.edu/-richs/EC/101/KoppenClimateClassification.pdf.


9. Eight of the 10 communities are located inland and situated next to lakes or rivers; 2 communities are located on the James Bay Coast at the mouth of major rivers – the Albany and Attawapiskat.

10. Comments and recollections from community members included ice strong enough to walk across within days after temperatures became very cold – the blue-ice trusted for its strength, lasting for many months.

11. Notes taken during a discussion Muskrat Dam, ON, January 19, 2011.


14. One culturally appropriate response would be how First Nations address changes in hunting areas because of wildlife habitat changes.

15. The Gradual Civilization Act sought to assimilate Aboriginal people (Indians) into Canadian settler society by encouraging “enfranchisement”, a legal process for terminating a person’s Indian status; Retrieved from http://indigenousfoundations.arts.ubc.ca/?id=1053.

16. FPIC is the principle that indigenous peoples and local communities have a right to give or withhold their free, prior, and informed consent to developments or potential effects by an external initiative or influence outside the community; Retrieved from http://www.recofoc.org/site/resources/FPIC-in-REDD/.

References


