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ORIGINAL ARTICLE

Climate change adaptation planning in remote, resource-dependent communities: an Arctic example

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Abstract This paper develops a methodology for climate change adaptation planning in remote, resource-dependent communities. The methods are structured using a vulnerability framework, and community members, local stakeholders and researchers are engaged in an iterative planning process to identify, describe, prioritize and pilot adaptation actions. The methods include: (1) analysis of secondary sources of information, (2) community collaboration and partnership building, (3) adaptation planning workshops, (4) adaptation plan development, (5) key informant and community review and (6) pilot adaptation actions. Vulnerability to climate change is assessed in the context of other non-climatic factors—social, political, economic and environmental, already being experienced in communities and which influence how climate change is experienced and responded to. Key exposure-sensitivities and related adaptation options are identified in five sectors of a community: business and economy, culture and learning, health and well-being, subsistence harvesting, and transportation and infrastructure. This organization allows for focused discussions and the involvement of relevant stakeholders and experts from each sector. The methodology is applied in Paulatuk, an Inuit community located in the Inuvialuit Settlement Region (ISR), Northwest Territories (NWT), Canada, and key findings are highlighted. The methods developed have important lessons for adaptation planning in remote, resource-dependent communities generally and contributes to a small but growing scholarship on methodology in the human dimensions of climate change.

Keywords Climate change · Inuvialuit · Adaptation · Adaptation planning · Arctic · Remote communities · Participatory research · Climate policy · Inuit

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Introduction

Climate change is already being experienced in the Arctic with implications for ecosystems and the human communities who depend on them. Changes in temperature and precipitation, sea ice dynamics, wind patterns, seasonality and permafrost, and coastal erosion have been documented across the Arctic and are expected to continue in the future (IPCC 2007). Inuit populations—most of whom live in small, isolated, coastal communities and who depend to some degree on subsistence hunting, fishing and trapping for their livelihoods—are particularly sensitive to these changes. Inuit hunters are experiencing restricted access to travel routes and hunting grounds on the land and ice, increased travel risks and changes in the health and availability of some species of wildlife important for subsistence, with implications for food security, health and cultural well-being (Nuttall et al. 2005; Furgal and Prowse 2008; Pearce et al. 2011; Bolton et al. 2011). Furthermore, landscape hazards associated with rising sea level, coastal erosion and flooding and

permafrost thaw are threatening the viability of buildings, damaging heritage sites and affecting the integrity of municipal infrastructure (e.g. buildings, roads, sewage lagoons, etc.) (Couture and Pollard 2007; Alessa et al. 2008; Larsen et al. 2008; Zhou et al. 2009). Benefits have also been noted as a result of changing conditions, including a longer boating and shipping season, fewer days with extreme cold and increased interest in resource development (e.g. Wenzel 2009; Ford et al. 2010a). The net impact, however, is widely believed to be negative (Bolton et al. 2011).

Despite efforts to reduce greenhouse gas emissions, the Earth is committed to some degree of climate change and adaptation has emerged as an essential component of climate policy (Pielke et al. 2007; Ford and Berrang-Ford 2011). This is particularly the case in the Arctic where the climate change signal is pronounced and accelerating (Newton et al. 2005; Budreau and McBean 2007; Ford 2009a, b; NRTEE 2009). In the climate change field, 'adaptation' refers to adjustments in human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (Smit et al. 2000; IPCC 2001; Preston et al. 2011). Federal and Territorial governments in Canada have acknowledged the importance of adaptation and are providing financial resources to facilitate adaptation planning in Northern communities (NWT ENR 2008; Ford et al. 2011a; AANDC 2012). Existing and ongoing human vulnerability to climate change research in the Arctic has generated substantial knowledge on the nature of current climate-related risks and related adaptations (e.g. Berkes and Jolly 2002; Ford et al. 2006a, b, 2009, 2010a; Nickels et al. 2006; Huntington et al. 2007; Pearce et al. 2010a, b; Ford and Beaumier 2011; Prno et al. 2011). This knowledge forms the basis for the development and implementation of practical adaptation plans. The process of anticipatory adaptation planning to prepare for climate change impacts, however, remains a fairly new and untested exercise with few case studies documenting or examining the process—an observation noted in the general climate change scholarship (Berrang-Ford et al. 2011; Ford et al. 2011b; Preston et al. 2011; Tryhorn and DeGaetano 2011). This is a major constraint as researchers, governments, non-governmental organizations (NGOs), communities, consultants and others seek to develop climate change adaptation plans at the community scale.

This paper develops a methodology for climate change adaptation planning in remote, resource-dependent communities. Elements of the methodology are illustrated in a case study of Paulatuk, an Inuit community located in the Inuvialuit Settlement Region (ISR), Northwest Territories (NWT), Canada, to document what climate-related risks are relevant and important to community members and to identify adaptation options and priorities. A major contribution of the paper is methodological; as such, the paper is an important contribution towards addressing the neglect of methodology in vulnerability and adaptation literature (Schröter et al. 2005; Pearce et al. 2009; Preston et al. 2011; Ford and Pearce, 2012). The paper begins by reviewing current knowledge on adaptation planning generally, and in Paulatuk specifically. Next, the adaptation planning methodology is outlined via a case study of Paulatuk and key findings are described.

Adaptation planning for climate change

Adaptation planning for climate change involves identifying actions to reduce risks and capitalize on the opportunities associated with climate change (Füssel 2007; Preston et al. 2011). Climate-related vulnerabilities and adaptation initiatives are considered in the context of other non-climate-related stresses (e.g. social, political, economic and environmental) that influence how climate change is experienced and the capacity to adapt (Ford and Smit 2004; Smit and Wandel 2006). As demonstrated in the climate change adaptation scholarship, supporting efforts that increase financial, health, educational and cultural capacity in a community will often inadvertently enhance the adaptive capacity of the community to deal with current and projected future climate change risks (Ford et al. 2010a; Pearce et al. 2010a).

In recent years, adaptation planning has become a priority issue for many municipal governments and decision-makers, and a variety of resources have been developed to guide the process. Most of these 'guides' or 'toolkits' have been developed by academics, research/consulting groups, or NGOs, often in partnership with, or funded by, government. Some are region specific, such as *SaskAdapt* for the Canadian province of Saskatchewan (PARC 2010), *Plan2Adapt* for the province of British Columbia (PCIC 2010) and *Adapting to Climate Change: A Risk-based Guide for Ontario Municipalities* (Bruce et al. 2006); some are intended for general or nation-wide application, including those by the UK Climate Impacts Programme (UKCIP 2008), ICLEI Oceania (2008), ICLEI Canada (2008) and the Climate Impacts Group (CIG et al. 2007); and others are targeted specifically at vulnerable populations and regions. The Centre for Indigenous Environmental Research (CIER), for instance, has published a series of guidebooks for First Nations in Canada (CIER 2006) and a website and guidebook for Arctic and Northern communities on managing risks associated with climate change (Black et al. 2010). There are a limited number of peer-reviewed articles, however, that develop or review these guides or tool kits for community adaptation planning (exceptions include: Allen 2006; Shaw 2006; Füssel 2007; Mukheibir and Ziervogel 2007; Suarez et al. 2008; Preston et al. 2011).

Among the guides and toolkits that have been developed for climate change adaptation planning, some general features can be noted, including: committing resources (in the form of time, people and money) to adaptation, understanding impacts and vulnerability, determining adaptation options with stakeholders, implementing adaptations, and monitoring and evaluating effectiveness. Other recurring themes include: the need to act in the face of uncertainty, ongoing communication and public outreach, making use of existing resources and assets, mainstreaming adaptation policy and the need to integrate new information and learning as it becomes available (Schröter et al. 2005; Füssel 2007; Ford et al. 2010a; Tryhorn and DeGaetano 2011). Most adaptation frameworks assume a high degree of local capacity in the form of planning experience, human and financial resources that can be dedicated to planning, access to 'experts', and ability to understand and interpret climate data and/or scenarios. These assumptions, however, do not always reflect the contexts within which adaptation planning occurs. Where developing nation localities are discussed for instance, an outside facilitator or coordinator is often assumed, and issues with dependency and disempowerment have been noted (Allen 2006; Shaw 2006).

Despite these and other developments, the field of adaptation planning for climate change remains in its infancy (Ford and Pearce, 2012). For example, there are few case studies and descriptions of adaptation planning outcomes in the literature (Berrang-Ford et al. 2011; Ford et al. 2011a; Preston et al. 2011) or publically available examples of municipal climate change adaptation plans (for exceptions see City of Keene, NH 2009; City of Homer, AK 2007; CIP 2010; and Ecology North and Community of Tsiigehtchic 2010). Even where planning exercises are documented, few describe the methodology employed or outcomes of the planning process, so while these are valuable resources for what an adaptation plan might look like, they contribute less to the development and evaluation of adaptation planning methods. Just as case studies may be used in vulnerability research to better understand root causes (Ford et al. 2010b), documenting and reflecting on adaptation planning in a given location can elucidate what conditions facilitate successful planning in particular contexts.

Arctic case study

Paulatuk

Paulatuk is an Inuit community of approximately 310 people (86% Inuit) located on the coast of the Beaufort Sea in the Inuvialuit Settlement Region (ISR) in the Northwest Territories (NWT), Canada (69′21′N, 124′04′W) (NWT Bureau of Statistics 2010) (Fig. 1). The community is located approximately 400 km east of the regional centre of

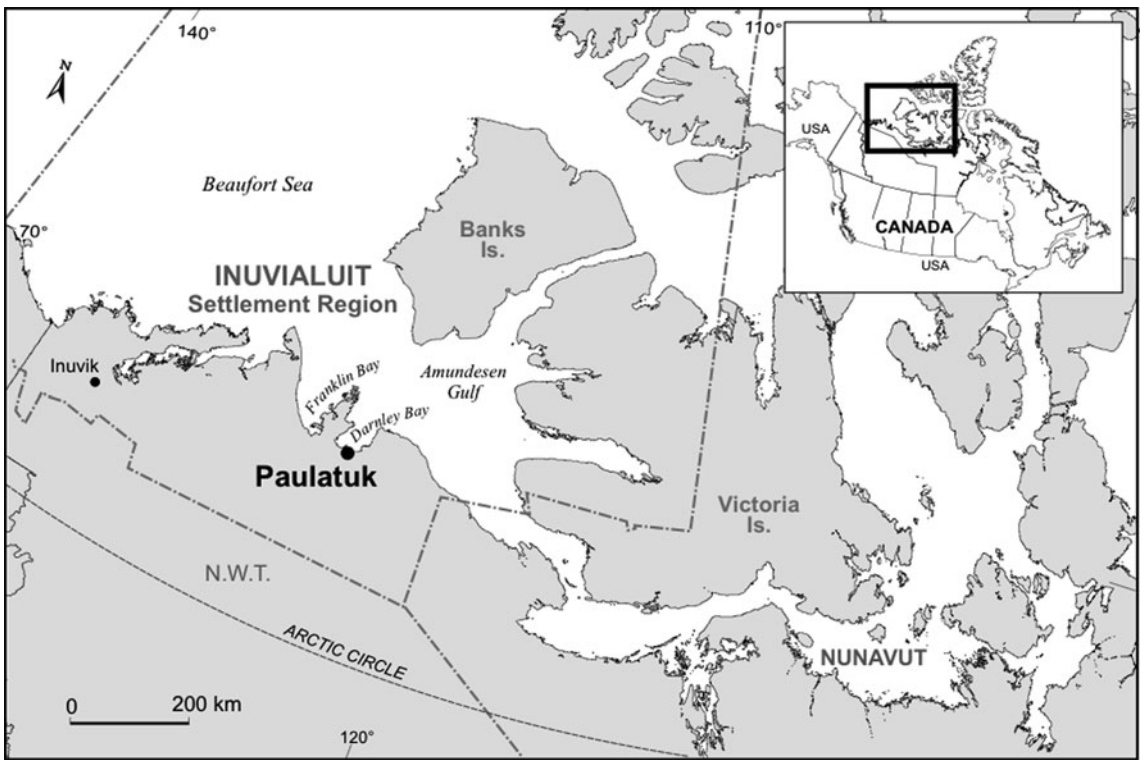

Fig. 1 Location of Paulatuk in the Inuvialuit Settlement Region (ISR) in the NWT, Canada

Inuvik and 885 km north-west of the Territorial capital of Yellowknife. Paulatuk is accessed by flights from Inuvik, and an annual sealift delivers bulk supplies including food, building materials and fuel once each summer.

For Inuit from the Paulatuk region, the transition from a semi-nomadic, subsistence hunting lifestyle to settlement living began in the 1950s when the construction of a Distant Early Warning (DEW) line brought wage employment to the area (Parks Canada 2009). Following the closure of the Hudson's Bay Company store at Letty Harbour in 1937, many people moved permanently to the site of present day Paulatuk, chosen for its proximity to natural resources, including fish, wildlife and coal (Parks Canada 2009). The Hamlet was incorporated in 1987, and the settlement has expanded considerably since.

Paulatuk has a similar demographic profile to other small communities in the Canadian Arctic, with 48% of the population under the age of 24 years (NWT Bureau of Statistics 2010). The economy in Paulatuk is mixed, with 69% of the Inuit population participating in subsistence activities in 2010, and limited wage-based employment in government and administration, guiding and outfitting, private business, and arts and crafts (NWT Bureau of Statistics 2010). The cost of living in Paulatuk compared with communities in Southern Canada is very high. Results in Paulatuk from the Revised Northern Food Basket price survey (based on recommended dietary requirements for a family of four for 1 week) were among the highest in all of the 'isolated northern communities' surveyed, at $492CN/week (the cost of the perishable portion of the basket increased by 13 % between 2006 and 2008) (INAC 2008).

Climate change observations and projections in Paulatuk

Nickels et al. (2006) document local observations of climate change in communities in the Canadian Arctic including Paulatuk, and these observations are summarized in Table 1. Instrumental data on temperature, precipitation and sea ice trends generally corroborate these observations (Furgal and Prowse 2008).

Climate change is expected to continue into the future, and in many instances, changes are expected to accelerate (Furgal and Prowse 2008; CCCSN 2009). Potential future climatic changes are summarized in Tables 2, 3. Knowledge of current and expected future climate change in the Paulatuk region formed the basis for discussions in the adaptation planning workshops described in section 'Methodology'.

Methodology

The methods described here and applied in the Paulatuk case study engage community members, local stakeholders

Table 1 Summary of concerns shared by ISR community (modified from community of Aklavik et al. 2005)

Changes to weather	Higher temperatures, winter lows less extreme
	Less snow
	More wind in summer
	Weather is less predictable in general
	More freezing rain
Changes to landscape	More erosion of banks and shores
	More sedimentary deposits in ocean and rivers
	Rougher and less safe trails → decreased accessibility of animals, fishing areas and camps
	Sea ice: diminished thickness; earlier spring break-up; later fall freeze-up
	Higher water levels in the ocean; higher tides and stronger currents
Changes to vegetation	Number/size of plants is generally increasing
	Range of willows is expanding
	Willow size is increasing
	Fewer berry-producing plants
	Berry-producing plants are yielding fewer berries
Changes to fauna	**Caribou migration routes are changing**
	Many new and unusual species
	More deformed char
Changes to insects	Many new and unusual species
	Shorter mosquito season
Increased stress and awareness	Concern for overall pollution levels/contaminants and risks to human health
	Desire for organization on Inuit climate change issues

Regular text = concern expressed in all ISR communities; italic text = concern specific to Paulatuk; bold text = contested during this project

Table 2 Projected climatic changes and impacts in Paulatuk, NWT

Projected change	Potential impacts on Paulatuk
Increase in annual mean air temperature	Permafrost thaw → damage to roads, buildings, dump and sewage lagoon (Couture et al. 2002; Borsy 2006; Duerden and Beasley 2006; Andrachuk 2008); potential for leaching of pollutants from industrial waste sites
	Reduced sea and lake extent; less stable ice → shorter season for ice travel, greater dependence on ATVs or boats versus snow machines (Furgal and Prowse 2008); increased risk associated with ice travel (Gearheard et al. 2006; Huntington et al. 2007; Ford et al. 2009; Laidler et al. 2009; Pearce et al. 2010a)
	Changes in wildlife range and distribution → decreased access to some traditionally harvested species, exposure to new diseases (Furgal and Prowse 2008); increased vulnerability of food system (Ford 2009b; Beaumier and Ford 2010; Goldhar et al. 2010)
Increase in precipitation (especially in winter)	Increased snow accumulation → larger and more hazardous snowdrifts, increased pressure on snow removal systems
	Increased run-off → contributes to erosion and water pooling
Increased storm activity	Travel around, and to and from community restricted → subsistence harvesting negatively impacted affecting emotional well-being and food security (Furgal and Prowse 2008; Ford 2009b; Beaumier and Ford 2010; Pearce et al. 2010a)
	Increased wave activity and run-off accelerate shoreline erosion
More unpredictable weather conditions	Increased sense of risk associated with traditional subsistence activities → decreased participation (Pearce et al. 2010a)
	Seasonal variation affects reliability of harvest (Ford 2009b; Beaumier and Ford 2010)

Table 3 Mean change in air temperature (°C) in Paulatuk region from (1961–1990) to (2041–2070) (CCCSN 2009)

	Low emissions scenario	Medium emissions scenario	High emissions scenario
Annual	3.1	3.6	4.1
Winter	4.6	5.2	5.9
Spring	2.6	3.1	3.5
Summer	1.5	1.8	2.0
Fall	3.8	4.2	4.8

and researchers in an iterative planning process. Community members are involved throughout, from project design to the identification, prioritization and piloting of adaptation actions. The role of researchers (or outside coordinators—e.g. consultants) is to work with local partners to facilitate the planning process and to provide additional information and technical support when needed. It is an iterative process in that preliminary planning documents undergo multiple rounds of community review, and feedback is routinely integrated into the plan. Final adaptation plans are considered 'living documents' and require continual assessment and updating. The methods outlined here are not prescriptive, but rather capture key elements that help facilitate community-driven adaptation planning for climate change in remote, resource-dependent communities. As illustrated in Fig. 2, these methods are addressed under six groupings: (1) analysis of secondary sources of information, (2) community collaboration and partnership building, (3) adaptation planning workshops, (4) adaptation plan development, (5) key informant and community review and (6) pilot adaptation actions and review of effectiveness and potential for scaling-up.

Analysis of secondary sources of information

The first stage in the planning process is the analysis of secondary sources of information (e.g. journal articles, books, reports, etc.) related to climate change risks and adaptations in the study community. The documentation of existing knowledge provides a starting point for adaptation planning workshops, during which time community members are able to review, update and verify the information. Synthesizing previously documented information helps to prevent research fatigue in the community, a problem readily identified in Arctic climate change adaptation scholarship (Bolton et al. 2011; Ford et al. 2012).

A useful way to organize existing information and structure adaptation planning workshops is according to community sectors. Pearce et al. (2011) identify five sectors in Arctic communities as particularly vulnerable to climate change: business and economy, culture and learning, health and well-being, subsistence harvesting, and transportation and infrastructure. The selection of community sectors will likely differ depending on the nature of the study community.

Community consultation and partnership building

The involvement of community members in the planning process follows the principles of community engagement described by ITK and NRI (2007), Wolfe et al. (2007) and

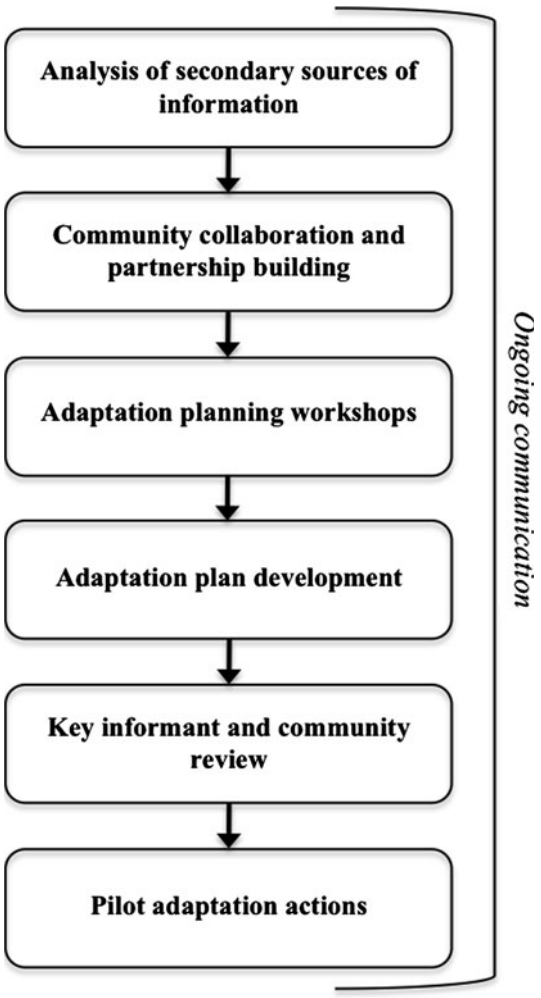

Fig. 2 Steps for climate change adaptation planning in remote, resource-dependent communities

Pearce et al. (2009). These principles include: (1) early and ongoing communication, (2) community involvement in research design and development, (3) opportunities for local employment and (4) dissemination of results.

In Paulatuk, a pre-research consultation visit was made by researchers to the community to discuss the scope and objectives of the project, formulate a work plan, identify local partners and research assistants and conduct preliminary outreach activities (e.g. radio address, posters and presentations at community meetings). Local partnerships were formed with the Senior Administrative Officer, President of the Hunters and Trappers Committee (HTC), members of the Hamlet Council, the Mayor and the Self-Government Officer. These partnerships were maintained throughout the planning process and were essential for building community support for the project. Two local research assistants (RAs) were also identified during the consultation visit and played invaluable roles in coordinating workshops, reviewing project materials, conducting one-on-one outreach (e.g. with elders) and liaising with community groups.

Adaptation planning workshops

Workshops can be effective forums for community members and stakeholders to document what climate change risks are relevant and what adaptations are realistic and desirable. Organizing workshops by community sectors helps enable focused discussions with relevant stakeholders and experts. For example, in Paulatuk community members who worked in municipal services (e.g. power, sewage and water) contributed to the workshop on 'transportation and infrastructure', whereas community members who worked in health services were better suited to participate in the workshop on 'health and wellbeing.'

In Paulatuk, workshops followed the principles of Participatory Rural Appraisal (Chambers 1997), and specifically methods outlined by Nickels et al. (2002) in the context of climate change research with Inuit communities. Prior to each workshop, the workshop facilitators (researcher and local RAs) wrote down previously documented climate change risks related to the workshop sector on blue note cards. Workshops started with participants reviewing, updating and verifying the information on the 'climate change risk cards', which were posted on the wall. The bulk of the workshop was then spent brainstorming, discussing and documenting adaptation actions to address each climate change risk. Possible adaptation actions were written on pink cards and posted around the risk(s) they addressed. Taking visual cues from the cards, the group applied itself to discussing each risk (blue card) until it had at least one potential adaptation action (pink card) (Fig. 3).

Adaptation plan development

Climate change risks that are affecting the community and possible adaptation actions are confirmed during planning workshops. This information can be summarized by sector in a table format and include five categories: (1) adaptation action; (2) climate change issue; (3) desired outcome; (4) resources and leadership; and (5) timeframe for implementation. Tables are a concise way to present workshop information and are easy to review, update and use. In addition, information on government funding and programme opportunities related to specific adaptation actions can be synthesized and included with the relevant tables. Examples of adaptation planning tables from workshops conducted in Paulatuk are reproduced in the Supplementary Data section.

Key informant and community reviews

Adaptation planning documents require continuous review and updates. In the initial stages of plan development, it is desirable to review proposed adaptations with key informants

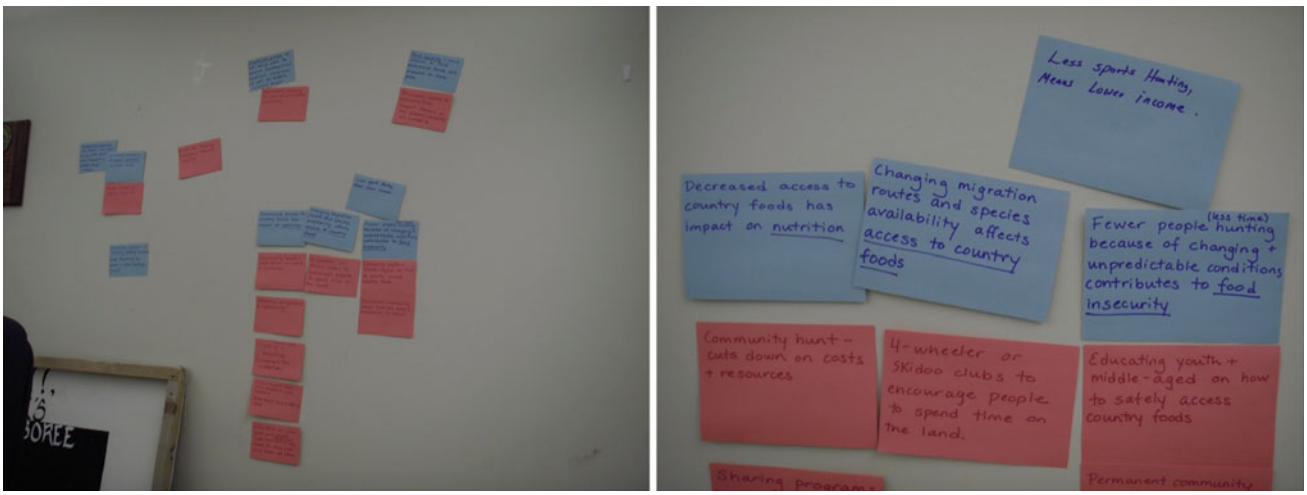

Fig. 3 Note card method used in adaptation planning workshops

and decision-makers from each sector to identify: (1) the feasibility of proposed adaptations (considering engineering, financial, social and political limitations); (2) who and what resources are pertinent to advancing an adaptation action; and (3) timeframes for implementation. This information is integrated into the draft plan, which undergoes further review by community members. Ongoing communication and involvement of local stakeholders, community members and other decision-makers is necessary to document adaptation actions that are relevant and desirable, and critical for implementation as these are the parties who will be undertaking adaptation. In Paulatuk, adaptation planning tables were reviewed with key informants including, but not limited to, members of the Hamlet Council, Mayor, Senior Administrative Officer, members of the Hunters and Trappers Committee, Environment and Natural Resources Officer, physical geographer with expertise in northern geomorphology and climate change, and Community Wellness Worker.

Pilot adaptation actions

Piloting adaptation actions in the community is an opportunity to operationalize the adaptation plan and demonstrate the utility of the planning process. Community partners, in communication with workshop participants and other local stakeholders, identify an adaptation action that is high priority and is feasible within the present funding and institutional capabilities. It is desirable to dedicate resources (financial and human) from the adaptation planning initiative to support piloting adaptation actions. This was the case in Paulatuk, and a pilot adaptation initiative was undertaken by the community to address concerns related to nutrition and food security. The Women's Community Kitchen project was initiated to provide opportunities for women to learn new techniques for preparing nutritious meals using both country and store-bought foods. A goal of the project was to educate women about the nutritional value of store-bought foods and how to prepare nutritious meals using a variety of food items in response to decreased access to traditional foods with changing ice and snow regimes. An evaluation of this pilot adaptation action is forthcoming.

Photovoice

Photovoice as described by Wang et al. (1998), and in a climate change context by Healey et al. (2011) and Lardeau et al. (2011), involves having participants represent their community or point of view by taking photographs, discussing them and developing narratives to go with their photographs. Photovoice can be used to engage community members who may otherwise have been left out of the adaptation planning process, including youth and individuals with limited literacy. In Paulatuk, digital cameras were distributed to four community members, and participants were asked to take photographs of things they identified with climate change in their community and aspects of community life they valued. The goal was for community members to help illustrate the topics being discussed in adaptation planning workshops, and also give the photographers an opportunity to express their own concerns and needs for adaptation. Participants described their photographs and shared their insights on adapting to climate change in a follow-up meeting with the project coordinator; a slideshow of participant photographs and captions was shared at a community presentation, and the photographs were developed into a community calendar that highlighted proposed adaptation actions.

Results

The results from adaptation planning in Paulatuk are given to illustrate the type of information that can be collected using the described methods. Results are organized by sector workshop, and include background information and examples of proposed adaptation actions. The complete adaptation planning tables from Paulatuk are included in Supplementary Data.

Business and economy

The economic sector in Paulatuk is sensitive to climate change in several ways. For one, increasingly unpredictable weather and hazardous travel conditions on the land and ice, together with a growing dependence on wage-based employment, are affecting participation in subsistence activities. Declining participation in subsistence has implications for the transmission of environmental knowledge and land skills among younger generation community members, food security and cultural well-being. Furthermore, there are a limited number of wage-based jobs in the community with few community members holding the necessary qualifications, resulting in high unemployment and dependence on social services.

Regulations aimed at protecting species identified as being sensitive to climate change, like the United States (U.S.) ban on the importation of polar bear products, are negatively impacting sport hunting businesses in Paulatuk. The same is true of reduced caribou quotas, which aim to address low species numbers thought to be due to natural population cycles and unusual weather patterns (e.g. freeze–thaw events) (CARMA 2010). Reduced quotas have resulted in competition among hunters to acquire caribou hunting permits.

In response to these sensitivities, workshop participants emphasized the importance of diversifying the local economy and providing new training opportunities for job seekers. Examples of specific recommendations include:

- undertake an annual inventory and prioritization of local training needs that would guide funding and recruitment of instructors and/or programmes by the Hamlet;
- institute a lottery or rotational system for distributing hunting permits to limit nepotism; and
- increase training and hiring for heavy equipment operators to help the community deal with increased snowfall and snow drifting.

Culture and learning

Inuit in Paulatuk and elsewhere in the Canadian Arctic have a long history of coping with and adapting to changes in the Arctic ecosystem. An important element of adaptation has, and continues to be, a profound knowledge of the Arctic environment and land skills, which enable dynamic and flexible use of the land and its resources (Pearce et al. 2010b). However, there is concern among community members that as a result of youth spending less time in subsistence activities and more time in formal education and wage employment, that younger and inexperienced hunters are not as well equipped to cope with the risks of hunting, especially under changing climatic conditions. To help address this concern and promote the transmission of environmental knowledge and land skills among Inuit youth, organizations in Paulatuk have held 'land camps' for youth during summer months. Workshop participants made several recommendations for improving land camps including:

- identify dependable funding to host annual land camps;
- host land camps throughout the year, in different seasons, and for longer durations of time;
- extend participation in land camps to older generation community members; and
- promote other aspects of Inuit culture at land camps (e.g. drum dancing, sewing, traditional art, and storytelling).

Health and well-being

Key issues raised in the health and well-being workshops included, (1) poor nutrition—due to compromised access to country foods, and the high cost and low availability of nutritional store foods, (2) compromised food security, (3) lack of adequate support services for substance abuse and addictions, and (4) limited emergency response capabilities. For example, in terms of nutrition and food security, workshops participants were concerned that due to climatic changes and other socio-economic stresses, some community members are relying less on country foods and more on expensive, and often less nutritious, store-bought foods with implications for health (Todd 2010). Examples of adaptation actions proposed to address health concerns include:

- provide education to community members for how to select and prepare nutritious meals using store-bought foods (research elsewhere in the Arctic indicates that this knowledge is not always well developed among community members (Beaumier and Ford 2010; Lardeau et al. 2011);
- offer more *local* services for people with addictions (communicate priority needs to Beaufort Delta Health and Social Services);
- review and update emergency response plans in light of new risks associated with climate change (e.g.

increased storm activity and potential for power outages; less predictable weather and ice conditions, and traveller safety).

Subsistence harvesting

Climate change poses a number of challenges for subsistence activities, with cascading effects on nutrition and food security, culture and household economy. The primary concerns of workshop participants were increasingly unpredictable weather and more hazardous travel conditions on the land and ice, and specifically the vulnerability of younger generation community members and less-experienced hunters to changing conditions. Examples of proposed adaptation actions include:

- build community-managed shelters at popular hunting locations and stock them with emergency supplies as a safety resource for travellers;
- organize community hunts which are a safer option for younger and less-experienced hunters, and a more affordable option for everyone, as resources such as gasoline can be pooled and shared; and
- develop a mentor programme that would match less-experienced hunters with veteran hunters and subsidize cost of supplies for trips they make together.

Other actions focus on reducing risk of personal injury and/or equipment loss or damage and include:

- encourage travellers to report trail and ice conditions to the local radio station to be shared with the rest of the community;
- make safety equipment such as beacons, VHF radios, satellite phones and global positioning systems (GPS) available to borrow from the Hamlet or Hunters and Trappers Committee (HTC); and
- maintain a public laminated map on which hazards can be documented and updated through the seasons.

Transportation and infrastructure

Paulatuk currently faces few immediate infrastructure risks associated with climate change. The permafrost in Paulatuk is generally stable and while shoreline erosion is a concern, it is progressing at a moderate rate and does not pose an immediate threat to infrastructure or community location (Manson et al. 2005; Irvine 2011). However, Paulatuk is a growing community and is projected to expand in the coming years, and planning and developing infrastructure that accounts for future climate change is important. The community has struggled with a backlog of maintenance for existing infrastructure, for which high cost and limited personnel have been factors. Furthermore, the NWT's 'New Deal', which began during 2007–2008 fiscal year, gave community governments authority over decisions regarding public infrastructure, including planning, budgeting and maintenance, while the Territorial government provides base funding. This represents a major policy shift for communities and has created new challenges and opportunities. For example, human resources across the Territory (for planning, project management, auditing and reporting) have not increased in step with responsibility (Centre for Public Management, Inc. 2009). Despite these, and other limiting factors, the New Deal gives communities decision-making authority to address infrastructure priorities, including planning for climate change. In the planning workshop, adaptation actions related to transportation and infrastructure can be grouped as, engineered solutions, and improving planning and decision-making capacity. Examples of proposed engineered adaptations include:

- install snow fencing to prevent hazardous and obstructing snowdrifts on roads and against houses. Snow drifting has been an increasing concern for the community, and since the workshops took place the Hamlet has piloted a snow-fence project;
- construct bridges along travel routes where open water (rivers and streams) now frequently necessitates long detours; and
- install culverts along natural drainage paths to divert heavy spring melts that create large pools of standing water in town.

Examples of actions aimed at improving planning and decision-making include:

- reconsider community land-use plans in the light the of expected future climate change; and
- amend building codes to account for increasingly unstable permafrost (e.g. mandate thicker gravel pads and a longer settling period before construction, and adjustable pilings); and

Conclusions

This paper develops a methodology for climate change adaptation planning in remote, resource-dependent communities and applies it in a case study of Paulatuk, NWT. Vulnerability to climate change is assessed in the context of other non-climatic factors—social, political, economic and environmental, already being experienced and which influence how climate change is experienced and responded to. The methods described in this paper are intended to help facilitate communication among community members, local stakeholders and researchers to identify,

describe, prioritize and pilot adaptation actions. Analysis of secondary sources of information related to climate change impacts and adaptations provides starting points for planning workshops and helps prevent research fatigue in the community. Community collaboration and partnership building is essential to identify climate change risks that are relevant and adaptation actions that are realistic and desirable. Effective collaboration is especially important because, to date, non-local consultants or research groups have primarily facilitated community adaptation planning in the Canadian North. Outside facilitation and/or expertise may be necessary to initiate adaptation planning in the case of many communities where there are limited human and financial resources to dedicate to the process, and other urgent issues that may take priority. When outside facilitation is involved, it is essential for facilitators to maintain communication with local coordinators who can liaison with local partners and give project updates. Adaptation planning workshops organized by community sectors, business and economy, culture and learning, health and well-being, subsistence harvesting, and transportation and infrastructure, allows for focused discussions with relevant stakeholders and experts. Summarizing workshop information in a table format that clearly identifies and describes proposed adaptation actions is a concise way to present the information for review, update and use in the community. Adaptation planning is an iterative process and planning documents require continuous reviews and updates by key informants and community members. Piloting adaptation actions operationalizes the adaptation plan and provides a chance to evaluate adaptation actions. Reviews and updates to the plan are critical to ensure the relevance of adaptation actions, learn from existing pilot initiatives and to integrate knowledge on relevant climate change impacts and adaptations as it becomes available.

Climate change is already affecting livelihoods in Paulatuk with implications for local economy, culture, health and well-being, subsistence harvesting and transportation and infrastructure. In several instances, proposed adaptation actions to deal with climate change risks are directed at enhancing social, economic and cultural capacity and thus represent opportunities to mainstream adaptation into existing, and new, programming. For example, educating community members how to select and prepare nutritious meals using store-bought foods was identified and piloted as an adaptation action to address concerns regarding the increased consumption of store-bought foods by some households. An increase in the consumption of store-bought foods compared with country foods among community members is exacerbated by changing climatic conditions that affect participation in subsistence, but it is also the consequence of settlement living and growing reliance on wage-based employment. The Women's Community Kitchen project and other examples of capacity building initiatives proposed in the Paulatuk plan support the argument that efforts that increase financial, health, educational and cultural capacity in a community will often inadvertently enhance the adaptive capacity of the community to deal with current and projected future climate change risks.

For Inuit, systematic planning is a relatively new convention. Inuit adaptability has long been derived from an in-depth knowledge of the local environment and continual assessments and adjustments to present conditions. This tendency to deal with the immediate can be a challenge when it comes to committing to future courses of action and long-term planning. It is helpful in this regard to maintain a flexible, even *ad hoc* approach to climate change adaptation planning in Inuit communities: speaking with people when they are available and about what they want to share or contribute; creating a variety of avenues for people to express concerns and ideas related to climate change adaptation (workshops, one-on-one, formal, informal, oral, visual, etc.); and emphasizing the ever-evolving nature of an adaptation plan, which should respond to variable needs and circumstances. In these ways, adaptation planning should be understood as the initiation of a practical and ongoing conversation that will shape actions through time. The goal is not to produce static knowledge, but rather to develop a framework for integrating and responding to new and changing information. The methods described in this paper are intended to help facilitate this dynamic process.

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