CLIMATE CHANGE AND IMPACTS ON HUMAN HEALTH IN THE ARCTIC: AN INTERNATIONAL WORKSHOP ON EMERGING THREATS AND THE RESPONSE OF ARCTIC COMMUNITIES TO CLIMATE CHANGE

Summary of Workshop held in Anchorage, Alaska, February 13–15, 2008

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BACKGROUND

The Arctic Climate Impact Assessment (ACIA) was published in 2005 and was the first comprehensive scientific assessment of climate change in the Arctic (1). Potential direct and indirect health impacts of climate change are described in chapter 15 of this assessment. Direct health effects of climate change will result from changes in ambient temperatures. As the ambient temperature increases, the incidence of hypothermia and associated morbidity and mortality may decrease. Conversely, hyperthermia may increase, particularly among the very young and the elderly. More significantly, unintentional injury, mostly related to extreme events (flooding, storms) and subsistence hunting and fishing — already a significant cause of mortality among Arctic residents — may increase. Indirect effects may include mental and social stress related to loss of community and culture. Changes in migratory patterns and other factors may result in reduced access to traditional foods, which may force Indigenous communities to depend increasingly on non-traditional and often less healthy Western foods. These will most likely result in increasing rates of modern diseases associated with processed foods, such as obesity, diabetes and cardiovascular diseases, and outbreaks of food-borne infectious diseases associated with imported fresh and processed foods. Other indirect effects include the potential increases in certain food and water-borne infectious diseases related to the damage of the sanitation infrastructure and the potential emergence of other climate sensitive vector-borne infectious diseases.

The potential impact on human health will differ from place to place, depending on regional differences in climate change as well as variations in health status and the adaptive capacity of different populations. Arctic residents living in isolated communities with fragile support

systems, little infrastructure and marginal to non-existent public health systems may be the most vulnerable. People who depend on subsistence hunting and fishing will be vulnerable to changes that affect targeted species. Climate stress and shifting animal populations may create conditions for the spread of certain infectious diseases from animals to humans. The ACIA provides recommendations for communities, researchers and policymakers so they can begin to address human health challenges posed by climate change. The main conclusions of the assessment on health impacts of climate change were (1) that much research remains to be done on the relationship between climate change and individual and community health, (2) that climate will continue to influence public health in small and remote communities of the Arctic and (3) that there was an urgent need for adopting community-based monitoring strategies that would identify both emerging threats and opportunities (1).

The concept for this workshop was developed as part of the Arctic Human Health Initiative, an Arctic Council International Polar Year project to "increase awareness and visibility of human health concerns of Arctic Peoples" (www.arctichealth.org). The purpose of the workshop was to (1) update current knowledge on the impact of climate change on human health, (2) examine the principle conclusions and recommendations of the ACIA on human health to determine potential items for action and (3) examine the feasibility of implementing community-based monitoring strategies with and across regions to measure and report a common set of climate, health status, environmental, infrastructure and ecosystem indicators.

The workshop was convened as part of the 2008 Alaska Forum on the Environment (AFE, AFE, www.akforum.com). This widely recognized annual event promotes cooperation, communication and education on a wide variety of environmental issues and concerns, and attracts participants from government agencies, industry, universities, non-profit and tribal organizations. Climate change was a major focus of the 2008 event. The AFE provided the opportunity to gather an international panel of researchers from circumpolar countries to share their expertise on climate change and the impact on human health in the Arctic. The workshop format consisted of presentations by invited speakers and discussions that focused on the following questions: (1) what is being seen at the village level, (2) what monitoring is being done in Alaska, (3) what is needed, and (4) what could be monitored in a village setting?

The proceedings of this workshop can be accessed through the Arctic Human Health Initiative website at www.arctichealth.org.

SUMMARY OF PRESENTATIONS

Climate change: Place, health and the public health response

Jeremy Hess, Centers for Disease Control & Prevention, National Center for Environmental Health, Atlanta, Georgia, USA

This presentation provided an overview of global climate change, impact on human health, the importance of place, the health effects of displacement and the role of CDC and the public health community in mitigating the human health impact of climate change (2).

Overview of the health implications of climate change in the Arctic
Joel Scheraga, Environmental Protection Agency, Washington, DC, USA
The presentation highlighted existing human health challenges faced by Arctic peoples and the potential health impacts that climate change brings to an already vulnerable population.

Northern climate change: Human thermal health impacts
Juhani Hassi, Institute of Health Sciences, University of Oulu, Finland
Dr. Hassi discussed the largely preventable impact of cold and heat on morbidity and mortality. He recommended the development of outreach education and communication programs targeting those at most risk (the elderly, those with underlying health conditions and those with outdoor occupations) (3).

Environmental variables and the risk of disease/symptoms
Torbjörn Messner, University of Umeå, Umeå, Sweden
Conflicting results of epidemiological studies of weather and disease have emerged, depending on the population and geographical setting. The bulk of these studies, mainly from temperate climate zones, find that cold weather increases the risk of suffering an acute myocardial infarction (AMI). Dr. Messner's studies, carried out in a climate similar to that of Alaska, have shown that static temperature, barometric pressure or humidity extremes are not related to changing rates of cardiovascular disease. However, Dr. Messner was able to show that changes in temperature, but not in barometric pressure or humidity, were related to the risk of having an AMI (4).

Climate change and contaminant transport to the Arctic
James E. Berner, Alaska Native Tribal Health Consortium, Anchorage, Alaska, USA
Dr. Berner reviewed the effect of the recent and predicted climate trends on the contaminant exposure of the Arctic's human residents. Topics discussed included basic Arctic climate processes, observed trends and model predictions for Arctic climate changes and the potential impact of climate change on Arctic levels of contaminants. The importance of making serial observations over time in the environment, biota and human residents was stressed (5).

Climate and pathogens: Consequences for human health and subsistence food chains across high latitudes of the North
Eric Hoberg, U.S. Department of Agriculture, Baltimore, Maryland, USA
Dr. Hoberg summarized potential modifications of the interface between people and the environment induced by climate change. For example, exposure to pathogens through water-borne and food-borne pathways will be altered. Diseases in key mammalian, avian and fish species will influence availability, sustainability and suitability of traditional food resources (6).

Climate change and potential infectious disease emergence in the Arctic
Alan J. Parkinson, Centers for Disease Control & Prevention, Arctic Investigations Program, Anchorage, Alaska, USA
This presentation discussed the impact of climate change on the spread of infectious diseases in humans. For example, increased ambient temperatures may lead to the northward spread of infectious diseases from temperate regions, or the increase or decrease in infectious diseases that

are spread from animals to humans. Damage to the sanitation infrastructure by flooding or melting permafrost may increase the incidence of water-borne infections. Key recommendations include enhancing the public health infrastructure and engaging communities in actions that can be taken to reduce the health impacts of climate change (7,8).

Community relocation and health in Greenland

Rasmus Ole Rasmussen, Department of Environmental, Social and Spatial Change, Roskilde University, Roskilde, Denmark

The presentation focused on 4 aspects of the relocation process and its consequences: (1) politics, (2) food access and the formal and the informal economies, (3) gender differences in aspirations and mobility and (4) generation differences in aspirations and mobility. The author concluded that the relocation processes have a marked influence on life-styles and physical and social health (9).

Infrastructure and climate change: Potential indirect impacts to human health

John Warren, Alaska Native Tribal Health Consortium, Anchorage, Alaska, USA

Climate change can include changes in temperature, precipitation and reductions in sea ice. These changes can increase the frequency and severity of storms, flooding or erosion. Other changes may include drought or degradation of permafrost. These changes can result in damage to sanitation infrastructure resulting in the spread of disease. Through monitoring of some basic indicators, communities can begin to develop a response to climate change. With this information, planners, engineers, health care professionals and governments can begin to develop approaches to address the health challenges related to climate change (10).

Community preparedness for extreme climate events

Michael J. Bradley, Alaska Native Tribal Health Consortium, Anchorage, Alaska, USA

Developing community-based emergency plans and programs for extreme climate events such as storms, floods and wild-land fires were discussed. The emergency disaster planning process, community and community clinic model disaster plan templates for communities and other resources can be used to develop emergency plans and improve emergency response capacity. The Incident Command System can be used for any type of emergency, including events related to climate change (11).

Community-based monitoring for climate and health in the Canadian Arctic

Chris Furgal, Indigenous Environmental Studies Program, Trent University, Peterborough, Ontario, Canada

Rapid environmental changes — such as climate, weather and contaminants — have begun to disrupt the relationship between northern Inuit populations and the ecosystems in which they live. A series of studies brought together community residents, university researchers and regional public health representatives to identify, select and begin to monitor, in a proactive way, aspects of environment and health relationships in northern Canadian Inuit communities. The intent of these projects is to support community capacity for monitoring and surveillance, in the hopes that it will enhance adaptive abilities at the local level in the face of climate and other forms of environmental change threatening various elements of health (12).

Climate change, Canada and the North: Perspectives on adaptation, vulnerability and community research

Chris Furgal, Indigenous Environmental Studies Program, Trent University, Peterborough, Ontario, Canada

Through the evolution of assessments on climate change, its impacts and the resulting adaptation processes since the last Intergovernmental Panel on Climate Change report, released in 2001, there has been a movement towards including an overview of the adaptation and identification of key vulnerabilities that make people susceptible to potential impacts of climate change. The most recent IPCC report (2007), the Arctic Climate Impact Assessment (2005) and two more recent Canadian Assessments (2007, 2008) include an assessment of key factors influencing human vulnerability to climate-change-related hazards. With this approach, it is argued that there is a greater understanding of where climate change is more likely to have a negative impact. Recent community-based projects in the Canadian Arctic are now adopting this "vulnerability approach" to understand where adaptation support is most needed now and in the future. The Canadian government is supporting a number of research and policy initiatives in this direction (13).

CONCLUSIONS AND RECOMMENDATIONS

The workshop supported the conclusion that resident Indigenous populations of the Arctic are extremely vulnerable to climate change because of their close relationship with, and dependence on, the land, sea and natural resources for their cultural, social, economic and physical well-being. Direct health threats from climate change include morbidity and mortality that will result from an increase in extreme weather events (storms, floods, increased heat and cold) and an increase in the incidence of injury and mortality associated with unpredictable ice and storm conditions. Indirect effects continue to include increased mental and social stress related to changes in environment and loss of traditional life-style, potential changes in bacterial and viral diseases and access to quality water sources. Some regions will be at risk of increasing illness due to failing sanitation infrastructures as a result of changes in permafrost and storm surges. Some regions will also experience changes in diet as a result of changes to the distribution and accessibility of subsistence species. This may have negative impacts on health as the diet shifts from a traditional to a more Western one that is associated with increases in "modern diseases" such as obesity, diabetes, cardiovascular disease and cancer. Projected warming will affect the transport, distribution and behaviour of contaminants and increase human exposure in northern regions, further threatening the safety of the traditional food supply.

It was re-emphasized that these changes are taking place in the context of ongoing cultural and socio-economic changes. Climate change represents another source of stress for these northern societies and cultures because it affects the relationship between the people and their land and environment, which places additional stress on communities and on the psychosocial health of individuals.

Communities must be prepared to identify, document and monitor changes in their region in order to support ways of adapting to the changes in their local environment. The basis of

this understanding will be the ability to collect, organize and understand information that indicates change is taking place and to recognize emerging threats and their potential effects.

The workshop reaffirmed the principle conclusions and recommendations of the ACIA report on actions needed to address just how seriously climate change will affect human health in the Arctic. Much still remains to be done to establish a relationship between climate change and individual and community health. There remains an urgent need to implement community-based monitoring strategies. A network of such communities, within and across regions, reporting a common set of similarly measured climate, health status and infrastructure and ecosystem observations would serve to identify both emerging threats as well as new opportunities.

The workshop concluded that the key elements of a community-based monitoring strategy could include the following:

1. *The identification of communities and segments of the population at greatest risk*. These should be targeted for assessment of existing or potential health risks, vulnerabilities and engagement in the design of community-based monitoring and formulation of intervention and adaptation strategies.
2. *Identification of community leaders or project managers.* In Alaska, communities have access to training in emergency preparedness and implementation of the Incident Command System for managing community emergencies. This system could be used for the management of incidents related to climate change (e.g., village evacuation, unsafe ice conditions, threats to the sanitation infrastructure).
3. *Evaluation of existing capacity, resources, motivation and infrastructure needed to establish a community-based monitoring system*.
4. *Identification and creation of regional partnerships*. Linkage with, and engagement of, appropriate tribal, public health and wildlife agencies, non-governmental organizations and universities engaged in climate change activities and research are important as potential funding sources and to ensure local, regional, national and international coordination of monitoring, research and prevention and control activities.
5. *Identification, selection and monitoring of basic indicators for climate change and community health (Table I).* The selection of site- or village-specific indicators should be guided by local concerns.
6. *Expansion of community-based monitoring systems to include other communities both regionally and internationally.* Linkage of community-based monitoring systems to include other communities is important for the detection of trends in climate and health impacts over larger geographic regions. This should include sharing standardized protocols for monitoring climate change indicators, community health and standardization of key climate-health indicators.
7. *Develop contingency plans, communication networks, education programs and early warning systems*. (For example, village evacuation contingency plans, posting of dangerous ice or weather conditions, alternate travels routes, alternate food sources and food storage/preservation methods, alternate water sources.)

Areas for additional work include (1) coordinating the monitoring of and research into changes in contaminant transport and bioavailability, (2) documenting, assessing and communicating current adaptive measures being used by others, (3) using to a greater extent Indigenous perspectives and knowledge to monitor and understand climate change and its impacts, and (4) enhancing a community's capacity to take advantage of the opportunities (e.g. opening of shipping lanes increasing coastal community access to shipping, oil and gas exploration, tourism and economic opportunities) created by local environmental change.

The workshop concluded that there are currently relatively few programs examining the feasibility of implementing community-based monitoring strategies in the Arctic. However, there are several pilot programs underway in the Canadian North that are beginning to assess current surveillance networks and measure the capacity of communities to monitor acute and chronic disease and other health determinants related to climate change (see www.arcticnet-ulaval.ca; http://www.qanuippitaa.com/).

Table I. Potentially useful indicators for monitoring the effects of climate change at the community level in the Arctic.

Monitoring wildlife, diet and health

Establish community-based and regional-scale monitoring programs for

- harvest data by species of interest (subsistence species, sentinel species)
- local arrival/departure dates of migratory species
- important subsistence species disease frequency using blood testing (e.g., brucellosis, trichinella, rabies, echinococcus, toxoplasmosis)
- appearance of a new wildlife or insect species that may contribute to the emergence of a new zoonotic disease (e.g., West Nile virus)
- local hunter reports of animal/fish abnormalities
- incidence of human cases of zoonotic diseases
- incidence of food-borne illnesses (botulism)

Monitoring snow, ice and community health

Establish surveillance and communication networks at the community level to support early warning of dangerous conditions for travel and land-based activities (weather, ice conditions). Monitor:

- rates of cold injuries (e.g., frostbite)
- mortality and coronary heart disease
- rates of unintentional injury (location and circumstance)
- local timing of river break-up, shore-fast ice break-up (ice thickness, annual date in, annual date out)
- weather extremes (warm or cold days) and stability (precipitation, temperature, barometric pressure)

Monitoring infrastructure and human health

Establish local level monitoring programs for data collection on permafrost and infrastructure stability. Monitor:

- basal depth of permafrost and compare to historic measurements
- incidences of flooding caused by storm surges or heavy precipitation
- drinking water quality (turbidity, pathogens) and gastrointestinal illnesses (clinic visits)

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REFERENCES

1. Arctic Council 2005. Arctic climate impact assessment scientific report. Cambridge: Cambridge University Press; 2005. pp. 863–960.
2. Hess J, Malilay J, Parkinson AJ. Climate change: the importance of place and places of special risk. Am J Prev Med 2008;35(5):468–478.
3. Hassi J, Rytkönen M, Kotaniemi J, Rintamäki H. Impacts of cold climate on heat balance, performance and health in circumpolar areas. Int J Circumpolar Health 2005;64(5):459–467.
4. Messner T. Environmental variables and the risk of disease. Int J Circumpolar Health 2005;64(5):523–533.
5. Kraemer LD, Berner J, Furgal CM. Potential impact of climate on human exposure to contaminants in the Arctic. Int J Circumpolar Health 2005;64(5):498–508.
6. Hoberg EP, Polley L, Jenkins EJ, Kutz SJ, Vetch AM, Elkin BT. Integrated approaches and empiric models for investigation of parasitic diseases in northern wildlife. Emerg Infect Dis 2008;14(1):10–17.
7. Parkinson AJ, Butler JC. Potential impact of climate change on infectious disease emergence in the Arctic. Int J Circumpolar Health 2005;64(5):478–486.
8. Parkinson AJ. Climate change and infectious disease: impact on human populations in the Arctic. In: Institute of Medicine. Global climate change and extreme weather events: Understanding the potential contributions to the emergence, reemergence and spread of infectious diseases. Washington D.C.: National Academies Press; 2008. 155 pp.
9. Rasmussen RO. Adjustment to reality-social response to climate changes in Greenland. In: Ørbæk JB, Kallenborn R, Tombre J, Hegseth EN, Falk-Petersen S, Hoel Ah, editors. Arctic alpine ecosystems and people in changing environments. New York: Springer Berlin Heidelberg; 2007. 167-178.
10. Warren JA, Berner JE, Curtis T. Climate change and human health: infrastructure impacts to small remote communities in the North. Int J Circumpolar Health 2005;64(5):487–497.
11. Bradley M. Climate-related events and community preparedness. Int J Circumpolar Health 2005;64(5): 438–439.
12. Furgal C. Monitoring as a community response for climate change and health. Int J Circumpolar Health 2005;64(5):440–441.
13. Furgal C, Prowse TD. Northern Canada. In: Lemmen DS, Warren FJ, Lacrois J, Bush E, editors. From impacts to adaptation: Canada in a changing climate 2007. Ottawa: Government of Canada; 2008. pp. 57–118.

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