

Anomalous climatic conditions during winter 2010–2011 and vulnerability of the traditional Inuit food system in Iqaluit, Nunavut

Sara Statham, James Ford, Lea Berrang-Ford and Marie-Pierre Lardeau

McGill University, 805 Sherbrooke Street West, Montreal, Quebec H3A 0B9, Canada

(James.Ford@mcgill.ca)

William Gough and Rick Siewierski

University of Toronto, 1265 Military Trail, Scarborough, Ontario M1C 1A4, Canada

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ABSTRACT. This study examines how climatic extremes during winter 2010–2011 affected the traditional food system in Iqaluit, Nunavut. This winter was anomalous throughout the Canadian Arctic, and manifested itself locally by warmer temperatures and decreased ice coverage. Drawing upon in-depth interviews with hunters ($n = 25$), a fixed question survey with public housing residents ($n = 100$), as well as analysis of remotely sensed sea-ice charts and temperature data from the Iqaluit weather station, this work identifies and characterises the extreme climatic conditions experienced, their subsequent effects on Iqaluit's traditional food system, and coping strategies used for dealing with food-related stresses. The results show increased environmental stress on the traditional food system compared to previous years. Freeze up occurred 59 days later than the average for the 1982–2010 period, while mean annual temperatures were 4.9°C higher than the climatological mean, which negatively impacted hunters' harvests and residents' food supplies. Coping strategies alleviated some stresses, but adaptability was limited for financially insecure households reliant on income support. The study shows that when challenging socioeconomic conditions, such as those associated with public housing, are coupled with significant environmental stress, such as experienced during that winter, the vulnerability of the traditional food system is exacerbated. We suggest that winter 2010–2011 can be used as an analogue for exploring future food system vulnerabilities, with climate models projecting similar conditions in the coming decades.

Introduction

There is strong evidence that the Arctic climate is rapidly changing, with temperatures increasing in excess of twice the global average (IPCC 2007b, 2013). These changes are having implications for northern populations, with more variable and less predictable weather conditions observed, and sea ice regimes dramatically shifting, characterised by later ice freeze up, earlier break up, and thinning documented across the circumpolar region (Holland and others 2010; IPCC 2007b; Serreze 2010, 2011; Stroeve and others 2011). The social, economic, cultural, and political implications are wide-ranging, and not all negative, particularly for Inuit communities, many of which depend on hunting and fishing for local livelihoods (ACIA 2005; Ford and others 2009; Furgal 2008; Furgal and Prowse 2008; Gearheard and others 2006; Huntington and others 2007; IPCC 2007a; Keskitalo 2008; Laidler and Ikummaq 2008; Laidler 2006; Laidler and Elee 2008).

The food security implications of climate change are particularly pertinent for Inuit communities (Ford 2009). Food security exists when 'people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (FAO 1996), and is determined by the characteristics of food systems. The Inuit food system comprises both traditional food (hereafter 'country food') and contemporary food (here-

after 'store-bought food'). Country food is obtained from terrestrial or (often frozen) aquatic environments (herein collectively termed 'the land') via local harvesting. Store-bought foods must be purchased (Kuhnlein and others 2009). Store-bought foods have played an increasingly important role in the diet of Canadian Inuit over the past 50 years (Ford 2009; Kuhnlein and Receveur 1996). The Inuit food system is particularly sensitive to climatic conditions, and scholarship documents how food access, availability, and quality have been affected by climatic changes already observed (Beaumier and Ford 2010; Chan 2006; Guyot and others 2006; Lambden and others 2006; Wesche and Chan 2010). In many instances, these implications have been exacerbated by socio-cultural-economic factors such as high rates of poverty, weakening traditional food sharing networks, high prices of food, and declining participation in hunting. These factors are reflected in high baseline food insecurity across Canadian Inuit communities (Egeland and others 2010a, 2010b; Egeland and Johnson-Down, 2009; Huet and others 2012; Johnson-Down and Egeland 2010).

The last decade has witnessed a rapid increase in research examining the human dimensions of Arctic climate change, with food security as a major area of study (Pearce and others 2011). Scholarship has typically focused on smaller, more 'traditional' communities, and has used interviews with community members to document observed changing climatic conditions and food system impacts, and to utilise local experiences to explore

future vulnerabilities. This has generated a wealth of information, yet some scholars have criticised the over-reliance on examining current risks that may not be consistent with projected future climatic conditions. In light of this, Ford and others (2009) in an Arctic context, and others in a general climate change context (Ford and others 2010c; McLeman and Hunter 2010; McLeman and others 2008; Smit and Wandel 2006), argue that focusing on years with extreme climatic conditions analogous to those projected in the future can help us better understand human-environment interactions that will shape future vulnerability and adaptation. With such climatic extremes happening with increasing regularity (Coumou and Rahmstorf 2012), there is an opportunity to develop a more in-depth empirical understanding of future vulnerability.

In this paper, we use anomalous climatic conditions in winter 2010/11 in Iqaluit, Nunavut, as a lens to examine vulnerability and adaptability of the traditional food system to climate change. Record breaking temperatures and sea ice conditions were observed during this period, and these observations mirror trends projected for the region mid-century (Dumas and others 2006; IPCC 2013). Specifically, we focus on hunters (i.e. food procurement) and public housing residents (i.e. food consumption) to: i) examine how community members experienced and managed the climatic risks, ii) identify processes and conditions that determine the potential for and success of coping mechanisms; and iii) use the extremes to develop a greater understanding of how social and biophysical processes shape vulnerability and adaptation. As such, the study is one of the first to focus on a larger Canadian Arctic community in a climate change context and to use extreme conditions as an analogue for examining traditional food system vulnerability. We begin the paper by outlining the vulnerability-based approach guiding the work and describing both the case study community and the mixed methods used. We continue by assessing the vulnerability of the traditional food system by characterizing its exposure, sensitivity, as well as facilitators of and barriers to adaptive capacity. We finish by discussing future implications of projected climate change for the traditional food system and assessing the usefulness of the temporal analogue methodology.

A vulnerability-based approach

Conceptual approach

The study of climate change vulnerability is a major area of research within the human dimensions of climate change scholarship. Vulnerability is a measure of the susceptibility to harm in a system in response to a stimulus or stimuli. Conceptual approaches to vulnerability have evolved considerably over the last three decades, from a focus predominantly on biophysical determinants to approaches that seek to understand the dynamic interaction between climatic conditions and social, economic, and

political processes that determine how climate change is experienced and responded to (for detailed reviews see Adger 2006; Eakin and Luers 2006; Ford and others 2010c, 2010d; Ford and Smit 2004; Fussel and Klein 2006; Keskkitalo 2004, 2008; Leichenko and O'Brien, 2008; O'Brien and others 2007; Ribot 2011; Smit and Pilifosova 2001; Smit and Wandel 2006). Some scholars have recently criticised the use of vulnerability concepts, which, it is argued, portrays climate change in negative terms and paints affected peoples as passive victims (for example Cameron 2012; Haalboom and Natcher 2012). Others, however, have noted that 'vulnerability' refers to the concepts used by scholars, rather than the outcome of studies that are typically action-orientated, focusing on the positive adaptability of populations and how capabilities can be strengthened (Andrachuk and Pearce 2010; Andrachuk and Smit 2012; Ford and others 2013, 2010c; Pearce and others 2010c; Ribot 2011).

This study is structured using a 'contextual approach' in which vulnerability is conceptualised as a function of exposure and sensitivity to climate change, as well as adaptive capacity (Ford and others 2010a; Ford and Smit 2004). Exposure refers to the nature of climate-related risks. Sensitivity concerns the organisation and structure of human systems relative to the climate-related risks and determines the pathways through which exposure manifests. Adaptive capacity reflects the ability to address, plan for, or adapt to climate-related risks and take advantage of new opportunities. The recognition of the role of adaptive capacity and sensitivity expands the scope of vulnerability studies to consider the role of non-climatic factors in amplifying or attenuating vulnerability alongside the nature of the climatic stress. These determinants are influenced by social, economic, cultural, and political conditions and processes operating over multiple spatial-temporal scales. As such, the research places emphasis not only on documenting and characterising the biophysical stresses affecting the food system, but also human factors affecting food availability (sufficient quantities available consistently), accessibility (sufficient resources to obtain food), and quality (sufficient nutritional and cultural value) (Ford 2009; Ford and Berrang-Ford 2009; Gregory and others 2005).

Methodology

Several methodologies have been used in vulnerability scholarship (see Ford and others 2010c; Fussel and Klein 2006; O'Brien and others 2007). While model-based studies driven by future climate projections have dominated, research is increasingly using past and present experience of and response to climatic variability, change, and extremes to develop an understanding of the pathways through which climate affects society and adaptation takes place. Such 'temporal analogue' approaches build upon the pioneering work of Michael Glantz that occurred over two decades ago (Glantz 1991, 1996b, 1990), and are based on the premise that human systems in the near future will probably conduct activities as

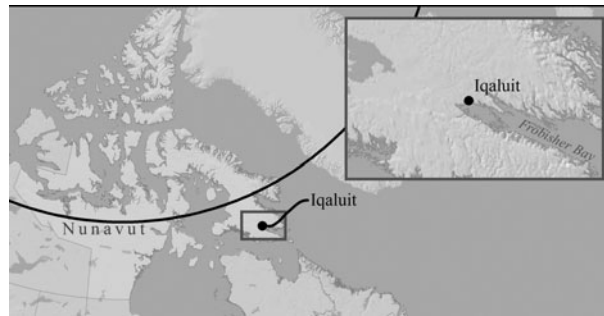


Fig. 1. Map of Nunavut.

they have done in the recent past and be influenced by similar conditions and processes. Empirical application of such approaches typically involves documenting climatic exposures and coping strategies from interviews and/or focus groups and using archival records to reconstruct how human systems experience (that is exposure and sensitivity) and respond to (that is adaptive capacity) environmental stress. Various timescales of analysis have been used, ranging from the recent past (Belliveau and others 2006; Ford and others 2009; Glantz 1992, 1996a; Hamilton and others 2000, 2003; Laidler and others 2009; McLeman and others 2008) to paleo-climatic analogues (Brooks and others 2009).

Analogues have significantly increased our understanding of climate vulnerability, empirically grounding analysis of vulnerability to changing conditions. However, some scholars have expressed concern about their use, noting that future climate change is likely to exceed in magnitude and speed anything previously experienced (Adger and Barnett 2009; Adger and others 2009). While the strength of analogues resides more in their ability to capture the broad pathways through which climate affects society rather than whether past climate stresses are identical to those predicated by climate models, the critics raise important points. Modifications to analogue approaches have therefore focused on limiting analysis to specific timeframes and sought to use climatic extremes similar to those projected in the future on which to focus analysis (Hamilton and others 2000, 2003). In this paper, we offer an additional modification, advancing the work of Ford and others (2009) who argue that examining recent cases of extreme climatic conditions analogous to those projected in the future can help us better understand future vulnerability. By focusing on recently experienced extremes, we are able to capture local knowledge on the nature of the risks, impacts on the food system, and adaptive capacity of community members. We are also able to examine the role played by multiple stresses in affecting vulnerability and adaptation. Examining recent events also minimises the chances that knowledge on exposure, sensitivity, and adaptive capacity will recede as time passes, a major challenge to retrospective studies of climate vulnerability (Ford and Pearce 2012).

Methods

This section describes the community case study and methods, with additional detail provided in supplementary materials at <http://www.jamesford.ca/rah/supplementary-data>.

Case study location: Iqaluit, Nunavut

This paper uses a case study of Iqaluit, Nunavut (Fig. 1) to identify and examine the key processes and conditions shaping vulnerability of the traditional food system to anomalous climatic conditions during winter 2010–2011. Iqaluit (63°45'N; 68°31'W) is the largest community and capital of the Canadian territory of Nunavut (Iqaluit population: 6,699). The proportion of Inuit in Iqaluit (58.2%) is much lower than the Nunavut average (84.8%), as its status as the capital draws many southern Canadians to the community for waged employment. The community has expanded dramatically since its establishment, and the economy has shifted from being based entirely upon subsistence activities to a mixed economy in which both the informal and formal economic sectors play an important role (Damas 2002). Located on the southeast coast of Baffin Island, the region is predisposed to hazardous weather in all seasons (Hudson and others 2001; Nawri and Stewart 2006), making traditional activities on the surrounding land and sea ice difficult. In contrast to smaller Inuit communities, there has been limited research on the human dimensions of climate change in the larger regional centers like Iqaluit (Ford and others 2012a), reflecting trends in Inuit studies more generally (Searles 2008, 2010). However, while Iqaluit is both demographically and economically anomalous in Nunavut, current socioeconomic conditions in Iqaluit may reflect the future of other Nunavut communities if current trends in diet and lifestyle across the Canadian Arctic continue.

Although Iqaluit is a rapidly expanding community with a strong wage-based economy, many residents still engage in land-based activities such as hunting, fishing, and trapping (Lardeau and others 2011; Searles, 2010). In the *Survey of living condition in the Arctic*, 57% of those surveyed in Iqaluit reported hunting and fishing in the last 12 months, and 33% reported obtaining more than half of their meat and fish from traditional sources (Poppel and others 2007). The most prevalent species

harvested during the sea ice season and its shoulder seasons (identified here as November to May) include caribou, ringed seal, and Arctic char and are therefore the main focus of this paper. Not only are these species the most commonly harvested, but they also account for the largest number of hunters harvesting them (NWMB 2004). Additional species harvested during this timeframe include ptarmigan, polar bear, walrus, and narwhal, amongst others.

Those with low household incomes, limited access to resources, and economic problems have been identified as particularly vulnerable to food insecurity in general and for Inuit communities in particular (Bohle and others 1994; Erber and others 2010; Ford and Beaumier 2011; Sarlio-Lähteenkorva and Lahelma 2001). Therefore, this study focuses on assessing the food security of those with limited access to financial resources who may be at greater risk to climate-related food stresses. Public housing data were used to identify such residents, as many of the households living under this jurisdiction are financially insecure and often rely upon government assistance to supplement, or to even fully provide, their income. Public housing dwellings account for 19% of the housing stock in Iqaluit, and 51% in Nunavut (Government of Nunavut 2010).

Data collection

Instrumental data

To characterise the nature of sea ice conditions during winter 2010–2011, ice data were obtained from the Canadian Ice Service. Ice charts were analysed in order to determine break-up and freeze-up dates, that control the length of time during which sea ice can be traversed, thus permitting or impeding harvesting activities. Two sea ice cover thresholds were used to determine freeze-up: 5/10 sea ice coverage, which is commonly used to define freeze-up reflecting a ship-navigable water threshold (Gagnon and Gough 2005); and 9/10 sea ice coverage, which approximates sea ice that can be navigated by community members on snowmobile or on foot (Laidler and others 2009). For break-up, 5/10 ice coverage was used as the threshold, which is consistent with other work (Ford and others 2009; Gagnon 2005; Gough 2004; Laidler and others 2009). While sea ice data are available from the late 1960s, data from 1982 to 2011 were used, reflecting the higher level of confidence in the more recent data through improved technology. Temperature and wind data were obtained from the climate station Iqaluit AWOS (Automated Weather Observing System), formerly known as Iqaluit A. Temperature and wind data spanning 1982–2011 were extracted from the complete dataset for this analysis, which coincides with the sea ice record utilised. The time period between 1200 and 1400 was used from the wind dataset, as this was the timeframe most frequently reported throughout the years of data collection.

Interviews with hunters

25 in-depth interviews with local hunters were conducted to document local knowledge and observations on climate-related conditions experienced in 2010–2011, describe the impacts these conditions had on their activities as well as wildlife, and identify adaptive strategies employed. In order to participate, hunters must have lived in Iqaluit for at least 5 years in order to have some baseline understanding of local environmental conditions. Hunters were also required to have been active on the land during winter 2010–2011, thus enabling them to compare conditions with previous years. The sample included Inuit as well as non-Inuit hunters, as all hunters contribute to the overall food security of the community. The sample was not restricted based on age, gender, or hunting experience because the interviews aimed to include a variety of perspectives in order to identify diverse determinants of exposure, sensitivity, and adaptive capacity. A purposive sampling strategy was used to identify participants who were involved with hunting and were knowledgeable about the local area. Interviews were open ended, structured using an interview guide, conducted in the preferred language of the interviewee (Inuktitut or English).

Surveys with public housing residents

100 household surveys with public housing residents were conducted to allow for a quantified baseline to be established with regards to food system and food security status during winter 2010–2011. The aim of the surveys was to examine and quantify stresses to the traditional food supply, identify whose supply of country food was particularly impacted, and describe the adaptive strategies that residents used to deal with food-related stresses. The surveys targeted a 25% sample of the 398 households under the jurisdiction of public housing, with households randomly selected. The person who was most involved in making food choices for the household was asked to participate in the survey, based on the logic that they would be most knowledgeable about sharing and purchasing food for the household, and in consistence with other food surveys administered in the north. Participants were required to be self-identified consumers of country food, specifically having eaten country food both this year and previous years in order for a meaningful comparison to be made in terms of country food availability, accessibility, and quality. Table 1 outlines the themes and topics of the survey.

Interviews with key informants

Semi-structured interviews were conducted with key informants, including municipal and territorial government representatives, local entrepreneurs, as well as wildlife biologists. These interviews provided contextual information that helped to understand the broader socio-economic factors affecting Iqaluit's traditional food system and the nature of climate-related stresses in 2010–2011.

Table 1. Survey themes and topics

Theme	Topics
Individual Characteristics	Gender Age Origin Occupation
Household Characteristics	Source of income Income satisfaction Economic structure (hunters/workers) Hunting capacity
Traditional Food System	Sources of country food Strength of sharing networks Availability/accessibility/quality of country food during winter 2010/2011 compared to previous years Amount of country food sharing during winter 2010/2011 compared to previous years Consumption patterns of country food during winter 2010/2011 compared to previous years
Adaptive Capacity	Use of community food programs during winter 2010/2011 compared to previous years Use of coping strategies during winter 2010/2011 compared to previous years

Participant observation

Participant observation involved ten weeks of field work during which the lead author experienced daily life in Iqaluit. This included going hunting with local hunters, participating in community feasts, and visiting the country food market. A research journal was kept in order to record relevant observations, impressions, and experiences.

Data analysis

Instrumental data

Detailed analyses of sea ice and climate data were conducted, focusing on susceptible times of the year (that is autumn ice freeze-up and spring break-up) when enhanced vulnerability and changing conditions have the greatest effect on local hunters (November to December and April to May). Least squares regression was used to identify linear trends in sea ice and climatic variables over time, with tests considered significant at the 95% confidence level. The models for all regressions were run using Excel's linear regression calculation and verified using the statistical software package STATISTICA for consistency. Temperature and wind data were binned by monthly pairs reflecting the timing of sea ice freeze-up and break-up at the study site and examined for residual trends during the 2010–2011 season. Wind direction was analysed using the standard sixteen wind rose wind directions.

Interviews and surveys

Interviews, open-ended survey responses, and participant observation notes were transcribed and analysed using qualitative content analysis (Mayring 2002), applying a systematic, theory-guided approach to text analysis (Kohlbacher 2006) in order to identify key themes related to exposure, sensitivity, and adaptive capacity (Ford and others 2006a, 2006c). Narratives from the interviews and surveys were cross-referenced with instrumental data,

archival sources, and participant observation, enabling data to be checked for consistency and credibility.

Surveys

Statistical analysis of closed-ended survey responses was conducted using SPSS Statistics v.19. Pearson's chi-squared analyses were conducted using a 95% confidence level. Fisher's exact tests were conducted using a two-sided alpha level of 0.05

Results

In this section, the vulnerability framework is used to structure the identification and characterisation of how anomalous conditions in winter 2010–2011 were experienced and responded to.

Respondent characteristics

The majority of hunter interviewees were male (92%), Inuit (84%), and were not originally from Iqaluit (64%). Most identified themselves as being part-time hunters (68%), with 20% hunting at weekends, and 12% reporting to hunt full-time. Survey respondents did not directly report their ethnicity, yet we can infer that they were predominantly Inuit as nearly all were born and raised in Nunavut (94%), most often in Iqaluit (52%). Most survey respondents were female (64%). Households generally had limited capacity with regards to direct country food procurement, with 89% reporting no full-time hunter(s) and 52% had no full-time worker(s). Many households were financially insecure, with 39% claiming they 'rarely' or 'never' had enough money to meet basic needs. One quarter of households were reliant on income support as the primary household income source. Over half (54%) of households were reliant on government assistance to some extent (for example income support, old age pension). 38% of households earned their income primarily from working. Households reported facing significant challenges with regards to food security; when

asked ‘Did you or anyone in your household not have enough money to buy store-bought food and/or you could not get country food?’ 54% of households said ‘yes’ for the winter 2010–2011, and 46% said ‘yes’ for previous years. A full table of results is provided in *supplementary materials*

Exposure

‘We’ve had bad years in the past. This was extreme. This was special’. Male, weekend hunter, non-Inuit, 51 years old, has lived in Iqaluit 14 years.

‘Very knowledgeable hunters have had accidents [this year], and that says a lot, to me’. Female, part-time hunter, Inuit, 56 years old, has lived in Iqaluit 27 years.

Hunters reported numerous observed anomalies in climate-related conditions during the winter in question (Table 2). A commonly reported observation concerned the unpredictability of the weather, with hunters describing erratic prevailing wind patterns affecting both direction and strength. Annual wind data, excluding summer, show a decrease in the dominance of wind from any particular direction since 1982 (7% decrease in wind dominance, $p < 0.01$). Winds were more variable, particularly during Nov–Dec, with an 18% decrease in wind predominance documented. Wind data also indicate a significant increase in wind speed of 1m/s over the observation period ($p < 0.01$), most pronounced during Nov–Dec and Jan–Feb when speed increased by 1.6m/s ($p < 0.01$) and 1.8m/s ($p < 0.01$), respectively. Hunters also noted warmer temperatures with shorter periods of cold. Indeed, weather station data indicate an increase in annual average temperature of $\sim 1.3^\circ\text{C}/\text{decade}$ over the 1982–2010 period for a total of 3.6°C ($p < 0.01$). The year 2010 was anomalous throughout the temperature data record: average annual temperature during 2010 (-4.3°C) was 4.9°C warmer than the long-term average (-9.2°C), maximum average temperature was 2.4°C warmer than the warmest year previously, while minimum average temperature of -8.0°C in 2010 was 5.1°C warmer than the average (-13.1°C). This anomalous warmth contributed to late freeze-up as it prevented ice from forming.

The most widely reported and influential anomaly noted by hunters concerned sea ice conditions, with freeze up occurring the latest in living memory, the sea ice being thinner and more dangerous throughout the ice season, and the floe-edge being closer to the community. Instrumental data from 1982–2011 are largely consistent with these observations, and for many climatic conditions the extremes of 2010–2011 reflect longer term trends; this is an observation also made by the hunters (Table 2). Thus the winter freeze-up was the latest on record (that is since 1982) occurring on 24 January 2011, 59 days later than the climatological mean of 26 November. Historical documents dating back to the 1940s show freeze-up having never occurred later than early December (Ford and others 2013). This continues a trend of later freeze-up documented over the last 28 years of 1.7 days per year ($p < 0.01$) or 50 days later over the observation period. On

the other hand, spring break-up was early, and occurred on 20 June 2011. Previous to the sea ice record, the formerly anomalous early break-up date was 27 June 1976. Not as pronounced as late ice freeze-up but still significant, ice break-up has occurred 0.8 days earlier per year ($p < 0.01$) or 23 days earlier over the same timeframe. When these conditions combined, it led to a shorter sea ice season. In fact, winter 2010/11 was the first year throughout the observation period that the open water period exceeded the stable ice period.

Sensitivity

‘Last year my freezer was full. Now it’s empty.’ Female, public housing resident, stay-at-home mother, 30–39 years old, has lived in Iqaluit her whole life.

‘This year there was barely any country food. Everyone is searching for it’. Female, public housing resident, stay-at-home mother, 20–29 years old, has lived in Iqaluit her whole life.

Wildlife availability, access, and quality

It was widely reported by hunters that winter 2010–2011 brought more ringed seals (*Pusa hispida*), a key food source, to Frobisher Bay compared to previous years, with some noting it was their best year for harvesting seal. This may reflect increased seal numbers, but was reported to be more likely be consequence of thinner ice allowing ringed seals to make breathing holes more easily and increasing the likelihood of surfacing, as well as late freeze-up allowing a longer period of boat access. Warmer temperatures were also believed to have improved the ability of hunters to locate seal pups in spring by melting their snow dens, leaving them exposed on the sea ice. This has been previously observed on the coast of southeast Baffin Island during years of abnormally warm temperatures (Stirling and Smith, 2004), and could therefore be explained by warm temperatures experienced during winter 2010–2011. However, not all hunters reported benefiting from this increased availability, as poor sea ice conditions prohibited many from traveling to hunting grounds and capitalising on this opportunity.

Most hunters reported that barren-ground caribou (*Rangifer tarandus groenlandicus*) were less available compared to previous years. According to hunters, this was because caribou herds had not returned from their migratory route, the herds were smaller, and the herds were further away from Iqaluit. While there have been similar observations over the past few decades, it was reported to be especially notable during winter 2010–2011 (Table 2). According to interviewees and key informants, icing in the winter is common in years with warm winters, as associated freeze thaw cycles form a thick layer of the ice on the snow and hinder foraging. Such icing is usually most severe along the coast where there are open leads, and instances of severe icing in the past have been linked to caribou herds moving inland to where icing was less severe or non-existent. Similar observations have been made in other Arctic regions of Canada (Gunn 2006;

Table 2. Exposure during winter 2010–2011

Exposure	Instrumental data*	Local knowledge	Opportunities/challenges
<i>Weather</i> <i>Wind</i>	<p>Annual 7% decrease in wind dominance from any particular direction, particularly during Nov-Dec, with an 18% decrease in wind dominance.</p> <p>Increase in wind speed of 1m/s over, most pronounced during Nov-Dec and Jan-Feb when speed has increased by 1.6m/s and 1.8m/s, respectively. Average wind speed for Apr-May show a slighter increase of 0.79m/s ($p = 0.04$), which is less pronounced but may contribute to earlier ice break-up.</p>	<p>Weather was described as being more extreme and unpredictable than ever before. Hunters stated that prevailing wind patterns were erratic and shifted constantly.</p> <p>Hunters reported that winds were stronger and more intense.</p>	<p>Volatile weather can prove dangerous for those on the land. Hunters who could traditionally predict the onset of storms or blizzards are increasingly caught off guard, potentially placing them in perilous situations.</p> <p>Strong winds can be dangerous while boating, can cause whiteout conditions in winter, and can rapidly disintegrate the ice during break-up.</p>
<i>Temperatures</i>	<p>Increase in annual average temperature of $\sim 1.3^\circ\text{C}/\text{decade}$, for a total of 3.6°C.</p> <p>The year 2010 was anomalous throughout the recorded temperature data: annual temperature of -4.3°C was 4.9°C warmer than the climatological mean (-9.2°C), average maximum temperature was 2.4°C warmer than the warmest year previously, and average minimum temperature of -8.0°C in 2010 was 5.1°C warmer than the climatological mean (-13.1°C).</p>	<p>Hunters noted that winter 2010–2011 was generally warmer than previous years. While cold temperatures were also experienced, hunters noted that they only lasted for a brief period of time.</p>	<p>Warm temperatures melted existing snow, thus leading to icy conditions on the land when temperatures subsequently dropped.</p> <p>Warm temperatures reduced exposure to extreme cold, so that more hunters were able to go on the land. Usually, extremely cold conditions prevent some hunters from leaving town.</p>
<i>Sea Ice</i> <i>Freeze-up</i>	<p>Freeze-up during winter 2010–2011 did not happen until 24 January 2011 – the latest ever recorded, occurring 59 days later than the climatological mean of 26 November.</p> <p>Previous to the CIS sea ice record, the formerly anomalous late freeze-up date, as of 1967, was 4 December which occurred in 1973.</p> <p>Ice freeze-up has occurred 1.7 days later per year, or 50 days later between 1982–2010.</p>	<p>Interviewees unanimously noted that the timing of freeze-up during winter 2010–2011 was much later than traditional timing.</p>	<p>Late freeze-up allowed hunters to go boating for longer periods of time, but go snowmobiling/hunting on the sea ice for shorter periods of time.</p>
<i>Break-up</i>	<p>Break-up has occurred 0.8 days earlier per year, or 23 days between 1982–2010.</p>	<p>Hunters predicted an early break-up, which had not yet occurred at the time of interviews.</p>	<p>2011 break up had not yet occurred at the time of interviews.</p>

Table 2. Continued

Exposure	Instrumental data*	Local knowledge	Opportunities/challenges
<i>Open-water versus stable ice periods</i>	The open water period has extended by 2.4 days per year, with the period of open water during 2010 lasting for 203 days – the first time throughout the observation period that the open water period has exceeded the stable ice period		The longer open-water period limited the amount of time during which hunters could use the sea ice as a platform for hunting or for accessing hunting grounds. On the other hand, it also meant that there was a longer open water season, enabling hunters to boat for a greater length of time.
<i>Stability</i>	As oceanic temperatures rise, sea ice may more often melt from the bottom via oceanic circulation rather than from the surface via solar radiation. This less familiar process is becoming increasingly common.	When the sea ice finally formed, hunters noted it was thinner and more dangerous than previous years. Hunters attributed unpredictable thickness to a change in the way the sea ice melted in the spring (i.e. from the bottom rather than from the top), causing “rotten ice.” It was noted that more accidents happened during winter 2010–2011 due to the extreme and unpredictable conditions.	Hunters who were normally able to predict the thickness and safety of the sea ice were unable to confidently navigate across the bay. Changing sea ice thermodynamics to be problematic since the “rotten ice” is often unidentifiable from above and poses as a hazard. Hunters who fall through the sea ice are at risk of exposure.
<i>Floe Edge</i>	No data were acquired for the floe edge. However, the position of the floe edge varies from year to year according to severity of weather conditions and the date of freeze-up (Meldrum 1975).	Hunters noted that the floe edge was closer to Iqaluit during winter 2010–2011 than in previous years.	Hunters wishing to access hunting grounds located further down the Bay, beyond the more proximal floe edge, were required to take less favourable overland routes instead of traversing the sea ice like normal. This increased the amount of time, fuel, and skills necessary. The closer floe edge was also beneficial as the reduced distance meant that shorter trips were required for those who went seal hunting at the floe edge.
<i>Land Terrain</i>	N/A	Warm temperatures and late winter rainfall were followed by freezing temperatures, leading to icy conditions on the land.	Some hunters were injured after slipping on the ice. Liquid-cooled snowmobiles overheated due to the fact that icy snow could not be adequately thrown onto the engines. Vegetation became locked into the ice, causing caribou to travel further inland to forage.

*Unless otherwise stated, all statistical values are significant at the 99% confidence level ($p < 0.01$); climatological trends are conducted over the 1982–2010 timeframe.

Miller and Gunn 2003). Many hunters explained that this icing might account for why caribou in Iqaluit were so distant and given their location some hunters had neither the financial means nor the available time required to go such distances.

The majority of hunters interviewed ($n = 14$) believed that the overall health of wildlife had not changed from previous years, although some noted that ringed seals and caribou were thinner and had less fat. Another observation was that seals and caribou were described as having burnt skin. Hunters conjectured that this may have been due to increased strength of the sun. This is thought to have caused differences in taste, as well as challenges when preparing skins for clothing since the skin was less malleable.

Country food availability, access, and quality

When discussing the availability and accessibility of country food in Iqaluit, a recurring trend among public housing residents was that winter 2010–2011 was more challenging than previous years. Even though hunters noted an abundance of seals, 49% of residents reported that seal was more difficult to get compared to previous years. Reports of decreased availability and accessibility of caribou by hunters translated into challenges in obtaining caribou in town, with 81% of residents believing it was more difficult to obtain caribou meat compared to previous years (noting that catch statistics are not available for 2010–2011 for quantitative comparison with previous harvests). This reported decrease is interesting in that caribou availability is largely determined by land access, yet land routes were not considered to be particularly anomalous during winter 2010–2011. So, while environmental conditions minimally impacted the hunters (that is caused minor injuries due to slipping, caused snowmobiles to overheat) they did affect the distribution of caribou. Travelling further distances was not feasible in many cases due to financial barriers or employment constraints. As such, socioeconomic conditions have influenced the sensitivity of the traditional food system, and are particularly pertinent for public housing residents. This is because with only 38% of public housing households reporting to have at least one part- or full-time hunter, the majority rely on others to procure their country food.

Public housing residents reported differences in the quality of country food. Many noticed that animals were skinnier, had a different taste, and had less fat than expected. This observation was noted predominantly for caribou, but also for seals, geese, ptarmigans, rabbits, belugas, and walrus. Another observation was the presence of small ‘white balls’ found most often in unhealthy caribou flesh and muscle, likely to be parasitic tapeworm cysts from the species *Taenia krabbei* (M. Campbell, personal communication, 28 September 2011). Residents also expressed concern about the health implications associated with their decreased country food consumption: 51% and 56% reported consuming less seal

and caribou, respectively, compared to previous years. One issue raised by residents was that they were not able to consume country food regularly, so when they did eat foods, such as caribou meat or seal meat, they had digestive difficulties. Symptoms were described as having hot flashes, heartburn, and stomach pains.

Another issue identified by public housing residents was that country food was too difficult to obtain, forcing them to switch to store-bought food instead. These often nutritionally inferior food choices led residents to ‘feel cold’ and ‘feel empty’ compared to when they consumed country food. Respondents were concerned, believing that they were not getting as many essential vitamins and minerals from store-bought food. Residents described how stresses to their traditional food system can greatly affect their mental health and that of other community members; consistent with work elsewhere with Inuit communities on climate change and mental well-being (Cunsolo Willox and others 2012; Harper and others 2012). As such, residents did not feel that relying more heavily upon store-bought food was an acceptable trade-off. It is noteworthy here that many described challenges of accessing country foods to be continuing, and not just experienced in 2010–2011, but nevertheless believed that that winter was more problematic than usual.

Adaptive capacity

Facilitators of adaptive capacity

Altered hunting behaviour

‘Hunters have a certain degree of resilience; it’s very hard to erode that.’ Male, part-time hunter, Inuit, 65 years old, has lived in Iqaluit 7 years.

In order to manage the anomalous ice conditions, hunters adjusted their travel routes so that they could access hunting grounds. Where the sea ice was unstable, hunters used alternative and less desirable land trails involving longer distances (that were therefore more costly), not all of which were passable in 2010–2011 due to a thin snow covering. In other instances, new trails were utilised. This was described as problematic for inexperienced hunters who do not typically deviate from traditional routes, as they may lack the skills required to safely navigate the unfamiliar landscape. The longer open water season and shorter sea ice season impacted the ways in which hunters could utilise the landscape. Some viewed this as an opportunity, as they were able to go boating for longer and harvest more marine mammals. Others viewed this as a challenge as they either had no boat or had already placed it in winter storage in anticipation of freeze-up. This indicates differential adaptive capacity, depending on the equipment to which hunters had access. Another reported coping mechanism in 2010–2011 was switching species harvested. For instance, some reported harvesting seals instead of caribou during the longer open water boating season, while others mentioned hunting land-based animals rather than marine-based animals during the dangerous sea ice season.

Due to exceptionally unpredictable weather patterns and dangerous sea ice conditions, hunters also noted using more caution and discretion. These behavioural responses are consistent with other studies documenting how hunters are responding to changing climatic conditions (Ford and others 2006b, 2006c; Gearheard and others 2006, 2010; Laidler and others 2009; Pearce and others 2010a, 2010b; Pearce, 2009), and are commonly utilised to manage the dangers of hunting.

Food-related coping mechanisms

'One week we had no food. We only had one dried noodle pack for four people. We can't live like that.' Female, public housing resident, stay-at-home mother, 30–39 years old, has lived in Iqaluit her whole life.

The most common coping mechanism, reportedly used by 63% of public housing residents in 2010–2011, was to switch to cheaper, less preferred foods. This was reportedly higher than previous years (54%) and explained as being due to the difficulty in obtaining traditional food during winter and thus causing increased reliance on store-bought food. The second most prevalent (46%) coping mechanism was reducing food intake, showing an increase from previous years where 36% of residents reported this. The third most common coping mechanism used by public housing residents involved eating elsewhere, such as at a friend's or family member's house, specifically due to a lack of food in their own home. This strategy was explicitly distinguished from merely being invited over for a meal, which is an important clarification due to the commonality of shared meals and communal feasts that are a significant component of Inuit culture. While 38% of residents ate elsewhere this is similar to that reported in previous years (36%), and is indicative of a consistent suite of coping mechanisms used by Inuit during times of food stress. Some residents described going to their family members' house uninvited if they did not have any food to eat, while others mentioned their child or grandchild making an effort to eat at a friend's house. The least common coping mechanism was selling belongings in order to obtain extra money to pay for food and/or hunting equipment. 17% of residents reported selling belongings during winter 2010–2011, a 3% decrease from previous years (20%). Strategies included hosting garage sales, as well as selling handicrafts or hunting equipment. While selling hunting equipment may provide short-term financial benefits, it hinders access to country food in the long run. It was found that households that used many food-related coping mechanisms in previous years were more likely to use many food-related coping mechanisms during winter 2010–2011 (Fisher's Exact Test, $p < 0.01$). It appears as though households that have had difficulty in the past continued to do so during times of stress, suggesting chronic food security challenges.

Sharing networks

'That's the way I was raised. That's the way we are. When we get country food, we hand it out.' Male, pub-

lic housing resident, full-time worker, 20–29 years old, from Baker Lake, has lived in Iqaluit between 5 and 10 years.

The majority of public housing residents obtained their country food through sharing networks, most commonly from family and friends (81% and 78%, respectively). Residents often expressed a strong preference for sharing, rather than purchasing, country food. Some households reported being both recipients and providers of country food. The amount of sharing and documented in the survey, either stayed the same (seal and Arctic char) or decreased (caribou). Residents believed that since there was so little country food available, people did not have surplus to share and therefore kept what they had for themselves. Residents also suggested that high costs of hunting during winter 2010–2011 (that is having to purchase more gas and equipment in order to travel further distances) caused hunters to sell their country food in order to offset their expenditures, an increasingly evident trend in the community.

Survey results indicate that reciprocity is an important factor in maintaining strong sharing networks. A significant relationship was found with regards to the frequency with which respondents and their friends/family share with one another. Residents who 'always' shared their country food with friends and/or family were more likely to have friends and/or family who 'always' shared with them (Fisher's Exact Test, $p < 0.01$). This has implications for households which do not have enough country food for themselves, let alone enough to contribute to others, as they will be less likely to receive.

While the sharing of country food traditionally occurs within and among households, the advent of snowmobiles and airplanes has caused increasing commonality of sharing between communities, even provinces and territories. Fig. 2 maps inter-community sharing networks reported by public housing residents, with people both sending country food to, and receiving country food from, other Nunavut communities. Public housing residents receive country food from more communities than to which they send it, perhaps indicating greater need than abundance. While having sharing networks *within* Iqaluit is beneficial, having sharing networks *beyond* Iqaluit is also useful since environmental stresses may hinder the procurement of country food in some areas (Iqaluit) but not others (alternative communities). Ford and Beaumier (2011) note that such diversification of the 'foodshed' to be an important factor enhancing adaptive capacity in contemporary Inuit settlements, which are no longer semi-nomadic and cannot spatially respond to changes in wildlife abundance and distributions.

Community food programmes

'There's a soup kitchen in town that's keeping me alive.' Male, public housing resident, unemployed, 30–39, has lived in Iqaluit his whole life.

Three community-based food programmes are available in Iqaluit: the Niqinik Nuatsivik Food Bank

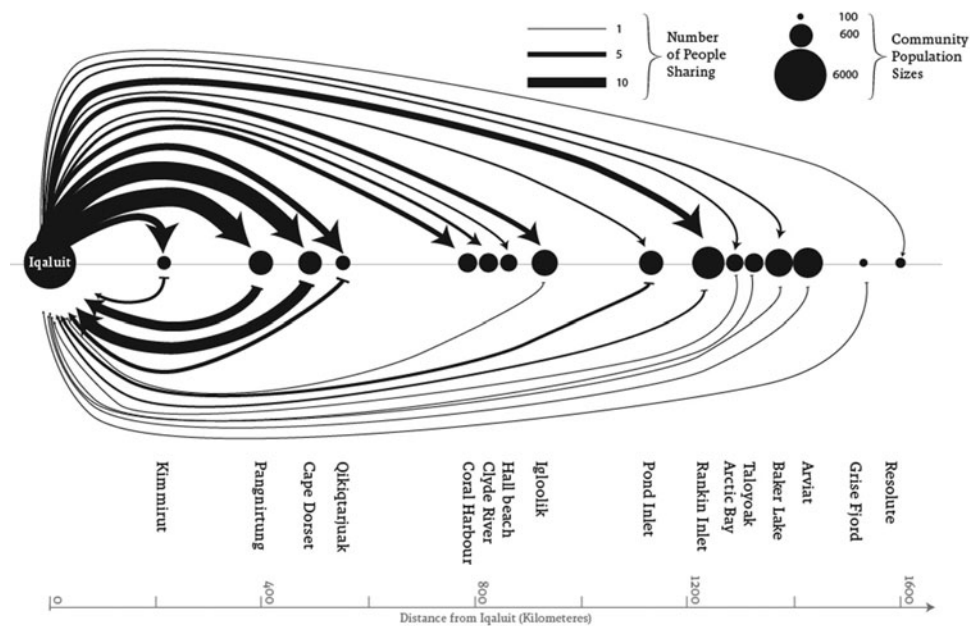


Fig. 2. Map of sharing networks to and from Iqaluit as reported by public housing residents. Arrow widths are proportional to the number of public housing residents sending and receiving country food. Radii are proportional to the community population sizes. Distance to and from Iqaluit is shown along the bottom.

(hereafter Food Bank) that offers bimonthly distributions of non-perishable food items, the Qayuqtuvik Soup Kitchen (hereafter Soup Kitchen) that serves weekday lunches, and the Tukisigiavik Friendship Centre (hereafter Tukisigiavik) that offers wellness programming and provides access to country food. A 2010 study found that demand for these services has dramatically increased in recent years (Lardeau and others 2011). Our survey revealed that households that used many food programmes in previous years were more likely to use many food programmes during 2010–2011 (Fisher's Exact Test, $p < 0.01$), suggesting repeat usership. Almost half (46%) of respondents used the Food Bank during winter 2010–2011, which shows a reported 11% increase from the previous year. 29% of respondents visited the Soup Kitchen during winter 2010–2011, representing a 3% reported increase compared to the previous year. Almost one quarter (23%) of respondents reported visiting Tukisigiavik this year, which shows a 2% reported increase compared to previous years. The role of such food programmes on food security has been widely debated in the north, with concerns raised over dependence (Ford 2012a; Lardeau and others 2011). However, this study shows that these mechanisms provide an important social safety net during difficult times for obtaining food, even though their usership may have only minimally increased.

Commercial sources of country food

'The country food market is the last option if country food is nowhere else.' Female, public housing resident, unemployed, 20–29, has lived in Iqaluit her whole life.

In Iqaluit, three major outlets exist for purchasing country food: Iqaluit Enterprises, the Country Food Market, and the 'Iqaluit Sell/Swap' Facebook group. Iqaluit Enterprises is a retail outlet that opened in the late 1980s and exclusively sells country food. Almost half (43%) of respondents reported using Iqaluit Enterprises as a source of country food. The Country Food Market aims to provide local hunters with the opportunity to sell their surplus harvest as a means of recouping hunting costs. The first market was held in November 2010, with over 200 attendees buying items such as caribou, seal, fish, clams, whale, berries, and bannock. One quarter of respondents reported utilizing the Country Food Market, with only three markets having been held by the time of the survey. Through social media, residents also noted using the 'Iqaluit Sell/Swap' Facebook group to obtain a variety of country food. Popular items on the website appear to be caribou and Arctic char, which can range from \$150 to \$300 per caribou and \$10 to \$50 per fish, plus the cost of freight when necessary. Some residents described refusing to pay for country food because it goes against their traditional values of sharing country food. However, many resident, especially single mothers, those without strong sharing networks, and those living in households without hunters, are thankful that commercial venues provide increased access to country food, even if they must pay for it. With limited country food supplies and reduced sharing during winter 2010–2011, commercial sources of country food were heavily utilised. These unconventional sources of country food are beneficial in that starvation is no longer an issue if hunting fails, as would occur before store-bought foods

were introduced. However, Iqaluit Enterprises and the Country Food Market could not keep up with increased demand and often sold out before all customers could make their purchases.

Adaptive capacity constraints

Limited access to financial resource

'Income support comes only once a month. It's never enough.' Male, public housing resident, stay-at-home father, 20–29 years old, from Igloolik, has lived in Iqaluit less than 5 years.

Public housing residents that relied on income support commonly expressed that the money they received each month was insufficient in terms of meeting their expense requirements. Even households that earned their income through employment stated that their earnings were often insufficient. Nearly all public housing residents expressed concern about the unaffordable prices of food, clothing, and other amenities. In addition, limited budgeting skills have posed a challenge in terms of being able to cope with food-related stresses. When low incomes are combined with the high costs of living in the north and a lack of budgeting skills, adaptive capacity is further constrained.

Households the primary income source of which was employment were less likely to use multiple food-related coping mechanisms ($\chi^2 = 9.14$, $df = 2$, $p = 0.01$) and multiple food programmes ($\chi^2 = 12.55$, $df = 2$, $p < 0.01$). If income support was the primary household income source, respondents were more likely to use food programmes ($\chi^2 = 8.35$, $df = 2$, $p = 0.02$). In addition, sole reliance on income support predicts the use of both the Food Bank ($\chi^2 = 12.08$, $df = 1$, $p < 0.01$) and the Soup Kitchen ($\chi^2 = 5.84$, $df = 1$, $p = 0.02$), but not the use of Tukisigiavik. This may indicate that this culturally valued drop-in centre is used by both those who are financially marginalised as well as financially secure. Finally, households with income support as the primary household income source were less likely to have a secure country food status (that is 'enough or more than enough country food to meet household needs') during both the fall ($p = 0.008$) and winter ($p = 0.020$), suggesting increased vulnerability compared to those who do not rely on this form of government assistance. These analyses show that those with limited financial resources encounter more food-related challenges than those who are financially stable, and are therefore particularly at-risk during times of environmental stress on the traditional food system.

Weakening traditional knowledge base

'It's a sacrifice I had to make. I had to get my education. It's not a negative impact, but I'd rather be out there [hunting/harvesting].' Male, part-time hunter, Inuit, 30 years old, has lived in Iqaluit his whole life.

A weakening traditional knowledge base was identified a continuing and underlying barrier to coping with changing climatic conditions in general and during 2010–2011 in particular, as it was noted that inexperienced hunters did not have the skills required to deal with extreme conditions experienced during this anomalous winter. Novice hunters were increasingly vulnerable to the exceptionally dangerous sea ice conditions and unfamiliar land routes required to hunt and harvest. The deteriorating knowledge base partially results from a shift toward engagement in the modern economy, similar to observations elsewhere in Nunavut (Ford and others 2006b, 2006c; Gearheard and others 2006, 2010; Laidler and others 2009; Pearce and others 2010a, 2010b; Pearce 2009). Amongst the local hunters interviewed, concerns were raised regarding the continuation of their traditional subsistence-based lifestyles as many were involved with school or work. This phenomenon is not unique but had a particularly severe impact during this exceptionally challenging year. If years like 2010–2011 become increasingly common, young hunters will face increasing difficulty getting the hands-on experience necessary for safely traversing sea ice and terrestrial environments.

Strained sharing networks

'When they catch a caribou, they hide it now. Even relatives. People are greedy now because there is less. Some people keep their freezers in their bedroom.' Female, public housing resident, stay-at-home mother, 30–39 years old, has lived in Iqaluit her whole life.

48% of the hunters reported an increase in the numbers of people they supported with country food in 2010–2011. Reasons included greater demand for country food, growth of social networks, reduction of hunters in the community, and becoming a more prolific hunter. Of the 12% who reported supporting fewer people with country food, the main reason for this decline was not due to reduced demand but instead due to reduced amount of country food procured, thus exacerbating the strain. Sharing networks are particularly important for public housing residents who receive most of their country food this way, and challenges evident in 2010–2011 are indicative of potentially sustained problems if similar access and availability constraints affect the food system in the future.

Discussion and conclusion

The overarching aim of this study was to identify and characterise the vulnerability of Iqaluit's traditional food system to extreme climatic conditions during winter 2010–2011. In its most basic sense, the study sought to assess whether or not these anomalous conditions affected the ability of local hunters to procure country food and whether or not this affected food security at the community level, thus exploring severe environmental conditions as a potential determinant of food insecurity.

The study shows that Iqaluit's traditional food system is sensitive to extreme climatic conditions. However, while the biophysical environment is an important determinant of food security, the implications of the 2010–2011 extremes depended as much, if not more, on socio-economic conditions.

This temporal analogue-based case study demonstrates that vulnerability to a specific climate-related event, in this case a shortened and dangerous sea ice season, can be exacerbated (or moderated) by broader socioeconomic conditions. Vulnerable groups often emerge due to the synergistic interaction between climatic and non-climatic stresses that combine to overwhelm adaptability. For instance, those public housing residents who rely on income support (rather than waged employment), have weak sharing networks (rather than strong sharing networks), and depend on country food for a large portion of their diet (rather than store-bought food) appear to be more vulnerable to food insecurity. Poverty, in particular, and the social issues that accompany it including unemployment, mental health issues, addiction, and homelessness, were widely reported to be factors constraining the ability to manage challenges to food access and availability. The most commonly used measure of poverty is participation in the income support programme, described as being a 'last resort to assist individuals and families meet the basic food and housing needs' (Nunavut Roundtable for Poverty Reduction 2012). Assistance may be granted to any individual who has been determined, on the basis of need, to be unable to provide adequately for themselves and any dependants. Using the income support programme as a proxy for poverty, our study found that 35% of public housing residents are impoverished. Although Iqaluit is increasingly prosperous as the capital of one of Canada's fastest expanding regions, there is pronounced inequality in income, employment opportunities, and health outcomes (Statistics Canada 2011; Ford and others 2012a; Searles 2010). This must be addressed in order to improve food security in Nunavut (Wakegijig and others 2013).

The future of the traditional food system in Iqaluit remains unclear. Currently, Iqaluit's traditional food system is unique compared to that of smaller Arctic communities with a larger proportion of non-Inuit living in the community, relatively fewer people reliant on country food, and a large in-migration. Additionally, the trend of increasing preference toward store-bought food may cause the reliance on country food to further decrease. This shift away from traditional foods will have varying effects on the vulnerability of the traditional food system. In one sense, decreased demand would allow those who *do* engage in the traditional food system to obtain more country food. On the other hand, decreased participation in the traditional food system could contribute to its deterioration. Iqaluit is also more conducive to sending country food to and receiving country food from other communities due to its well-developed transportation network as a hub for Nunavut and links to the south. As

such, it is becoming rapidly integrated into a territorial-wide network of both inter-community sharing (via cargo shipping) and inter-community purchasing (via social media). Iqaluit's rapidly increasing population will also place localised pressure on wildlife. Therefore, it is likely that country food obtained from non-local sources will become increasingly incorporated into Iqaluit's traditional food system. If the traditional food system becomes increasingly interconnected, its vulnerability will become more complex as well, moderated by a decrease in pressures on local wildlife and hunters, but it may increase due to reliance on outsourced supplies.

When examining the winter 2010–2011, traditional food system vulnerability was not as pronounced as anticipated when beginning the study. However, it should be noted that the issue of food insecurity amongst public housing residents was pervasive. While exposure to stress was extreme, adaptive capacity was displayed by hunters for dealing with environmental stresses and residents for dealing with food-related stresses. Many of the coping mechanisms used were not unique to winter 2010–2011, although the augmented stress to the traditional food system probably contributed to the increased use of them. It is hoped that the experience of this extreme climatic event may provide some adaptive knowledge for the future. Indeed, responses that increased resilience (that is using more discretion when hunting, improving financial awareness) should be reinforced and those responses that were maladaptive (that is reducing food intake, selling belongings) should be reduced. The development of such 'lessons learned' in the wake of stress has been identified as an important component of adaptive capacity in multiple contexts (Berkes and Jolly 2002; Berrang-Ford and others 2011; Davidson-Hunt and Berkes 2003; Fazey and others 2007; Penning-Rowsell and others 2006; Sayles and Mulrennan, 2010). We argue that broader socioeconomic conditions were more pressing than environmental conditions in terms of food security determinants amongst those living in public housing. The study shows that when challenging socioeconomic conditions, such as those associated with public housing, are coupled with significant environmental stress, such as experienced during winter 2010–2011, the vulnerability of the traditional food system is exacerbated.

As a continuation of climatic change is predicted for the future, associated environmental stresses are expected to have an increasingly prevalent impact on the traditional food system. Winter 2010–2011 provided valuable insight as to how future climatic conditions might influence food security in Iqaluit, with conditions similar to those projected mid-century (Dumas and others 2006). While the adaptive capacity of Inuit should not be underestimated, the underlying socioeconomic determinants of food security must be addressed as the rapidly changing environment exacerbates this already stressed traditional food system. This paper provides a snapshot of the vulnerability and adaptability of Iqaluit's traditional food system to climatic extremes during winter 2010–2011.

The work is not intended to be a representative baseline of food security in general, as this year was climatically anomalous. Instead, it provides a lens for exploring food system vulnerability and its determinants in the context of an extreme year, recognising that these environmental influences may become increasingly common with future climate change.

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