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An Analysis of the Capacity for Public Environmental Health Surveillance to Detect and Monitor the Health Outcomes of a Changing Climate through an Exploratory Case Study in Nunavut

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The Faculty of Graduate Studies

Of

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Abstract

Using a conceptual framework for effective surveillance and through and exploratory case study informed by key informant interviews and document reviews, this thesis explores the capacity for environmental public health surveillance systems in remote Aboriginal communities to detect and monitor the health outcomes related to a changing climate. The findings demonstrate that several activities associated with effective surveillance systems are being performed in Nunavut, including formal and informal data collection approaches to health and environmental information. Nevertheless, this thesis also reveals that the existing health surveillance and environmental monitoring systems are carried out in a manner that involves very little data integration. Recommendations include the investigation of the feasibility of integrating existing data for health-related climate impacts on Nunavummiut and to research and develop the appropriate partnerships between all stakeholders (community, government, academia, others) to better integrate existing health surveillance and environmental monitoring systems.

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Acronyms

ACIA ..... Arctic Climate Impact Assessment

IASC ..... International Arctic Science Committee

CDC ..... Centres for Disease Control and Prevention

EPHS ..... Environmental Public Health Surveillance

EPHT ..... Environmental Public Health Tracking

GHG ..... Greenhouse Gas

IPCC ..... International Panel on Climate Change

NIPHQ ..... National Institute for Public Health in Quebec

NTI ..... Nunavut Tunngavik Incorporated

PHAC ..... Public Health Agency of Canada

RCMP ..... Royal Canadian Mounted Police

UNFCCC ..... United Nations Framework Convention on Climate Change

WHO ..... World Health Organization

Chapter 1: Introduction

Public and environmental health surveillance to assess health status of a population in order to establish priorities, to evaluate programs, direct research priorities, understand the scope and magnitude of issues as well as inform policy and decision-makers to improve health outcomes (Teutsch, 1994). Recent assessment reports (ACIA, 2005; Furgal, 2008; Furgal and Prowse, 2008; IPCC, 2007) have outlined the potential direct and indirect health impacts of climate and environmental change for northern Canadian populations. Some of these impacts include changes to subsistence activities such as hunting and fishing, threats to water quality, increased infrastructure risks through permafrost instability and psycho-social stress of rapid environmental change (ACIA, 2005). Due to these impacts, there is increased importance in understanding the relationship and incidence of health outcomes as they relate to climate mediated environmental exposures and hazards in the North. For rural and remote Aboriginal populations, an environmental public health surveillance system's capacity to detect and monitor climate mediated health outcomes is of particular importance due to the unique connection of health, culture, and environment as significant determinants of Aboriginal health (Furgal & Seguin, 2006; Richmond & Ross, 2008).

At the moment, the world is experiencing record environmental change (ACIA, 2005; IPCC, 2001, 2007). Some of these changes include a 6.4 degree Celsius increase in global mean air and ocean temperatures, increasing amounts and intensity of severe weather events such as storms, droughts and precipitation, rising sea levels up to 0.59 meters, and increased melting of polar regions with projected late-summer ice free Arctic ocean (IPCC, 2007). In addition to the physical environmental impact of these environmental changes, also known as

climate change, there is emerging knowledge of the direct and indirect impacts of these changes on health. These identified impacts range from increased prevalence and incidence of infectious diseases (e.g. malaria) to psychosocial impacts caused by infrastructure instability from melting permafrost (e.g. moving of settlement areas) (Furgal, 2008, IPCC, 2007; WHO, 2003). It is argued that with the occurrence of climate change significantly adding to the spectrum of environmental health hazards (McMichael et al. 2003) and impacting many determinants of health, the importance of environmental public health surveillance emerges as a key activity for ensuring effective public health practice in the coming decades.

Climate change is defined as "any change in climate over time whether due to natural variability or as a result of human activity " (IPCC, 2007). From this definition, a *"change"* is considered a change that has important economic, environmental, health and social implications in the context of this thesis.

Over the last decades, the Arctic has been experiencing environmental change more rapidly than other regions in Canada (Arctic Climate Impact Assessment (ACIA), 2005; Nickels, Furgal, Buell, & Moquin, 2006). These changes in the environment are significantly influencing a variety of determinants of health including income and socio-economic status, culture, social networks and physical environments (Furgal, 2008; Furgal & Seguin, 2006). For example, northern Aboriginal residents often depend on hunting and fishing as a critical source of security in their food systems (Statistics Canada, 2001) and climate change has impacted the physical environment by altering the patterns of ice coverage and permafrost, in turn, decreasing the predictability of safe travel routes over ice and snow for subsistence activities (Furgal, 2008; Furgal & Seguin, 2006; Nickels et al.,

2006). These impacts ultimately influence the population's access to food, their income, and social well-being via a growing disassociation from the land (Nickels et al., 2006).

In 2005, the Arctic Council and the International Arctic Science Committee (IASC) published one of the most comprehensive reports on Arctic climate change. The *Arctic Climate Impact Assessment (ACIA) – Scientific Report*, provides a synthesis of impacts related to current and future projected environmental change in the Arctic. Some of the impacts of the projected changes in this report include rising Arctic temperatures of 7-10 degrees Celsius over the next century; declining sea ice with average summer decline of up to fifty percent; melting glaciers and sea level rise projected to over ninety centimetres in some regions; changes in animal species diversity, range and distribution; major economic and cultural impacts affecting subsistence activities such as hunting and food-sharing; increased exposure to storms and erosion disrupting transportation, building and infrastructure; significant impacts on health through increases in contaminants transported by winds and increases of infectious disease vectors; among others (ACIA, 2005).

Public health and environmental health stakeholders, including scientists, clinicians, policy-makers and Aboriginal community members have been calling attention to climate change health impacts for some time (Frumkin, Hess, Luber, Malilay, & McGeehin, 2008; Furgal, 2008; Furgal & Seguin, 2006). Canadian research is currently emphasizing adaptive capacity in order to address the current impacts of climate change (Furgal, 2008; Lemmen, Warren, Lacroix, & Bush, 2008). Recently, the government of Canada has published two significant climate change reports titled: *From Impact to Adaptation: Canada in a Changing Climate 2007* and *Human Health in a Change Climate: A Canadian Assessment of*

Vulnerabilities and Adaptive Capacity (2008) with an emphasis on understanding the current and future adaptive capacity of Canadians. Highlights from these reports show that climate change impacts are currently being observed in every province and territory in Canada and there is a need to balance both mitigation and adaptation science and policy. As such, an analysis of the capacity for surveillance activities and systems, designed to measure, register, confirm, report, analyse, communicate, train and respond to the direct and indirect health impacts of climate change, could positively influence health status, policy and program delivery as it is a critical part in adaptation planning. Surveillance can provide the basis of understanding of change and impacts on human populations.

Generally, the health status of northern Canadian residents, as measured through select indicators, is considered lower than average Canadians (Statistics Canada, 2001; Furgal et al. 2008). The Canadian North, represented in Figure 1, is characterized by its geography as well as political boundaries and commonly includes the three Territories (Yukon, Northwest Territories, Nunavut) in addition to two other modern land claim regions namely Nunavik in northern Quebec and Nunatsiavut in northern Labrador.

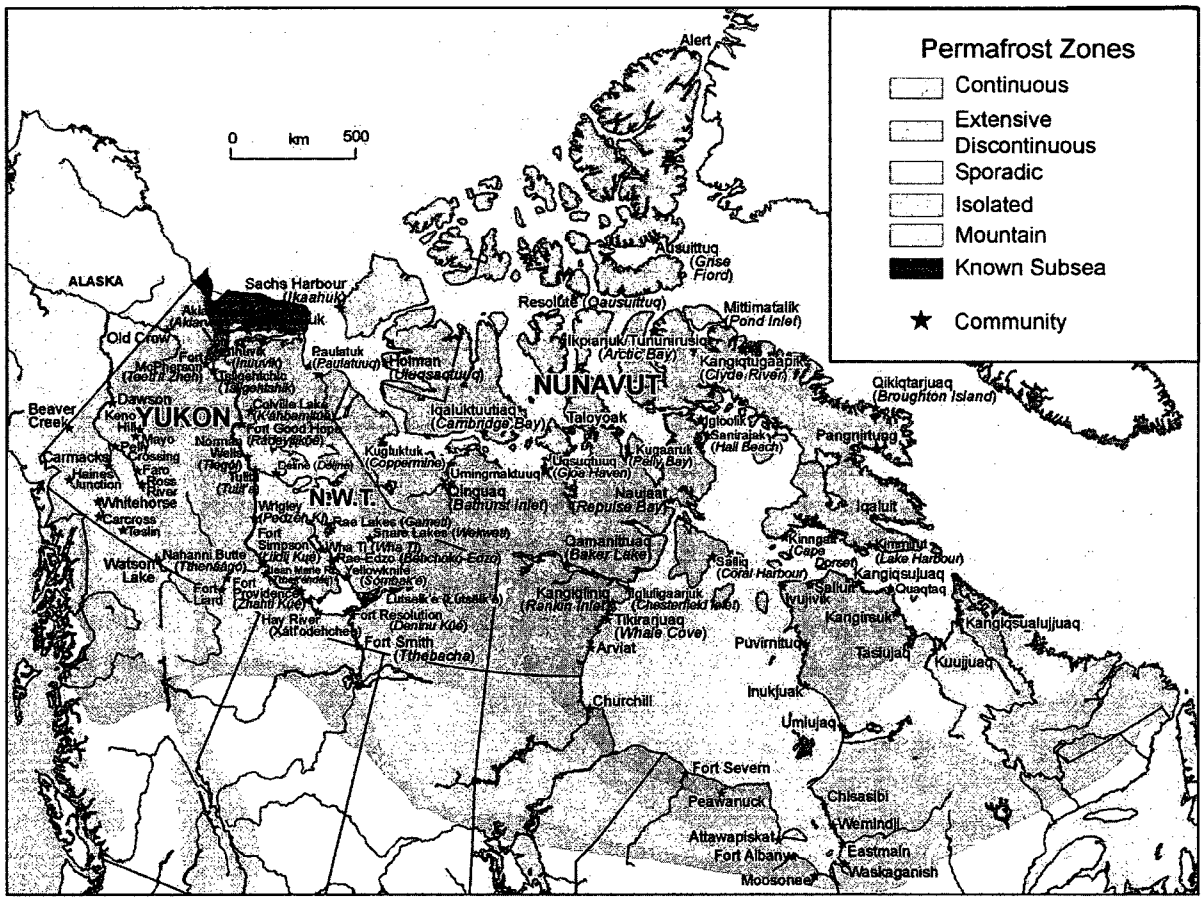

Figure 1. Map of northern Canada including all 112 communities, superimposed on a permafrost map – reproduced from Furgal and Prowse, 2007 (p. 309) (derived from Heginbottom et al., 1995; Furgal et al., 2003)

Within its boundaries, you will find a diversity of cultures where over half are from a variety of Aboriginal groups: Yukon First Nations, Dene, Métis, Gwich'in and Inuit (Furgal & Seguin, 2006). In terms of health status in the Canadian North, some select indicators are discussed and represented in Table 1.

Table 1

Selected Crude Mortality Rates by Cause (per 100,000 deaths) for Canadian Northern Regions Reproduced from Furgal et al. 2008 (p. 316)

Indicator	Canada	Yukon	NWT	Nunavut	Nunavik*	Labrador
Total Mortality Rates (per 1,000) (2004) ‡	7.1	5.4	3.6	4.1	7.1	8.3
Major cardiovascular diseases	233.2	111.3	118.5	78.9	n/a	n/a
Acute myocardial infarction	59.8	6.5	35.5	10.3	n/a	n/a
Deaths due to heart attack	52.1	37.1	28	3.7	n/a	n/a
Lung Cancer	48.2	73.2	61	209.5	n/a	n/a
Accidents, unintentional injuries	28.6	65.5	59.2	30.9	n/a	n/a
Transport accidents (motor vehicle, other land transport, water, air and unspecified	9.9	19.6	16.6	27.5	n/a	n/a
Accidental drowning	0.8	9.8	7.1	<0.5	n/a	n/a
Intentional self-harm (suicide)	11.9	19.6	23.7	106.4	131.2	n/a

Note: Crude mortality rates per 100,000 deaths in 2003 unless otherwise noted.
* Source: INSPQ, 2006.
n/a Not available at the regional level included in this chapter.
‡ Population estimates used for the 2003 mortality rate calculations are July 1, 2003 updated Post censal estimates, adjusted for net census under coverage and included non-permanent residents (Statistics Canada, 2004a).
Source unless otherwise indicated: Statistics Canada, 2006.

These indicators show lower than average life expectancy, higher infant mortality rates, and higher lung cancer rates as well as higher unintentional and intentional injury rates (Statistics Canada, 2001). Some of the key factors influencing overall health status of northern Aboriginal groups are higher than average rates of smoking, obesity rates, and alcohol consumption. In addition, The National Institute for Public Health in Quebec (INSPQ, 2006) has reported that exposure to environmental hazards, leading to negative

health outcomes, is particularly greater among northern Aboriginal residents. In northern Aboriginal communities, residents and scientists have also reported other environmental factors affecting northern health status such as shifts in the range and distribution of key subsistence species (e.g. caribou, seal) negatively affecting food security; changes in frequency and intensity of severe weather events leading to more death and injuries; changes to permafrost distribution and composition affecting key infrastructure such as water-sanitation plants; among others (Furgal, 2008; IPCC, 2001; Lemmen et al., 2008; Nickels et al., 2006).

Two general strategies exist as possible classes of response to climate change: mitigation and adaptation (IPCC, 2001, 2007). Mitigation is defined as "an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks" (IPCC, 2007, p. 878). To mitigate environmental change, caused by global warming activities, the international community has adopted the *Kyoto Protocol* aimed at the reduction of global greenhouse gas (GHG) emissions from anthropogenic origins (UNFCCC, 1992). The reduction of greenhouse gas emissions is an important global mitigation effort, however, recent studies have supported that the extended life of some greenhouse gasses in the atmosphere (Albritton, 2001) and the inevitable increase in mean global temperature over the next decades will require immediate adaptation measures (Lim, 2004; Willows, 2003). The IPCC in its Fourth Assessment Report (IPCC, 2007) noted that three types of adaptation responses exist in response to climate change: anticipatory, autonomous, and planned (Table 2).

Table 2

Definition of adaptation to climate change reproduced from the IPCC Glossary of Terms from the 4th Assessment Report and WG 2 Key Word: Adaptation (2007, p.869)

Adaptation Adjustment in natural or *human systems* in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation: Anticipatory adaptation – Adaptation that takes place before impacts of *climate change* are observed. Also referred to as proactive adaptation. Autonomous adaptation – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*. Also referred to as spontaneous adaptation. Planned adaptation – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

It further defines autonomous adaptations as "invariably taking place as a reactive response (after initial impacts are manifest) to climatic stimuli as a matter of course, without directed intervention by a public agency" (Smit & Pilifosova, 2001) . For example, an Arctic hunter, using ice and snow as his hunting platform, could change the dates he hunts when noticing shifts in ice distribution and movement (instability and unpredictability). On the other hand, planned adaptation responses are deliberate and anticipatory actions often associated with policy implications (IPCC, 2001). Examples of planned adaptation include the prevention and control of infectious diseases exacerbated by climate change by providing adequate financial, human public health resources, training, surveillance and emergency response system capacity for targeted health endpoints (U.S. Environmental Protection Agency, 2008).

Adaptation to climate change is currently underway in the Canadian North and researchers have identified gaps and needs for an assessment of northern capacity for surveillance and monitoring of future climate impacted health outcomes (Ebi, Kovats, & Menne, 2006; Furgal & Gosselin, 2002; Furgal, Martin, Gosselin, & Viau, 2002; Furgal & Seguin, 2006). As such, in targeting planned adaptive responses to climate change and empirically understanding how the changing climate is impacting health status, environmental public health surveillance is a necessary starting point.

Research Question

Therefore, this thesis has investigated the following research question: What is the current capacity within northern health surveillance systems and environmental monitoring systems to detect and monitor the health impacts of a changing climate among northern Aboriginal populations?

The discussion of surveillance system "capacity" is informed by the following key questions in order to meet the thesis objectives:

1. What components of surveillance and monitoring systems exist?
2. Do the systems function in a way that allows capturing of information required to monitor climate and health issues?
3. If system components are missing, are there other compensatory actions in their absence?
4. What measures could improve performance and productivity of the surveillance system and the program(s) that it supports?

Thesis Objectives

1. Identify, document, and describe present health surveillance and environmental monitoring capacity in one northern Canadian Territory (Nunavut);
2. Analyze environmental and health system capacity in a remote northern Aboriginal region to detect and monitor the health impacts of a changing climate by identifying strengths and weaknesses of present environmental public health surveillance systems;
3. Recommend areas for improvement to strengthen current environmental and public health surveillance capacity in the case study region (Nunavut) to be able to better respond to projected climate change influences on human health.

Thesis Structure and Outline

This thesis explores environmental public health surveillance in northern rural and remote Aboriginal populations and their ability to detect and monitor the direct and indirect health impacts of a changing climate. The first chapter outlines the context and importance of the research. It summarizes aspects of environmental public health surveillance and future projected impacts of climate change in Canada's north, as well as some examples of adaptive responses. The second chapter summarizes relevant literature supporting environmental public health surveillance and its role in public health systems; shares pertinent climate change and health impacts information from global to northern Canadian Aboriginal perspectives; as well it elaborates on environmental public health surveillance as a specific adaptive response to climate change health impacts. The third chapter describes the qualitative methods used in the case study. It defines the conceptual framework and variables used to review the public health and environmental surveillance systems in addition

to describing the semi-structured interview guide used in the case study, as well as the methods used for analysis. The fourth chapter outlines the case study region along with general health surveillance programs and environmental monitoring of relevance to the case in Canada and Nunavut. Chapter five reports on the case study findings gleaned from the interviews and document reviews. It summarizes the key informant interviews as well as provides a synopsis of the collected information in table format. Chapter six discusses the Nunavut environmental public health surveillance system in terms of its ability to detect and track health outcomes currently and potentially associated with a changing climate in northern Canadian Aboriginal communities. The thesis will conclude with recommendations for future directions to strengthen present surveillance systems in Nunavut in addition to on the identification of future research needs.

Chapter 2: Literature Review

This chapter outlines the current definitions, concepts, activities, and approaches associated with environmental public health surveillance systems. It provides a brief synopsis of climate change health impacts in the Canadian North and the responses currently associated with these impacts. It also examines climate change adaptive responses and how environmental public health surveillance systems are able to positively contribute to northern Canadian Aboriginal capacity in responding to the direct and indirect health impacts related to climate change.

The World Health Organization defined health as *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity* (1947, p. 100) and, "*the extent to which an individual or group is able, on the one hand, to realize aspirations and satisfy human needs and, on the other hand, to change or cope with the environment* (WHO, 1986, p. 2) ". Although still widely applied, other definitions of health have emerged over the years. Notably, in Canada, the Lalonde and Epp reports (1974 & 1986) added the concept of health promotion and broadened its definition to include "*a basic dynamic force in our daily lives, influenced by our circumstances, our beliefs, our culture and our social, economic and physical environments"* (Epp, 1986, p. 2). It is recognized, from these definitions, that a range of categories from bio-physical to social networks will contribute to an individual or population's capacity to adapt, respond and control life's challenges and changes (Frankish, Green, Ratner, Chomik, & Larsen, 1996). The Public Health Agency of Canada utilizes a set of twelve determinants of health to holistically understand health: income and social status, social support networks, education, employment/ working conditions, social environments, physical environments, personal

health practices and coping skills, healthy child development, biology and genetic endowment, health services; gender, and culture (Public Health Agency of Canada, 2003). An important area to highlight for purpose of this research is the recognition of the influence of environment and culture in determining overall health status of a person or community.

Today, public health is considered "*the science and art of promoting health, preventing disease, prolonging life and improving quality of life through the organized efforts of society*" (Last, 2001). In 2001, the Canadian Advisory Committee on Population Health (ACPH) outlined five public health core functions which include: population health assessment; health surveillance; health promotion; disease and injury prevention; and, health protection. From this list of core functions we can take particular note of the presence of public health surveillance as a crucial component of effective public health practice (McNabb et al., 2002).

Public health surveillance is a process through which a population can assess its health status, define its priorities, evaluate programs, and direct research (CDC, 2000). It is characterized, in general terms, as the ongoing systematic collection, collation analysis and interpretation of health data with the purpose of dissemination for action (McNabb et al., 2002). Public health surveillance is applied to health data for planning, implementation, and evaluation of public health practice (Teutsch, 1994) with a final outcome of prevention and control systems for health outcomes. The typical activities associated with public health surveillance have been outlined in the literature and include the detection, registration, confirmation, reporting, and analysis of a health event (McNabb et al., 2002; Teutsch, 1994; Stephen B. Thacker & Berkelman, 1988). In addition to these typical activities, McNabb et

al. (2002), through their conceptual framework of public health surveillance reform, have added the component of "action" through planned and reactive public health responses. They state (McNabb et al., 2002):

> "Surveillance, *per se*, does not include the public health action(s) resulting from the interpretation of the data. Few envisaged the inherent responsibility of surveillance practitioners (i.e., those public health officials responsible for interpreting the data collected) for prevention and control actions. However, as early as 1963, the international public health community through the WHO recognized the importance of linking public health surveillance to public health action [no page number]."

Public health surveillance data is drawn from a broad range of sources such as environmental monitoring records, zoonotic vector records, individuals, laboratories, medical records, administrative records, police records as well as birth and death certificates (CDC, 2000). Thacker (1992) and the Centers for Disease Control (2000) propose using health surveillance data for several purposes: to estimate magnitude of issues; to determine geographic distribution of illness; to portray history of diseases; to detect epidemics; to stimulate research; to evaluate control measures; to monitor changes in infectious agents; to detect changes in public health practice, and to facilitate planning for better health outcomes. Several public health surveillance initiatives already exist in Canada. Examples of a few of these initiatives include: chronic disease registries (e.g. National Diabetes Registry); environmental and occupational health programs (e.g. Northern Contaminants Program); emerging infectious diseases reporting systems (e.g. West Nile Surveillance in Manitoba)

and injury control and prevention program, (e.g. Water Safety Programming in the Northwest Territories).

Environmental Public Health and Surveillance

There is increased recognition that a very intimate relationship exists between ecological well-being and human health (Kotchian, 1997). Also, there has been increased awareness among health practitioners, administrators and politicians that environmental public health surveillance is an important component of public health practice (Glad, Kotchian, & Barron, 2004). Environmental health practice is one of the very first recognized and organized public health activities on record (Kotchian, 1997). It has been a key public health practice for centuries and at the forefront of major public health interventions such as potable water, sewage treatment, food safety inspections, lead paint prevention, in addition to others (Hann, Kean, Matulionis, Russell, & Sterling, 2004). Through public health practice, environmental health and specifically surveillance thereof, has emerged as a key component able to positively contribute and safeguard lives (Campbell-Lendrum, Corvalan, & Neira, 2007; Furgal et al., 2002; Gochfeld & Goldstein, 1999).

The WHO (1999) defines environmental health as *"those aspects of human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing and controlling factors in the environment that can potentially affect health"*. Environmental public health surveillance, the practice of assessing factors in the environment, applies to all of the traditional public health surveillance system activities while adding the measurement of environmental hazards and exposures (S. B. Thacker, Stroup, Parrish, & Anderson, 1996). McGeehin et al. (2004) state:

"...there is a distinction between environmental health surveillance systems and traditional systems in that emphasis is placed on data integration across health, human exposure, and hazard information systems...that includes linkage of these data as part of regular surveillance activities ... to identify potential relationships between exposure and health conditions that either indicate the need for additional research or require intervention to prevent disease, disability or injury." (p.1411)

Gochfeld & Goldstein (1999) note that traditional subjects being examined through environmental health include air and water pollution, food quality, solid and hazardous waste disposal, environmental toxicology, pesticides and radiation exposure, environmental law and occupational health. Environmental health science has not remained stagnant, tackling other contemporary issues such as risk assessments, exposure assessments, understanding causation, susceptibility of special groups and global environmental quality (Gochfeld & Goldstein, 1999). The results from environmental public health science and practice have influenced important health policy and legislation ranging from air pollution regulations, rabies vaccinations and dog licensing, laws mandating clean indoor air, seatbelt legislation, in addition to many others (Hann et al., 2004). Therefore, environmental public health surveillance systems utilize hazard information (biological, chemical, physical, mechanical, psychosocial), exposure rates and health data to provide public health professionals information and tools capable of influencing appropriate public environmental health interventions (Charleston et al., 2008). Over the last decades, increasing emphasis on improving environmental public health surveillance (EPHS) has garnered attention as a priority public health concern (Litt et al., 2004; Malecki, Resnick, & Burke, 2008; S. B.

Thacker et al., 1996). Therefore, understanding the elements that comprise EPHS is very important.

Thacker et al. (1996) originally described the elements needed in the support of environmental public health surveillance (EPHS) and describe the presence of three types of surveillance: hazard surveillance, exposure surveillance, and outcome surveillance. The Centers for Disease Control and Prevention (CDC) have since used this model to design their Environmental Public Health Tracking Network in the United States where they looked to combine all the three elements of hazard, exposure and outcome surveillance into a network of standardized data systems and public health action represented in Figure 2 (McGeehin, Qualters, & Niskar, 2004).

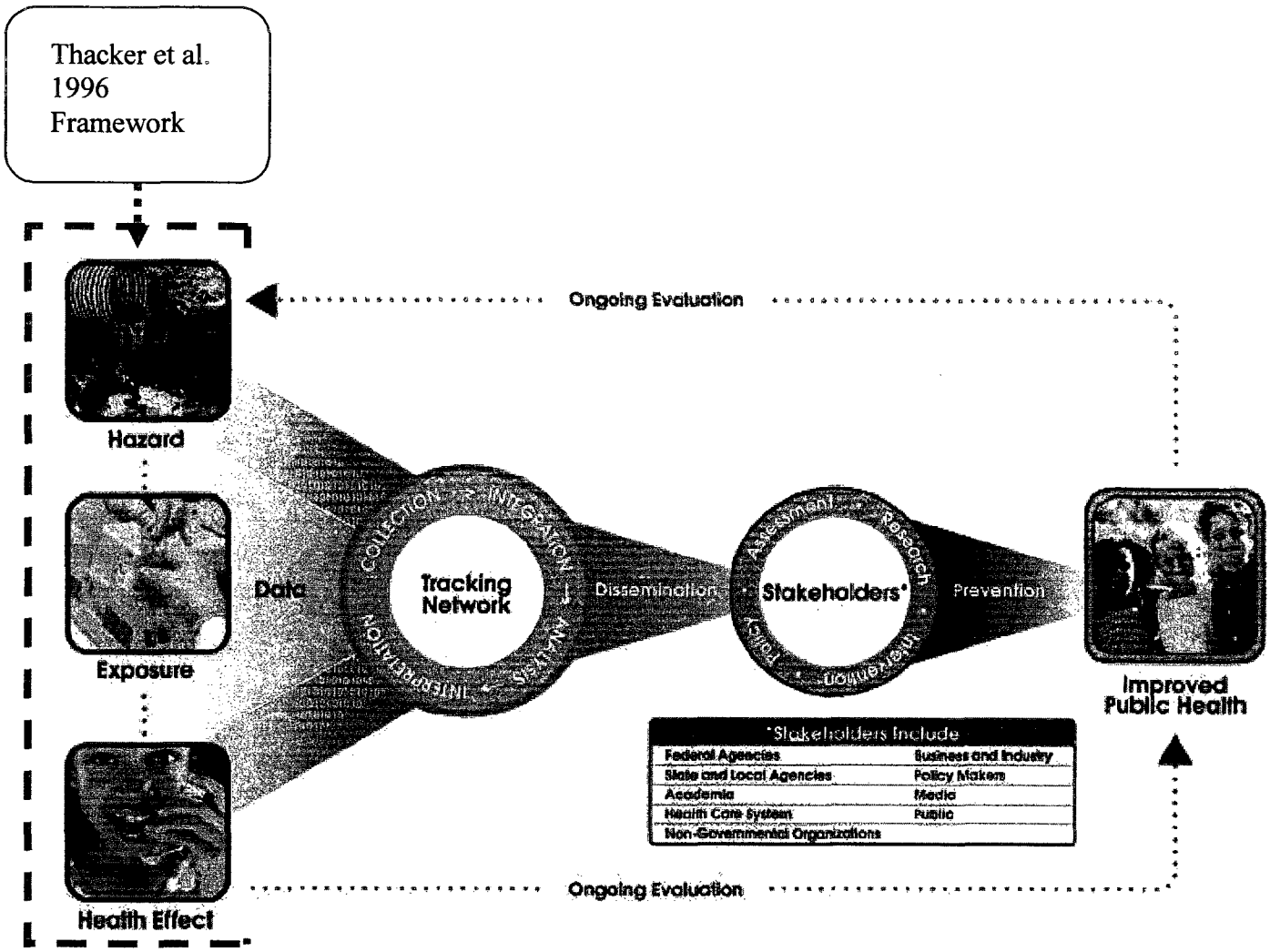

Figure 2. Centers for Disease Control and Prevention environmental public health surveillance system (with Thacker et al. 1996 framework) reproduced from: http://www.ehponline.org/members/2004/7144/fig1.jpg

To elaborate on the conceptual framework from the CDC, environmental health hazards arise from human as well as natural sources. Hazard surveillance assesses the occurrence, distribution and trends of hazards in relation to chemical, physical, biomechanical, biological and psychosocial agents responsible for disease and injury (S. B. Thacker et al., 1996; Yassi A., Kjellstrom T., de Kok T. , & Guidotti T, 2001). Exposure assessment or surveillance is the monitoring and measurement of individual members of a population exposed to an environmental agent (S. B. Thacker et al., 1996; Yassi A. et al.,

2001). Outcome surveillance, measuring the health effects of environmental exposure is very similar to traditional health surveillance and pulls its data from disease registries, vital statistic data and national health surveys (Backer et al., 2001; McGeehin et al., 2004; S. B. Thacker et al., 1996). These types of surveillance do not work in isolation and are often complimentary in responding to environmental public health issues such as water quality and availability, air pollution, and food contamination (S. B. Thacker et al., 1996). Thacker (1996) also notes that the combination of several data sources might be needed to ascertain the effect of an environmental health endpoint such as vital records, recurrent exposure surveys, registries, office records, in addition to others (S. B. Thacker et al., 1996). From the CDC model, an environmental health surveillance system demonstrates the presence of five functions: 1) measurement of hazard exposure, 2) measurement of health outcomes, 3) production of ongoing data records, 4) production of timely and representative data, and 5) data used for planning, implementing and evaluation of public health activities.

Environmental health indicators, quantitative summary measures, have served as the foundation of a comprehensive surveillance and monitoring system (Malecki et al., 2008). In helping develop good systems, researchers and organizations suggest choosing an appropriate set of environmental health indicators with a balance from local and national needs/levels (Glad et al., 2004). An environmental health indicator provides information about a population's health with respect to a chosen environmental factor and can be categorized by hazard, exposure, health effect, or intervention (Centers for Disease Control and Prevention, 2006). Examples of these include: residence in a flood plain (hazard); blood lead level in children (exposure), childhood morbidity due to acute respiratory illness (effect), morbidity or mortality attributed to ambient or drinking water contaminants (effect);

emergency preparedness, response, and mitigation training programs, plans, and protocols to address the hazard (intervention). The CDC shares that in first designing an EPHT network, there must be a selection indicators for which data will be tracked and analysed through typical surveillance structures (such as McNabb et al., 2002). Indicators help to identify potential links between environment and health, risks to health, monitor trends, assesses the effectiveness of policies and helps allocate resources (Kjellstrom & Corvalan, 1995).

To appropriately respond to environmental health hazards and exposure such as those associated with climate change for example, there is recognition that several categories of data are required to perform surveillance. A distinction is often made between surveillance and monitoring; the first being a continuous standardized recording of morbidity incidence, health risks and status; and the second being associated to environmental data collected at the local, regional and global levels (Haines & Patz, 2004). For environmental public health surveillance, systems require both types of data categories (surveillance and monitoring) to make appropriate health event attributions. Some examples of date sources and categories include environmental risk such as meteorological and ecosystem data, vulnerability data such as elevation, snow cover and isolation, poverty; morbidity data such food borne and waterborne diseases, in addition to many others.

To execute an environmental public health tracking network or system able to perform the five functions from the CDC model, different surveillance approaches exist: passive and active. In active surveillance, a system employs human resource personnel to regularly contact care providers to seek information about a health condition(s) (Backer et al., 2001; Nsubuga, 2006); this type of surveillance is said to be very accurate however very

costly. Passive surveillance, on the other hand, relies on health jurisdictions to receive reports submitted from hospitals, clinics, public health units as well as others (Backer et al., 2001; Nsubuga, 2006). Often, passive surveillance is less costly however it encounters risks to data quality and timeliness as it depends on different people and institutions to provide data (Nsubuga, 2006; Teutsch, 1994) . Whether a surveillance system is passive or active, several attributes can contribute to its success such as the number of conditions tracked, flexibility, clear goals, and usefulness of data to policy and decision makers for preventative action. These elements become even more important when dealing with the complexity, interaction and attribution of environmental hazards and exposure and their effect on health events.

Health Surveillance System Evaluation

According to the literature (Baker & Fidler, 2006; Teutsch, 1994; Stephen B. Thacker & Berkelman, 1988) evaluating health surveillance systems shows the presence of two important steps; the first is a description of the purpose, operation and elements that encompass the system and the second is the assessment of system performance against selected attributes.

To evaluate the effectiveness of a health surveillance system, it is important to understand how it operates. Teutsch (1994, p. 180-181) proposes that the following elements must be described in an evaluation: people and organizations involved, the flow of information; tools used for data collection; analysis and dissemination; mechanisms of information transfer; frequency of reporting and feedback; quality control. A description of

these elements will enable administrators and community decision makers to identify the strengths and gaps currently existing within their systems.

In addition to the description of objectives and operations of a surveillance system, the CDC (2001) has proposed a list of attributes associated with effective surveillance. These attributes include: usefulness, sensitivity, timeliness, stability, simplicity, flexibility, acceptability, data quality, positive predictive value, representativeness (German et al., 2001). The following Table (3) provides a brief description of each attribute.

Table 3

List of Attributes and Details Related to Effective Surveillance Systems (Baker et al., 2006, p.1061)

Attribute	Details
Usefulness	Contribution to prevention and control of adverse health-related events
Sensitivity	Proportion of true events detected by system and ability to detect outbreaks
Timeliness	Speed between steps particularly from event onset to response
Stability	Reliability and availability of surveillance systems
Simplicity	Simplicity of structure and ease of operation
Flexibility	Ability to adapt to changing information needs and operating conditions
Acceptability	Willingness of persons and organizations to participate
Data quality	Completeness and validity of recorded data
Positive predictive value,	Proportion of reported events that are true events
Representativeness	Ability to describe events over time and their distribution by place and person

An evaluation of health surveillance activities against each attribute will contribute to an important understanding of system effectiveness. However, important to highlight for the purpose of this thesis are the challenges and constraints associated with effective traditional public health surveillance in low and middle income countries that share similar health status

to Inuit in Canada. Challenges include but are not limited to: limited resources available for public health, multiple vertical systems in place with little data integration, and lack of laboratory support, in addition to infrastructure and communication constraints (Baker & Fidler, 2006; Teutsch, 1994). To overcome some of these challenges, a variety of approaches has been discussed in the literature to address insufficient surveillance systems and data (Andresen, Diehr, & Luke, 2004; Calain, 2007; Groce & Reeve, 1996; Oum, Chandramohan, & Cairncross, 2005). Andresen et al. (2004, p. 27) propose that *"it may be necessary to use data more flexibly to understand a population of interest"*. In this, they propose that, for low-frequency populations, improved decision making through data acquisition might require the recognition and use of several different methods of data collection and auxiliary approaches. For example Andersen et al. 2005 recommend the use of non traditional sources such as census information, population specific surveys, research project results, multi-method surveys (in-person interviews, multiple languages used). Groce et al. (2005) also propose the inclusion of information from local specialists (traditional healers) to help close the gap not typically being addressed through current surveillance systems. They argue that local specialists are familiar with the diseases commonly found in their area, aware of disease patterns (increase and decrease), usually among the very first to detect the emergence of new cases, and, aware of recurrence of a disease through time (Groce et al., 2005, p. 352). Incorporating the use of the informal data methods, filling the gap left by traditional surveillance systems, allows for an understanding of health trends and behaviours in population groups (Andresen et al., 2004) constrained by the lack of resources, technology and infrastructure. Another approach being proposed for public health data collection where traditional surveillance systems are encountering challenges (lack of resources, lack of flexibility, lack of positive predictive-value and usefulness) is community

based surveillance systems. In 2005, Oum et al. reported on a community-based surveillance system in rural Cambodia. This system used a syndromic approach where lay people provided information on health problems, life events and communicable diseases (Oum et al., 2005). It found that a community based surveillance system was able to be sensitive, positive predictive and useful to local health services (Oum et al., 2005) offering an alternative and viable approach to surveillance through community engagement. Calain et al. (2006) also confirm the need for an informal surveillance data and community-based surveillance system as an integral part of collecting health information for eventual health program and policy decision making in developing countries.

Specific Challenges Associated with Environmental Public Health Surveillance Systems

Some challenges and issues are unique to environmental public health surveillance systems such as the difficulty of attributing a specific environmental cause to an outcome due to the multiple and compounding effects (Backer et al., 2001; Nsubuga, 2006). There is also recognition that multiple isolated types of data are collected, without being linked among different programs and jurisdictions and difficulties arise in making associations between environment and health status (Glad et al., 2004). Also, other challenges include the data collected for other purposes might not be sufficient for environmental public health surveillance needs (Backer et al., 2001). Bekkedal et al. (2008) propose that three major challenges are included in successful environmental public health tracking (EPHT) programs and these include: the identification of what is needed and available from the partner organizations; addressing the disparities between the original intended use of the data and their integration into an EPHT network; negotiating formal and informal agreements that

ensure that all partners agree on the most effective use, dissemination and policy implications of the collected data. There is recognition that data for public health surveillance and environmental monitoring are currently collected in silo fashion with a need for harmonization and integration (Frumkin et al., 2008). A review of the available literature shows that environmental hazard tracking is often handled by environmental agencies and health outcomes are handled by public health agencies with the exception of those issues that are regulated and supported by programs such as drinking water and air pollution (Frumkin et al., 2008; Litt et al., 2004). In the Unites States, the National Environmental Public Health Tracking Programs is currently implementing a model that addresses harmonization and integration of data (McGeehin et al., 2004) and researchers note (Frumkin et al., 2008) a need to expand the program to other jurisdictions, increase collected data elements, and increase spatial resolution of the data to better understand association amount for long term environmental changes on direct and indirect health outcomes.

Climate Change and Health: Trends, Impacts, and Adaptations in the Arctic

Climate is defined as:

> " ... *the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. "(IPCC, 2001, p. 942).*

Evidence exists that climate is changing faster than originally predicted and impacts from these changes will affect all levels society from small regional communities to international

conglomerates (IPCC, 2007). Reports confirm with confidence, that the global climate systems are presently changing with observed air and water temperature increases, snow and ice melting, and increases in sea level (ACIA, 2005; IPCC, 2001, 2007). The IPCC (2007) also notes that these changes will influence overall ecosystems, water quality and availability, food, coasts, and human health with particular impact on Polar Regions.

Polar Regions are already experiencing climate variability impacts on bio-physical systems, human systems, infrastructure and indigenous ways of life (ACIA, 2005; Furgal & Prowse, 2008; IPCC, 2007; Nickels et al., 2006). Climate change is one of the many factors that can influence the overall health of an individual or community. Health impacts of climate change will be felt through different pathways and will vary in directness, scale, and complexity (Séguin & Clarke, 2008). McMichael et al. (2003) outline three broad ranges of health impacts from climate change: 1) impacts that are directly related to weather/climate, 2) impacts that result from environmental changes that occur in response to climatic change, and 3) impacts resulting from consequences of climate-induced economic dislocation, environmental decline, and conflict. Factors contributing to a particular Polar/Arctic vulnerability to climate change are cryosphere sensibilities with large areas of snow and ice cover likely to change with increased temperature (implications for dwellings that are rooted in permafrost); a large number of indigenous inhabitants living in coastal communities (risk of sea level rise); a strong reliance on subsistence economies; lower socioeconomic and health status; lack of infrastructure for coping mechanisms; and, socially marginalized populations with reduced access to services (ACIA, 2005; Furgal, 2008; WHO--Work programme, WMO., & UNEP., 2003). The potential direct and indirect health impacts from climate change are now commonly discussed in the literature (ACIA, 2005; Frumkin et al.,

2008; Furgal, 2008; Furgal & Prowse, 2008; Haines & Patz, 2004; IPCC, 2001, 2007). The scientific community (ACIA, 2005; Furgal, 2008; IPCC, 2007) as well as northern Canadian Aboriginal communities (Nickels et al., 2006) have outlined and detailed a number of potential impacts from climate change. A list proposed by Furgal et al. (2002, 2008) outlines the potential direct and indirect climate change health impacts in northern Aboriginal communities. Each of the climate mediating factors and health outcomes represented in Table 4 and 5 are influenced by both climate change as well as a unique set of psycho-socio-economic, environmental and cultural circumstances in the Canadian North. For example, studies have discussed (Furgal et al., 2002; Nickels et al., 2006) that changes in ice distribution and stability, in cultures such as Canadian Inuit, can affect accident rates by the use of unsafe passage ways for travel and hunting over ice and snow. Also, the scientific literature and local observations report that changes in permafrost extent, stability and quality disturbing settlement areas is associated with increased psychosocial disruption and economic impacts such as loss of income and social status, rebuilding and relocating of homes as well as damage to primary community infrastructure such as health centres, emergency roads, and public works water systems (Furgal, 2008; Nelson, Anisimov, & Shiklomanov, 2002; Nickels et al., 2006; Warren, 2005).

Table 4

Potential Direct Impacts Related to Climate Change reproduced from Furgal et al. (2008 p.324)

Mediating Process	Possible Direct Health Impacts
Exposure to thermal extremes	Changed rates of illness and death related to heat and cold
Changes in frequency or intensity of other extreme weather events (storms, floods, etc.)	Death, injuries, infectious diseases, stress related disorders, psychosocial disruption
Changes in ice distribution and stability, and snow composition and amount	Death and injuries related to travel and hunting accidents
Increased UV exposure	Increased risks of skin cancers, burns, infectious diseases, eye damage (cataracts), immunosuppression

Table 5

Potential Indirect Impacts Related to Climate Change reproduced from Furgal et al. (2008, p.327)

Mediating Process	Possible Indirect Health Impacts
Exposures to thermal extremes	Infectious disease, stress related disorders, other health related disorders (such as psychosocial disruption)
Changes in ice distribution and stability, snow composition and amount	Dietary problems associated with decreased availability and accessibility of wild foods
Effects on range and activity of vectors and infective parasites	Changes in geographical range and incidents of vector-borne diseases and their transmission to humans
Changes in local ecology of water-borne and food-borne infective agents	Changed incidence of diarrheal and other infectious diseases and their transmission to humans
Changes in food and drinking water availability and productivity	Dietary problems: malnutrition and hunger and consequent impairment of child growth and development, cultural and social implications due to diet shift, diabetes, nutritional deficiencies, changed contaminant exposure, etc.

Changes in distribution and composition of permafrost	Psychosocial disruption related to damages to infrastructure, housing and population displacement, dietary problems associated with impacts through ecosystem change
Sea level rise	Increased risks of infectious diseases, psychosocial disruption associated with infrastructure damage and population displacement
Changes in air pollution (contaminants, pollens and spores)	Increased incidence of respiratory (asthma, hay fever) and cardiovascular diseases, cancer, premature death, visual impairment, reduced work capacity

Although the potential direct and indirect impacts of a changing climate are commonly discussed in the literature, still very little is known about the degree of attribution these climate impacts have on health outcomes/endpoints. Recommendations, in the literature, have been made to better understand and empirically link these potential (direct and indirect) climate change impacts to health outcomes (Furgal, 2008; Furgal & Gosselin, 2002; Litt et al., 2004). Better understanding the degree of attribution between climate change and health will help inform current responses in proactively dealing with the impacts of climate change.

Current Responses to Climate Change

As described in the first chapter of this thesis, two general strategies exist as possible classes of response to climate change: mitigation and adaptation (IPCC, 2001, 2007). Presently, northern residents report that they are responding (autonomous adaptation) to the associated health burdens of rapid environmental change (Furgal, 2008). Furgal (2008) has summarized the current adaptive climate change/variability responses presently taken by individuals and communities in the Canadian North (Table 6).

Table 6

Current Northern Canadian Adaptive Responses to Climate change Reproduced from Furgal et al. (2008, p. 342)

Environmental Change and Impacts and Threats to Health and Well-Being	Existing Responses
Precipitation extremes and natural disasters • Property damage, injuries and death, increased travel risks	• Relocation of buildings in avalanche hazard zones • Increased needs for local search and rescue teams
Unpredictability of weather • Limitations on hunting and travelling • Increased travel risks and injuries • Increased damage to equipment • Decreased access to traditional foods	• Increased use and dependence on built (shelters) and natural (protected bays) refuges from storms • Increased communication among hunters • Increased preparations for travel and hunting • Decreasing outings during variable times • Use of technology (e.g. GPS)
Temperature-related injuries • Changes in incidence of cold-related injuries • Increased heat stress	• Reduce physical activity • Increasing house ventilation and accessing cool areas
Warming temperatures and changing ice conditions • Increased travel risks • Increased injuries and deaths (e.g. drowning) associated with uncharacteristic and dangerous ice conditions • Impacts to equipment and household economies • Decreased access to traditional food • Disruption of traditional cycles and impacts on social cohesion and mental well-being •	• Shifting hunting patterns (e.g. times) • Using multiple means of transportation for same trip • Increasing community monitoring and communication of ice conditions • Use of new or alternate routes of travel • Use of technology (GPS, satellite imagery)
Increased exposure to UV radiation • Increased incidence of sun burns, rashes and blisters	• Increased use of protective creams • Stay out of sun and indoors

New and emerging diseases	
• Increased incidence and exposure to zoonotic diseases • Increased exposure to new vectors	• Increased use of insect repellents and bug nets • Increased selectivity of animal meat consumed (to screen for parasites and other abnormalities)
Environmental changes and food security	
• Decreases in traditional food availability (wildlife health and numbers), accessibility (changes in ice and snow conditions impacting routes to hunting grounds) and quality (safety of meat for consumption) • Appearance of new species • Increased potential for local-scale northern agriculture	• Changes in times of hunting (to match shifts in availability) • Shifting species hunted (to match changes in availability) • Purchase of new transportation equipment to access animals harder to reach • Return to community in summer more often from hunting trips to store fresh meat
Water security	
• Decrease in availability and accessibility to safe natural drinking water sources	• Carry bottled water on trips from the community • Use snow more often for water in winter than multi-year ice • Travel further from community for good natural water sources
Permafrost coastal erosion and community infrastructure	
• Loss of land along shorelines near buildings • Destabilization of foundations and threats to buildings and other public health structures	• Reinforcing shorelines • Relocate buildings away from shorelines

In public health practice, Frumkin et al. (2008) propose that the principles of health protection and prevention (primary, secondary and tertiary) follow clear analogies to mitigation and adaption approaches to climate change. Mitigation, compared with primary prevention in health, aims to prevent the onset of injury or illness, by slowing, preventing, and reversing environmental change caused by greenhouse gas emissions (Frumkin et al., 2008). This type of response to climate change is most often associated to the energy,

transportation and industry sectors (Frumkin et al., 2008). Within the health sector, the process of adaptation consists of actions taken to minimize the negative impact of climate change (Furgal, 2008) and can take shape in a variety of forms such as institutional, behavioural, economic, and technological (McMichael, Friel, Nyong, & Corvalan, 2008). Frumkin et al. 2008 detail that adaptation (secondary and tertiary prevention in health) is well suited for medical and public health responses to climate change. They describe that secondary and tertiary prevention in public health aims to diagnose, control and reduce health burdens and is comparatively associated with adaptive responses to climate change in order to anticipate and react appropriately to the effects of climate (Frumkin et al., 2008).

Ebi et al. (2006, p. 1930) state that assessing the potential health impacts of climate change requires an assessment of both vulnerability and capacity to respond to new conditions. Health vulnerability to climate change is conceptually defined as the function of sensitivity, exposure, and adaptive capacity to risks and hazards (Ebi et al., 2006; Ford & Smit, 2004; IPCC, 2001). Ebi et al. (2006, p. 1931) define sensitivity as "the extent to which health, natural and social systems, and individuals are sensitive to changes in weather and climate". Exposure is defined (Ebi et al., 2006, p. 1931) as "a weather or climate-related hazard including the character, magnitude and rate of variation". Ebi et al. (2006, p. 1931) also defined adaptation measures and action as *"the reduction of burden or specific adverse health outcome from the exposure-response relationship"*. A conceptual model of vulnerability to the health impacts of climate change is presented in the following figure (Figure 3).

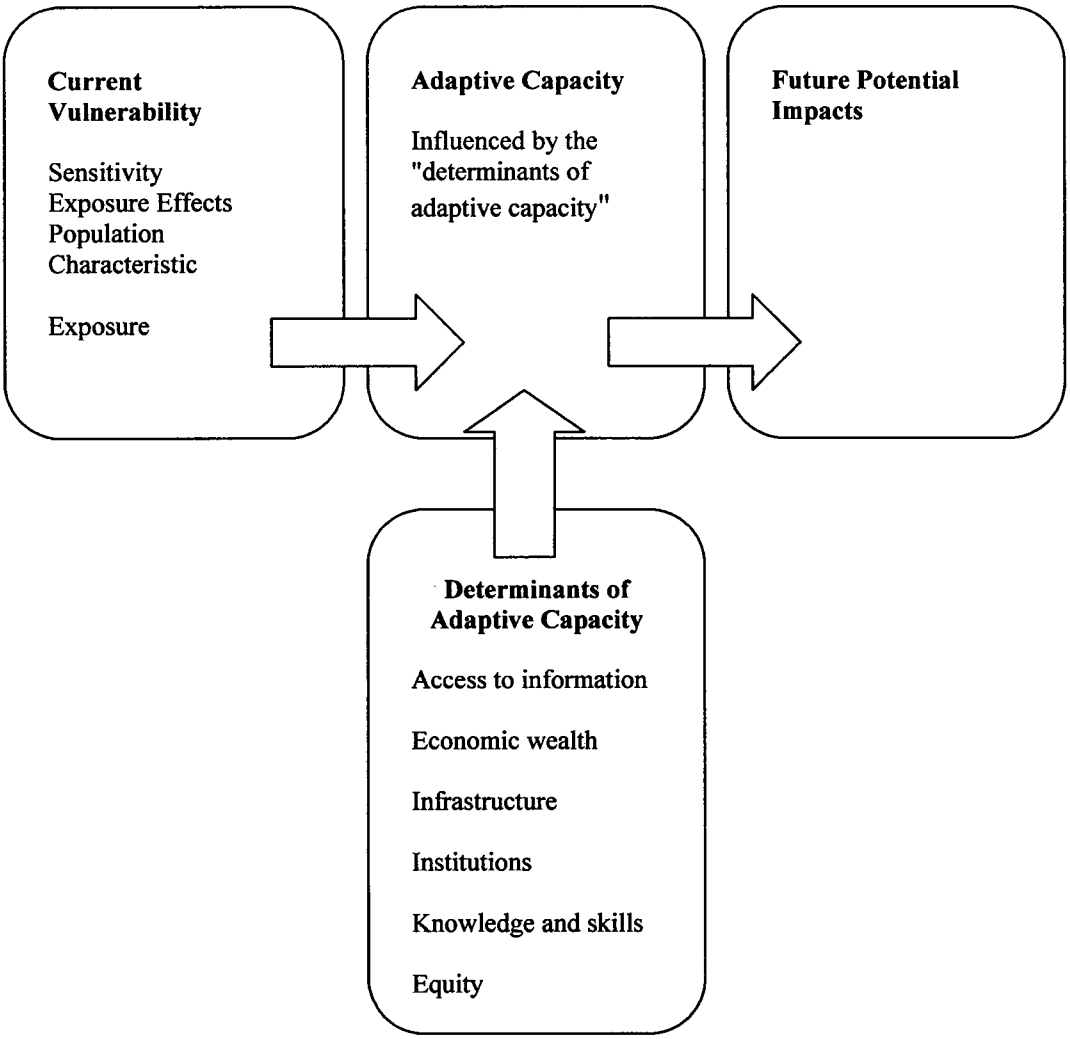

Figure 3. Conceptual model of vulnerability to the health impacts of climate change modified from Ebi et al. (2006, p. 17); (Barry, 2008; IPCC, 2001, 2007)

Adaptive capacity, in this model, refers to "the general ability of institutions, systems and individuals to adjust to the potential harm, to take advantage of opportunities, or to cope with the consequences of climate variability and change (Ebi et al., 2006, p. 1931). The

literature (Barry, 2008; IPCC, 2001, 2007) indicates that adaptive capacity to climate related impacts is influenced by a variety of determinants such as: access to information, social capital, economic wealth, knowledge and skills, access to technology, infrastructure, and institutions. Adaptive capacity is also impacted by a current population's health status and pre-existing disease burdens (IPCC, 2007; McMichael, Woodruff, & Hales, 2006). Table 7 further explains how each determinant impacts adaptive capacity.

Table 7

Description of the Relationship of Determinants of Adaptive Capacity for Health Related Climate Impacts (Barry, 2008; Ebi et al., 2006; IPCC, 2001, 2007);

Determinant of Adaptive Capacity	**Relationship to Adaptive Capacity**
Access to information	Greater access to information increases the likelihood of timely and appropriate adaptation;
Economic wealth	Greater economic resources increases adaptive capacity;
	Poverty generally increases vulnerability;
Infrastructure	Greater variety and characteristics of infrastructure (public health, flood control structures, etc.) enhances options and adaptation capacity;
Institutions	Well developed social institution increases adaptive capacity;
	Collaboration between private and public sectors can enhance adaptive capacity;
Knowledge and skills	Knowledgeable and skilled staff enhances adaptive capacity;
Equity	Equitable distribution (based on risk and vulnerability) of resources increases adaptive capacity;
Access to technologies	Increase in access to technology enhances adaptive capacity;
	Many health protection adaptive strategies involve technology

Most effective responses to climate change are associated with the strengthening of key functions of environmental management, surveillance and response (Campbell-Lendrum et al., 2007). For instance, when a population group is able to access information on the

threats and risks to its health, the better they are able to adapt proactively to these actual threats and risks. It is noted that the complexity of changes and the plethora of other influence factors (determinants of adaptive capacity) require better understanding and profile by individuals and organizations (health organizations and systems) to aid in the development of effective adaptive responses (Ebi et al., 2006; Furgal, 2008; Furgal & Seguin, 2006). As such, understanding and evaluating environmental public health surveillance capacity to generate information on climate-exposure-outcome will play a vital role in addressing this gap in current response. For some time now, the WHO has been lobbying for effective surveillance systems as essential public health practice components and note that surveillance becomes even more essential under rapid environmental change (Campbell-Lendrum et al., 2007). As such, increases in environmental public health surveillance capacity as an adaptive response to direct and indirect impacts of climate change has the potential to contribute to health adaptation capacity by ensuring better access to information regarding a hazard-exposure-outcome cycle. Therefore, information produced and accessed through an environmental public health surveillance system will be able to contribute by 1) making empirical links between environmental hazards, exposures and health outcomes and 2) directing very scarce resources into the right type of intervention programming related to hazard-exposure-outcome cycles 3) informing policy responses to the health impacts of climate change.

A public health response to the health implication of climate change is said to be lacking at the moment (Campbell-Lendrum et al., 2007). More health research, such as the research and questions explored through this thesis, is needed to provide data based support for public health action on climate change which includes a better understanding to the

capacity of environmental public heath surveillance to generate information of health outcomes associated with a changing climate (Frumkin et al., 2008; Furgal et al., 2002).

Chapter 3: Methodology

This chapter outlines the research approach, selection rationale for the case study, and a description of the specific conceptual framework chosen for data collection, information organization and analysis. The chapter concludes by a discussion of ethical considerations as well as a declaration of any biases and control measures the researcher employed for the thesis.

Research Approach

Historically, qualitative research was one of the first forms of social study mostly restricted to the fields of anthropology and sociology (Yin, 2003). Today, qualitative research is an approach applied in a multitude of fields such as education, social work, nursing, health services, psychology, communication, and management (Yin, 2003) and often, in a mixed methods context, applied as a precursor to quantitative research as it helps to generate leads and ideas for other hypotheses (Creswell, 2003). The process of inquiry in qualitative research is typically concerned with answering the questions *Why*? *How*? and *In what way*? (Yin, 2003). To elaborate on defining characteristics of qualitative research, Creswell (2003, p. 181-182), building on the work of Rossman and Rallis (1998), proposes that qualitative research takes place in the natural setting enabling the development of a level of detail about individuals or place; uses multiple approaches that are interactive and humanistic often incorporating active involvement from participants; is emergent research rather than tightly prefigured where data collection methods might change as the inquirer learns about the phenomena; is fundamentally interpretive, meaning that the inquirer filters data through specific socio-political lenses; will view social phenomena holistically often offering panoramic views (vs. micro-analysis); offers

reflectivity on the bias the researcher might bring to the inquiry; and will often adopt one or more strategies for inquiry.

In qualitative research, an "approach" is a general way of thinking about conducting research by describing the purpose of the qualitative research, the role of the researcher, the stages of research, and the method of data collection and analysis (Trochim, 2000). Different qualitative research approaches exist such as ethnology, phenomenology, grounded theory, narrative and case study (Creswell, 2003), among others. These approaches are briefly described in Table 8.

Table 8

Description of Qualitative Research Approaches (Creswell, 2003)

Approach	Description
Ethnography	Researcher studies an intact group in an intact cultural setting over a long period of time using mostly observational data; it is flexible and can evolve contextually
Grounded Theory	Researcher attempts to derive a general, abstract theory of a process or relationship using multiple stages of data collection and allowing the theory to be derived from the data
Phenomenology	Research attempts to identify the "essence" of human experience by studying a small number of subjects through prolonged engagement to develop patterns and relationships
Narrative	Researcher studies the life/lives of individuals to retell the story in narrative form by combining the views of participants and researcher's life
Case Study	Researcher studies in depth the program, event, activity or process by using a variety of data collection procedures

Case Study and its Selection

Case studies are a qualitative research approach concerned with exploring questions with a particular social context (Yin, 2003). Specifically, case study design has been defined as "a research method that investigates a contemporary phenomenon within its real-life and holistic context; when the boundaries are not clearly evident; and in which multiple sources of data are used" (Yin, 2003, p.13). Therefore, case studies are popular strategies for contextual research for a variety of disciplines such as psychology, political science, business planning and

community health (Yin, 2003). The focus of this thesis is to explore environmental health surveillance capacity in a particular, unique, and contextual condition where climate change is impacting remote, rural and Aboriginal communities. Therefore, the researcher selected the Territory of Nunavut as the case example, with over twenty five remote, rural and Aboriginal communities (Atlas of Canada, 2003) already experiencing effects of environmental change (ACIA, 2005; Furgal & Prowse, 2008; Natural Resources Canada, 2006; Nickels, Furgal, Buell, & Moquin, 2006).

Collection Methods and Data Sources

To conduct a qualitative case study, the researcher must select appropriate data collection strategies in order to explore the research question. Appropriate selection of data collection strategies and analysis units will add to the robustness and validity of the research study (Creswell, 2003; Yin, 2003). For case studies, there are several sources of data a researcher can use such as: documentation, archival records, interviews, physical artefacts, direct observations and participant observations (Creswell, 2003, p. 86). The selected data collection methods for this thesis include interviews and document reviews. Strengths and limitations exist in terms of the two identified primary data collection methods (Table 9). For interviews, strengths include gathering targeted and focused rich data in a cost-effective way to raising awareness and enthusiasm around the issue. Limitations include difficulties in generalization in addition to appropriate representation of diverse knowledge and viewpoints. For document reviews, some strengths include stable and exact references for longer periods of time with historical details of events and unobtrusiveness. Document review limitations include difficulties in access and retrieval as well as selection bias from the researcher. A summary of these strengths and limitations are presented in Table 9.

Table 9

Strengths and Limitations of Key Informant Interviews and Documentation Review adapted from UCLA Centre for Health Policy Research (http://www.healthpolicy.ucla.edu/HealthData/ttt_prog24.pdf) p. 9 and Yin, 2003(p. 86)

	Strengths	Limitations
Interviews	Detailed and rich data can be gathered in a relatively easy and inexpensive way	Bias (interviewer and interviewee) may be present
	Targeted and focussed on the case study topic	Inaccuracies due to poor recall
	Allows the interviewer to establish rapport with the respondent and clarify questions	Selecting the "right" key informant may be difficult so they represent diverse backgrounds and viewpoints
	Provides and opportunity to build or strengthen relationships with important community informants and stakeholders	May be challenging to reach and schedule interviews with busy and/or hard-to-reach respondents
	Can raise awareness, interest and enthusiasm around the issue	Difficult to generalize results to the larger population unless interviewing many key informants
	Can contact informants to clarify issues as needed	
Documentation	Stable – can be reference and reviewed repeatedly	Difficulties may arise in retrieving
	Exact as it may include references, names and details of events	Biased selectivity
	Broad coverage can span long periods of time, events and settings	Access might be deliberately blocked

Among various forms of interviews, distinctions exist between structured and semi-structured interviews in that a semi-structured interview leaves the researcher room for exploration, by not limiting questions solely from the interview guide (Patton, 2002). Within

semi-structured interviews, the interviewer can build a rapport and later probe the research participant. Such probes allow for a "deeper response" (Patton, 2002, p. 372) than structured interviews, allowing a researcher to better understand the context in which a phenomenon (surveillance capacity) is taking place. However, in a semi-structured environment, importance arises for the researcher to stay within the same guidelines for each interview in order to collect similar data from each participant (Yin, 2003).

For purposes of this thesis, semi-structured key informant interviews in addition to document reviews were used to try to more holistically understand capacity in environmental public health surveillance systems to detect and monitor the health outcomes of a changing climate. Key informant semi-structured interviews were selected due to the fact that policy-makers, administrators and community leaders in northern Aboriginal populations have particular knowledge and insight on the studied phenomenon: environmental public health surveillance. A semi-structured interview guide, founded on a conceptual framework from McNabb et al. 2002 was developed to ensure consistency in language and discussion topics for this research (Appendix A). The researcher conducted a total of 16 interviews, 11 from the health sector and 5 from the environment sector, from September 2006 to February 2008. From these data strategies (document reviews and key-informant semi-structure interviews), the researcher had an opportunity to look for convergence (triangulation) among multiple data sources adding strength and rigor to the research approach. In addition, document reviews offered a secondary source of data, when available, to corroborate, complete or complement findings. When the convergence of documentation and key informant data did not corroborate each other, the researcher looked for other sources of verification (e.g. additional documents or other key informants). Also, the researcher was able to re-contact key informants to ask for clarification upon conflicting

conclusions. Ultimately, upon lack of convergence, the researcher presented findings from the key informant interviews as they represent the current and actual levels of activity within health surveillance and environmental monitoring systems.

Key Informant Selection

Sampling for key informants was conducted by snowball effect, a form of purposeful sampling, used to locate key informant interview participants. Creswell (1998, p. 119) notes that snowball sampling "*identifies cases of interest from people who know people who know what cases are information-rich*". To begin, key informant inclusion criteria were developed in consultation with research groups and government partners. Due to reduced staffing capacity and personnel turnover rates (Nunavut Public Service Annual Report, 2006-2007) in Nunavut, an organizational approach, by position title, was selected for the recruitment and contact process as opposed to individual targeted names. Key informant selection was targeted to professional positions having knowledge of environmental monitoring and/or public health surveillance in Northern Canada (e.g. Public Health Director, Wildlife Officer). The list was populated by speaking with government officials, researchers and national Aboriginal organizations for contact names in each identified position. Recruitment and retention of participants was conducted through email, letter and telephone calls. Upon contact with the potential key-informants, those with a minimum of eight months experience in their position were selected for interviews. An abridged list of select key informant selected professional positions can be consulted in Table 10.

Table 10

List of Targeted Case Study Key Informants Professional Positions

Identified Professional Positions of Interest for Key Informant Interviews
Nunavut Medical Officer of Health
Nunavut Physician
Nunavut Nurse, Community Health Representative
Nunavut Social Worker
Nunavut Environmental Health Officer
Nunavut Administrator: Hospital and Public Health
Academic Researcher: Independent and Institute Based
Nunavut Archivist
Nunavut Justice and Police Officer (RCMP)
Nunavut community and Local Organization Leaders: Hunters and Trappers Organizations, Advocacy Bodies, Aboriginal organizations,
Nunavut Director of Environment

Conceptual Framework

Yin (2003, p.34) describes internal validity as "establishing a causal relationship, whereby certain conditions are shown to lead to other conditions". Since the case study approach is not addressing an explanatory or causal link where cause 'x' led to impact or response 'y' (Yin, 2003), the threat to internal validity was deemed low. Internal validity is often, in case study research, extended to inference (Yin, 2003). To ensure generalization of results (validity), the case study approach must ensure it uses appropriate research tools and methods often addressed through construct validity. Yin (2003, p.34) describes construct validity as "establishing correct operational measures for the concept being studied". The construct validity of the study was addressed through two methods: participatory research methodology that emphasizes interaction between the researcher, research partners and key stakeholders (Cornwall & Jewkes, 1995); and the use of a conceptual framework. A participatory research approach contributes to construct validity by allowing a targeted consultation in the selection of appropriate research tools. In

addition, the use of a conceptual framework also contributes to construct validity by ensuring consistency in the recording of findings and increased clarity in reporting (Smyth, 2004).

As such, to address participatory research in this thesis, the researcher consulted with a broad range of experts in the North. These experts included, but were not limited to, for example, other researchers, managers and policy-makers with the intent to gain knowledge of systems and priorities in support of environmental public health surveillance. As a secondary element contributing to construct validity, a conceptual framework was used as "*a theoretical structure of assumptions, principles, and rules that holds together the ideas comprising a broad concept*" (Business Dictionary). In qualitative research, Smyth (2004) notes that the conceptual framework, as a research tool, can inform research design, provide reference points for discussion of literature, methodology and analysis of data, and contribute to the trustworthiness of the study. A conceptual framework from McNabb et al. (2002), endorsed and tested through WHO programs in developing countries, outlining the importance and key components of regional to national level surveillance systems was selected as a research tool and data collection framework for the thesis (Figure 4). McNabb et al.'s (2002) framework includes all the elements of a successful surveillance systems (Teutsch, 1994; Stephen B. Thacker & Berkelman, 1988) and specifically links each surveillance activity (variables) to its role in effective public health action. Furthermore, this conceptual framework was selected due to its ease of operationalization in the study in addition to being equally applicable to both health and environmental endpoints.

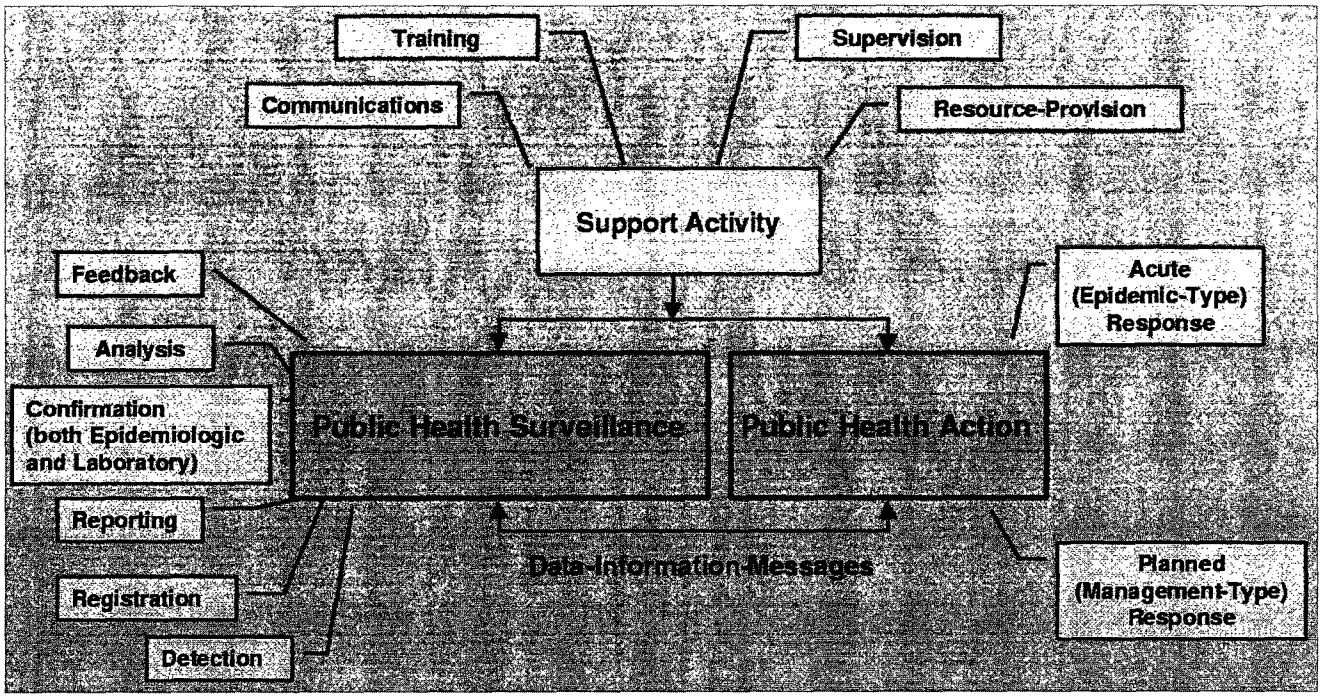

Figure 4. Conceptual framework of public health surveillance and action reproduced from McNabb *et al. (2002,* p. n.d.)

Each variable from the framework, dependant and mediating/intervening, was described and applied to a northern environmental public health surveillance context. In support of the research, one independent, eight dependent, and three mediating variables for environmental public health surveillance are identified through the present conceptual framework. The independent variable is the environmental public health surveillance capacity per se, due to its responsibility to detect and monitor climate impacted health outcomes. The dependant variables, which can be measured and observed among organizations (Creswell, 2003) include: detection; analysis; confirmation; reporting; registration; feedback; acute response; and planned response. Mediating factors or intervening variables for surveillance and monitoring include: communication; training, supervision and resource provision. Each variable is defined and described for both health surveillance and environmental monitoring in Table 11.

Table 11

Dependent, Mediating or Intervening Variables of Surveillance Activities for Both Health and Environmental Events, adapted from McNabb et al (2002) and Owens et al. (2007)

Dependent Variables: Core activity	**Health**	**Environment**
Detection/ Measurement	Case/event/public health circumstance; Often at the health-facility level but not always	Sampling of specific parameter for the environment.
Registration	Formal reporting through a standardized procedure	Formal reporting through a standardized procedure
Confirmation	Evaluation of epidemiological criteria or laboratory results	Evaluation results which precede registration
Reporting	Movement of public health surveillance data collected from lower levels of the health system to higher ones.	Movement of environmental surveillance data collected from lower levels of the environmental system to higher ones
Analysis	Once received at the appropriate level, data are analysed producing results which are interpreted into public health messages used for action.	Once received at the appropriate level, data are analysed producing results which are interpreted into public health messages used for action.
Feedback	The flow of information from higher levels to lower ones	The flow of information from higher levels to lower ones
Acute Response	Occurs directly, reactively and generally includes public health action	Responses occur directly, reactively and generally includes environmental public health action
Planned Response	Occurs with standardized frequency over time and requires vision of future needs	Occurs with standardized frequency over time and requires vision of future needs

Mediating/Intervening Factors: Supporting Activities	Health	Environment
Communication	Provided from a public health authority, provision of public health messages through health bulletins and other mediums	Provided from an environmental authority, provision of messages through environmental bulletins and other mediums
Training and Supervision	Considered the day-to-day operations, management and decision making	Considered the day-to-day operations, management and decision making
Resource provisions	Availability of funds, trained personnel and materials such as infrastructure	Availability of funds, trained personnel and materials such as infrastructure

From the conceptual framework, an interview guide was designed (Appendix A) to collect information describing environmental public health surveillance abilities in Nunavut related to each of the variables in the context of climate change and health impacts. Organization of the guide was divided into broad categories of environmental and health endpoints using specific climate and health related indicators from Furgal et al. (2002). A full list of the indicators proposed by Furgal et al. (2002) can be consulted in Appendix B. The results from the data collection methods are presented through two mediums: a descriptive text of the key informant interviews for each of the climate related health and environmental endpoints and a summary table format indicating the presence, partial presence, absence or lack of information availability related to a particular endpoint (component of surveillance or monitoring). In addition, the summary table indicates if the information for each collected variable is part of a 'formal or informal' surveillance system. For the purpose of this thesis, 'formal' is considered as a systematic collection and collation of data such as in McNabb et al.'s (2002) framework.

'Informal' refers to 'health and environmental activities performed non-systematically linking to public health action through non-conventional channels' (e.g. citizen requesting a land-based water quality test due to personal concerns, other forms of ad-hoc reporting and analysis with follow-up or not).

Analysis and Observations

Data analysis relied on a framework approach of mapping and interpretation as defined by Pope (2002):

> "...using charts to define concepts, map the range and nature of phenomena, create typologies and find associations between themes with a view to providing explanations for the findings. The process of mapping and interpretation is influenced by the original research objectives as well as by the themes that have emerged from the data themselves" (p.116)

Following this approach, a data matrix (Appendix C) with all dependent and mediating/intervening variables was created to describe the existence of public health and environmental monitoring data for the analysis of its capacity to detect and monitor the health outcomes of a changing climate. The research evaluates the present system's characteristics via those proposed by McNabb et al. (2002). Following, it asks key questions (Health Canada, 2004) to better understand the system's capacity such as:

1. What components of surveillance and monitoring systems exist?
2. Do the systems function in a way that allows capturing of information required to monitor climate and health issues?

3. If system components are missing, are there other compensatory actions in their absence?
4. What measures could improve performance and productivity of the surveillance system and the program(s) that it supports?

Ethics and Role of the Researcher

Creswell (2003, p.184) states that qualitative research and the interpretative nature of such research introduces a range of strategic, personal and ethical issues that must be identified, considered, and addressed. Due to a sustained and involved process with research participants, biases and ethical issues might arise within the study (Creswell, 2003). In qualitative research, an individual researcher, as the main instrument of data collection, might be in a biased situation due to personal attributes such as culture, disposition, personal abilities, group membership or other environmental factors (Cohen & Crabtree, 2008; Malterud, 2001). Malterud (2001, p. 483-484) further defines this as "*a researcher's background and position will affect what they choose to investigate, the angle of investigation, the methods judged most adequate for this purpose, the findings considered most appropriate, and the framing and communication of conclusions*". In case study research, this bias can be addressed through reporting relevant preconceptions known as "reflectivity" where a researcher performs a self-reflection in relation to the topic of research (Norris, 1997) . For this thesis, three elements were identified and addressed: protection of participant rights, selection bias, and response bias.

The protection of participant rights was addressed though the process of approvals of institutional review and licensing boards. Ethics approval was provided from the ethics committee for research from the University of Ottawa as well as the Nunavut Research Institute.

Both certificates can be consulted in Appendix D and E. For the purpose of this research, informed consent and confidentiality were addressed through several mechanisms. These mechanisms included communication materials such as introduction letters to participants stating the research objectives and sponsorship (Appendix F). Also, consent forms (Appendix G) were presented and signed along with withdrawal options from the interview and/or full study at any time. The protection of informant confidentiality was addressed by alphanumeric coding, for example the first code will be regional (N=Nunavut) followed by their status as informant (Type=K1) with a numerical identifier at the end e.g. NKI05. The presentation of data is aggregate and stored in password protected computers (minimum of 2 passwords needed). All hard copy field notes are kept at a specific location for a minimum of 7 years after publication.

It is noted that, through professional and personal experience, the researcher, as a former resident of Nunavut working in the field of health care and a present employee of a national Aboriginal organization, may have introduced potential bias into the study through a variety of means. These biases may be of a positive or negative nature in terms of the success of the research project achieving its stated goals, or answering the proposed research question. The selection of the research topic may have been biased due to personal interests as well as preconceived ideas of environmental public health surveillance system capacity for the Territory. Personal and professional relationships with the researcher within the public health care system in Nunavut enabled the selection and ultimately the participation of select key informants either as friends or colleagues. Although personal contacts were utilized, most of the potential key informant selection bias was addressed through the consultation of government and research experts to identify key professional positions that held knowledge regarding the research question. However, in terms of response bias, personal relationships might have influenced key

informant responses due to the interviewer's familiarity with the participant in addition to the subject matter. Response bias was controlled by probing key informant responses seeking clarification when assumptions on the researcher's understanding of a particular endpoint or social context were made. In addition, the utilization of a conceptual framework allowing for consistent concepts to be applied throughout all interviews was used to decrease any data collection bias which in turn strengthened data interpretation.

Summary

The selected research approach for this thesis is an exploratory single case study situated in Nunavut, Canada. Given that the focus of this research is to explore environmental health surveillance capacity in a particular, unique, and contextual condition such as climate change health impacts among populations in remote, rural and Aboriginal settings, this approach and selection of the case study region, arguably lends itself well to understanding the established research question. In addition, very little is known about environmental public health surveillance capacity in Nunavut, or other northern regions to detect and monitor the health outcomes of a changing climate (Furgal et al. 2002). Therefore, an exploratory case study approach, using multiple data collection strategies to strengthen the study construct, offers the opportunity to develop a holistic understanding of processes and contributing factors (Yin, 2003) for effective environmental and public health surveillance and monitoring allowing the research to more easily identify future research gaps and additional recommendations.

Chapter 4: Overview of Case Study Region, Public Health Surveillance and Environmental Monitoring

This chapter provides a general overview of the case study region of Nunavut outlining the governance structures, geography, health, and wellness statistics, in addition to the current Territorial climate change impacts. This overview is important to understanding and contextualizing the results and discussion on environmental and public health surveillance and monitoring in the following chapters of the thesis. It also provides an overview of the major organisations involved in both public health or environmental management and their respective areas of expertise, programs and coordination within Canada and Nunavut. The particular organizations and programs chosen to present here were selected due to their ability to contribute to our understanding of current and future existing surveillance/monitoring systems underway at the Federal and Territorial levels with specific contributions to track climate related health impacts. The information collected for this chapter is compiled from federal and territorial documents as well as respective organization's websites.

Case Study Region: Geography and Governance

Nunavut, originally the eastern part of the Northwest Territories, is the largest and newest Territory in Canada since 1999. It is bordered by the Northwest Territories and Arctic Ocean to the west, Manitoba to the south, Hudson's Bay and Baffin Bay to the east and it extends all the way to the North Pole including most of Canada's Arctic islands covering approximately 2,093,190 square kilometres (Nunavut Planning Commission, 2007). Nunavut, and its 28 communities, includes one fifth of Canada's land mass. Nunavut is

divided into three distinct regions: the Kitikmeot to the west; Kivalliq to the south; Qikiqtani to the east represented in Figure 5 and 6 (Atlas of Canada, 2003) .

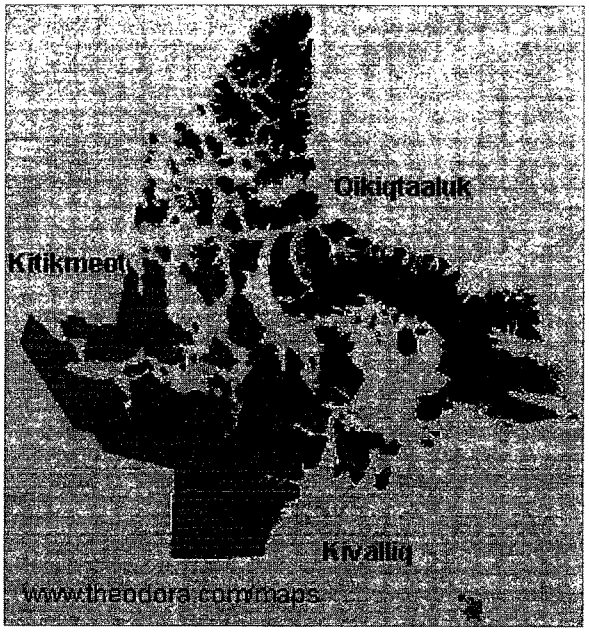

Figure 5. Regional Map of Nunavut from: http://www.geographic.org/maps/nunavut.html

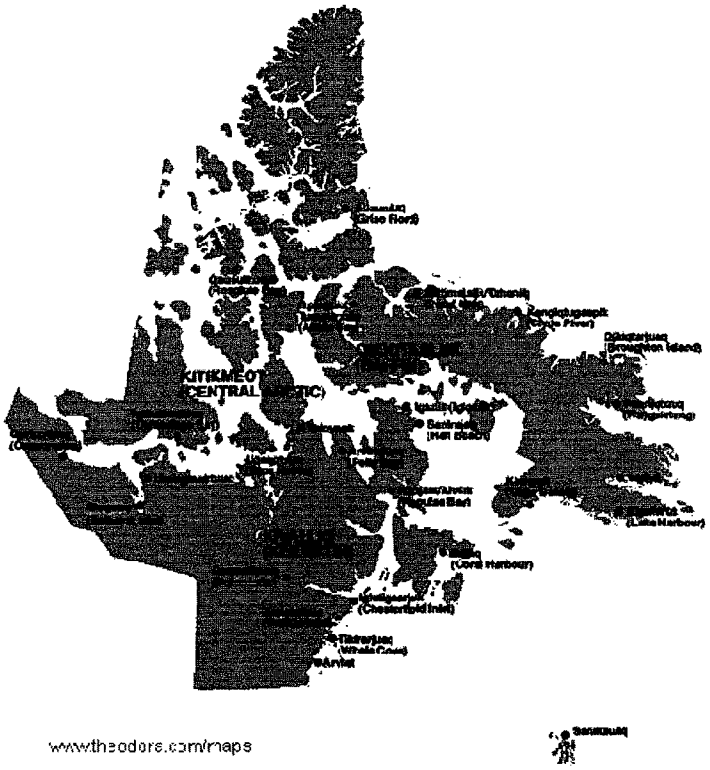

Figure 6. Community Map of Nunavut from: http://www.geographic.org/maps/nunavut.html

The Nunavut Land Claims Agreement Act was signed on May 25, 1993 and is the largest land claims agreement in Canadian history. The Territory, officially recognized in 1999, negotiated an incremental devolution of responsibilities from the federal to territorial level over a sixteen year period spanning from 1993-2009 (Nunavut Planning Commission, 2006). The political and government structure includes a 19 Member elected Legislative Assembly (MLA), a Cabinet, and a Territorial Court with highly decentralized departments and agencies throughout the Territory (Nunavut Planning Commission, 2006). In Nunavut, Nunavut Tunngavik Incorporated (NTI) is a non-profit organization representing Inuit and their interests. NTI's mandate is the full implementation of the land claims agreement signed in 1993 with a present day emphasis on the devolution of environmental management responsibilities from the federal to territorial level (Nunavut Tunngavik Incorporated, 2008).

Within Nunavut, you can find four of the fifteen types of ecozones represented in Canada (Atlas of Canada, 2001). They include: Northern Arctic, Arctic Cordillera, Southern Arctic, and Taiga Shield (Atlas Canada, 2001). The Territory is mostly comprised of permafrost, glaciers and tundra where its winters are typically very cold with average January temperatures of -20°C along southern Qikiqtani to -37° C along northern Ellesmere Island (Atlas of Canada, 2001). Average summer temperatures range from 10°C along the south to 2°C further north; inland temperatures are typically warmer (Atlas of Canada, 2001). Today, Nunavut is presently experiencing changes in climate (Furgal & Prowse, 2008). The physical nature of these impacts include some of the following: warmer average year round temperatures (note: eastern Nunavut is cooling while the western part is warming), warmer than average ground temperatures, rise in number of yearly extreme storm events, shifts in prevailing wind direction, less snow and rain, and changing snow and ice conditions (Natural Resources Canada, 2006).

All of Nunavut's 28 communities are coastal with the exception of one, Baker Lake (Figure 6). Its population is comprised of 85% Inuit and the remaining 15% as non-Aboriginal ethnicities (*Aboriginal peoples of Canada: Inuit*, 2001 Census Data). Of the 1,172,790 people who identified themselves as an Aboriginal person in the 2006 Census, about 4%, or 50,485, reported that they were Inuit. This was a 26% increase from 40,220 in 1996 (Statistics Canada, 2006). The population of Nunavut in 2006 was 29,474 with an increase of 10.2% from the 2001 census. Of the 50,485 individuals who self-identified as Inuit, 49%, 24,600, lived in Nunavut making this Territory the most densely Inuit populated region in Canada. Four of the five largest Inuit communities in Canada are found in Nunavut and include: Iqaluit, Arviat, Rankin Inlet, and Baker Lake.

The territorial residents of Nunavut, also called Nunavummiut, live in a unique environment which ultimately affects their capacity to adapt to the impacts of a changing climate (Furgal & Prowse, 2008). The following statistics and tables represent some of the health and socio-economic information which could be considered to fully understand Nunavut's capacity to adapt, respond and control the health impacts of a rapidly changing climate.

Health endpoints associated with the direct and indirect impacts of climate change in Nunavut include increased mortality and morbidity trends (Furgal, 2008; Furgal & Prowse, 2008; Furgal & Seguin, 2006). Some of these trends are characterized by increases in: exposure to vector-borne infectious diseases, new and emerging diseases, unintentional injuries, food insecurity, respiratory and cardiovascular disease, cultural erosion and psychosocial disruption (Furgal, 2008; Furgal & Prowse, 2008; Furgal & Seguin, 2006). In Nunavut, life expectancy is ten years lower than that of other Canadians (Government of Nunavut, 2004). In contrast to all other regions of Canada, Nunavut's population has a life expectancy of 68.7 compared to 77.9 for that of Canada (Statistics Canada, 2005). The principal causes of mortality for Nunavut are unintentional injuries (which includes suicide and other accidents) and lung cancer (Government of Nunavut, 2004). Table 12 represents selected mortality trends for the Territory of Nunavut.

Table 12

Selected Crude Mortality Rates by Cause (per 100,000 deaths) for Canada and Nunavut

*Reproduced from Furgal (*2008, p. 316)

Indicator	**Canada**	**Nunavut**
Total Mortality Rates (per 1,000) (2004) ‡	7.1	4.1
Major cardiovascular diseases	233.2	78.9
Acute myocardial infarction	59.8	10.3
Deaths due to heart attack	52.1	3.7
Lung Cancer	48.2	209.5
Accidents, unintentional injuries	28.6	30.9
Transport accidents (motor vehicle, other land transport, water, air and unspecified	9.9	27.5
Accidental drowning	0.8	<0.5
Intentional self-harm (suicide)	11.9	106.4

Note: Crude mortality rates per 100,000 deaths in 2003 unless otherwise noted.
‡ Population estimates used for the 2003 mortality rate calculations are July 1, 2003 updated
Post censal estimates, adjusted for net census under coverage and included non-permanent residents (Statistics Canada, 2004a).
Source unless otherwise indicated: Statistics Canada, 2006.

In addition to the health indicators presented in Table 12, socio-economic factors can also influence Nunavummiut's ability to adapt to the health outcomes of a changing climate. Examples include: lower personal average income, higher percentage of lone female-parent families, and lower high school graduation rates (Furgal, 2008; Statistics Canada, 2005) . The following Table (13) expresses select socio-economic indicators for Canada and Nunavut.

Table 13

Selected Social and Economic Indicators for Canada and Nunavut reproduced from Furgal (2008, p. 319)

Indicator	Canada	Nunavut
Sense of belonging to community (very strong or somewhat strong)	62.3	80.9
Percentage of Census families that are lone female-parent families	15.7	25.7
Personal average income (year 2000) $	29,769	26,924
Percentage of long term unemployed (labour force aged 15 and over) *	3.7	11.2
Percentage of population aged 25-29 that are high school graduates	85.3	64.7

Note: Labour force aged 15 and over who did not have a job any time during the current or previous year
Source unless otherwise indicated: Statistics Canada, 2001

Despite considerable disparities in health status between Canadian averages and other population sub-groups, experts observe trends in Inuit health conditions and report a general decline of infectious diseases, increase of chronic diseases and increase of social pathologies such as violence, suicide and substances abuse (Bjerregaard, Young, Dewailly, & Ebbesson, 2004).

In summary, the information presented in this section describes the case study region for the following categories: geography, governance, climate change impacts, and select health and socio-economic indicators. The information was presented to contextualize the potential influencing factors that may contribute to understanding current and future environmental public health surveillance capacity in Nunavut.

Public Health Surveillance in Canada and Nunavut

The core functions of public health practice in Canada are delivered through a multitude of organizations from federal departments and agencies, provincial and territorial agencies, and municipal levels of government, non-government organizations, and professional associations in addition to others (Lydia, Ole Frithjof, & Douglas, 2007; WHO Regional Office for Europe, 2005). As such, these agencies and stakeholders participate in the development and support of infrastructure, systems, and policy to ensure monitoring of population health and its threats (and trends) within a given population or community. The following will give a brief synopsis of the major federal and territorial organizations (Health Canada, Public Health Agency of Canada, Statistics Canada, Department of Health and Social Services in Nunavut) and their activities which directly or indirectly have relevance to the capacity for environmental public health to detect and monitor the health outcomes of a changing climate. The information presented in this section is collected from Federal and Territorial documents as well as the respective organization's published website information. The section first provides an overview of initiatives and legislative processes at the Federal level and then those that are particular to the Territory of Nunavut.

Public health surveillance activities constitute an important component of the federal public health system. A selected list of surveillance programs are described in the following section. The information is retrieved from the various federal department and agency websites.

Canadian integrated public health surveillance (CIPHS). This system is designed to support collection and collation of health surveillance data comprised of two major programs. First, the Public Health Information System (iPHIS) which can track immunization information and assists with communicable disease case management; second, the Laboratory Data Management System (LDMS) operating in the Laboratory for Foodborne Zoonoses in Guelph as well as the National Microbiology Laboratory in Winnipeg which assists in tracking, testing and quality assurance. Nunavut is not one of the jurisdictions participating in CIPHS (Public Health Agency of Canada, 2008b).

Canadian perinatal surveillance system (CPSS). Designed for maternal and child health surveillance with targeted measurement of select health indicators. Nunavut is not part of the jurisdictions participating in CPSS (Public Health Agency of Canada, 2008b).

C-EnterNet. This program is designed to support the reduction of enteric disease by comprehensive sentinel site surveillance that focuses on food and water safety. Nunavut is not one of the jurisdictions participating in C-EnterNet (Public Health Agency of Canada, 2008b).

Chronic disease infobase. This database provides users with public health statistics, risk factors as prevalence rates for certain chronic conditions, behaviors, and other major non-communicable diseases. It retrieves its information from a variety or sources such as census data, community health surveys, vital statistics databases, cancer registries as well as

others. Nunavut statistics are reported through this database (Public Health Agency of Canada, 2008b).

Disease surveillance on-line. This online system has three major components: cancer, notifiable disease and injury surveillance data reporting. It provides users with incidence, prevalence and other epidemiological data. The reporting years vary from component to component however data for each of the three (cancer, notifiable disease and injury surveillance) exists for Nunavummiut (Public Health Agency of Canada, 2008b).

Geographic information systems (GIS) for public health practice. This program, offered free of charge by the Public Health Agency, is used to store, analyze and display health information with spatial components. It is also used to link health data with other information such as environmental data. From the reviewed documentation (both federal and territorial websites) it does not appear that Nunavut is accessing this service of the PHAC (Public Health Agency of Canada, 2008b).

Canada communicable disease report: Flu Watch. This program summarizes influenza surveillance activities across the country. Provinces and territories, including Nunavut, participate in the program. Flu Watch is part of the Canada Communicable Disease Report Weekly Digest that also reports on other infectious diseases and preliminary outbreaks (Public Health Agency of Canada, 2008b).

Notifiable diseases monthly report. This report presents a summary of the number of cases for notifiable diseases across Canada. Nunavut is included in these reports on a regular basis (Public Health Agency of Canada, 2008b).

West Nile virus surveillance information. This program reports on the human cases and asymptomatic infections of West Nile virus. Nunavut is included in the reporting (Public Health Agency of Canada, 2008b).

In summary, Table 14 offers an overview of the surveillance programs presently available and operating at a federal level with a particular emphasis on program participation from Nunavut.

Table 14

Federal Health Surveillance Programs with a Special Note on Nunavut Participation

Program	**Nunavut**
Canadian Integrated Public Health Surveillance (CIPHS)	Not participating
Canadian Perinatal Surveillance System (CPSS)	Not participating
C-EnterNet	Not participating
Chronic Disease Infobase	Participating however less data sets are available for Nunavummiut statistics
Disease Surveillance On-Line	Participating however less data sets are available for Nunavummiut statistics
Geographic Information Systems for Public Health Practice	Not participating
Canada Communicable Disease Report: Flu Watch	Participating fully in Flu Watch
Notifiable Diseases Monthly Report	Participating however less data sets are being submitted for Nunavut
West Nile virus Surveillance Information	Participating

Another important department involved in generating surveillance data for Aboriginal people is Statistics Canada. Specifically, Statistics Canada supports the Canadian Vital Statistic Registry for births/deaths/marriages, Aboriginal People's Survey, Census specific information for Aboriginal population profiles and the National Population Health Survey (now -Community Health Survey). Each will be briefly described below.

Vital statistics. Vital statistics are derived from birth and death certificates sent from territorial and provincial vital statistics registrars. These databases collect information annually on live births, demographics and medical causes of death. Nunavut participates in submitting data to the program (Statistics Canada, 2008b).

Census information – Aboriginal population profile. This census, performed every five years, is designed to provide information on demography, social and economic characteristics in addition to housing. Aboriginal population profiles are available where Aboriginal self-identity population is above 250. Information from the results of the survey are available free of charge online. Nunavut is included in the survey findings and publications (Statistics Canada, (n.d))

Aboriginal people's survey. This survey, performed every five years following the Canadian census, aims to collect data on the social and economic condition of Aboriginal people in Canada. Its purpose is to identify the needs of Aboriginal people (Inuit, Métis, First Nations) in areas of health, language, employment, income, education, housing and mobility. This survey is developed and implemented in partnership with National Aboriginal Organizations. Information from the results of the survey is available online. Nunavummiut participate in this survey (Statistics Canada, 2009).

National population health survey – Community health survey. The central objective of this survey is to gather health data from specific sub-regions of provinces and territories in Canada. It is designed to support health surveillance and population health

research and performed on a biennial basis. Nunavut's ten largest communities participate in the survey (Statistics Canada, 2008a)

In summary, the following table (Table 15) offers a brief overview of Statistics Canada programs presently available and operating at a federal level with a particular emphasis on program participation from Nunavut.

Table 15

Relevant Statistics Canada Programs and Nunavut's Participation

Program	**Nunavut**
Vital Statistics	Participating
Census Information – Aboriginal Population Profiles	Participating
Aboriginal People's Survey	Participating
National Population Health Survey – Community Health Survey	10 largest communities included only

Public Health in Nunavut

Until 1999, health for the region of Nunavut was administered by the Government of the Northwest Territories. Legislation governing health in Nunavut was carried over from the Northwest Territories in 1999 (Health Canada, 2008a). It has since devolved to the Government of Nunavut following the implementation of Nunavut's land claims agreement. Health, in this newest Territory, is funded from Federal government transfers and administered by the Government of Nunavut. Although all regions in Nunavut are centrally

served by the government of Nunavut's Health and Social Services, its delivery is divided into its three distinct regions: Qikiqtani, Kivalliq and Kitikmeot.

As per Nunavut's Health and Social Services Department website, their mission is to promote, protect and provide for the health and well being of Nunavut residents, in support of leading self-reliant and productive lives (Government of Nunavut Department of Health and Social Services, 2000). Its core areas of focus include primary health care, child protection, family services, health promotion and protection as well as injury prevention. Public Health in Nunavut is coordinated from the office of the Chief Medical Officer of Health and assures appropriate standards of public health practice in monitoring, evaluating, communicating and responding to health issues (Government of Nunavut Department of Health and Social Services, 2000). Public Health in Nunavut is also supported by the federal Non Insured Health Benefits (NIHB) program. This program is Health Canada's national, needs-based health benefit program that funds benefit claims for a specified range of drugs, dental care, vision care, medical supplies and equipment, short-term crisis intervention mental health counselling and medical transportation for eligible First Nations people and Inuit (Health Canada, 2008b).

Primary health care in Nunavut is delivered through 24 community health centres (larger Community health centers exist in Rankin Inlet and Cambridge Bay), in addition to the Baffin Regional Hospital in Iqaluit. Most residents of Nunavut are cared for in their home community however, for serious illness cases or services that cannot be offered in their community, patients are transported by plane to other referral centres in the south. Depending on the geographical placement of their community, patients (clients) can be

referred to Edmonton, Ottawa, Toronto, Yellowknife and Winnipeg. The Government of Nunavut estimates that over one fifth of its total annual budget is allocated to medical travel (Health Canada, 2008a).

Health promotion in Nunavut includes programming for the prevention of diabetes, home and community care, addictions and mental health, foetal alcohol spectrum disorder prevention, as well as tobacco control. In addition to providing targeted health promotion programming, the Health and Social Services Department of Nunavut provides specific social services for children and families, mental health, community corrections, adoption services as well as acting as public guardian and trustee (Government of Nunavut Department of Health and Social Services, 2000).

In summary a number of health models and programs exist within health governance and delivery structures at the federal and territorial levels. The purpose of this section is to demonstrate federal and territorial structures that interact or can contribute to understanding environmental public health surveillance capacity in Nunavut to detect and monitor the health outcomes of a changing climate.

Environmental Management and Monitoring in Canada and Nunavut

Similar to public health, environmental management and monitoring falls within the responsibility of several agencies working at various levels and scales from federal, provincial, territorial, municipal, to non government and Aboriginal organizations. Environment Canada states that several levels of government have responsibilities to protect the environment and that the shared nature of environmental jurisdiction requires close

cooperation between federal, provincial, territorial and Aboriginal governments for environmental well-being (Environment Canada, 2006a) . The following section will give a brief synopsis of the major organizations and/or programs (Environment Canada, Indian and Northern Affairs Canada, Fisheries and Oceans Canada, Nunavut Wildlife Management Board, and others) which directly or indirectly have relevance to the capacity for environmental public health to detect and monitor the health outcomes of a changing climate in Nunavut. The information presented in this section is collected from Federal and Territorial documents as well as the respective organization's published website information. Federal initiatives and legislative processes are first described, followed by those that are particular to the Territory of Nunavut.

Climate and weather monitoring. Environment Canada is responsible for meteorology as well as education and research related to climate in Canada. Nunavut is included in its geographical area of responsibilities (Meterological Services Canada, 2002). Additional information on the contribution of Environment Canada's Meteorological Services in Nunavut will be further discussed in Chapter 5.

Environmental assessments. Federal legislation addressing environmental management in Canada are *the Canadian Environmental Protection Act, 1999 (CEPA 1999)* and the *Canadian Environmental Assessment Act (CEAA)*. The Minister of the Environment is responsible for administering these acts, with some responsibilities of *CEPA 1999* falling to the Minister of Health. The Federal Government is involved in environmental assessments of projects that trigger the *Canadian Environmental Assessment Act*, such as large scale hydroelectric dams (Environment Canada, 2009). The Canadian Environmental

Assessment Agency maintains a registry of environmental assessment documentation, which provides a wide range of environmental monitoring data, as well as information on human populations (Environment Canada, 2009).

Ecological monitoring and assessment network (EMAN). Environment Canada is the coordinating body for EMAN which engages a range of organizations such as federal, provincial and municipal governments, academic institutions, Aboriginal communities and organizations, industry, environmental non-government organizations, volunteer community groups, elementary and secondary schools and other groups/individuals involved in ecological monitoring, with a purpose to better detect, describe, and report on ecosystem changes within Canada (Environment Canada, 2008b). The program has an on-line data management system to enable partners to enter, access, view, manage, search and share data that follow the standardized protocols (Environment Canada, 2007b).

Water (levels, quality, other) monitoring. Several federal departments are involved in water monitoring in Canada. The following will briefly describe their jurisdiction and areas of responsibility.

The Federal Department of Fisheries and Oceans provides services related to the monitoring of water levels through its Canadian Hydrographical Service (CHS). Their website indicates the program is serving the territory of Nunavut (Fisheries and Oceans Canada, 2007).

The Water Survey of Canada, administered through Environment Canada, is responsible for the collection, interpretation and dissemination of standardized water resource data and information in Canada (Environment Canada, 2004). Services include the measurement, acquisition, processing, transformation and management of environmental data and provide real-time, current year and historical information in the order of 2,200 sites in Canada. Approximately 39 sites were identified (active & non active) in Nunavut (Environment Canada, 2006b)

The Guidelines for Canadian Drinking Water Quality are published by Health Canada (Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment, 2008). These guidelines set the maximum acceptable concentrations of microbiological, chemical, physical and radiological substances in drinking water.

Permafrost monitoring. Natural Resources Canada's Geological Survey (GSC) performs services with respect to the monitoring, mapping, and modelling of permafrost in Canada (Natural Resources Canada, 2007). National Permafrost Databases on both ground temperatures and permafrost thickness have been compiled and are accessible by internet access. The data is compiled from observations of over 500 government, university and industry boreholes. Information on site characteristics such as air temperature, snow cover and vegetation which influence the ground thermal regime and the permafrost distribution has also been compiled. The reference for each site is also provided and may be consulted for further information. The entire database and complete text are published (Smith, 2005). The

majority of the sites in Nunavut for both the ground temperature and the permafrost thickness are inactive (Natural Resources Canada, 2007).

Ice and glaciers monitoring. The Canadian Ice Service provides information about ice conditions in Canadian waters including ice hazard bulletins, daily iceberg bulletins and charts. In terms of monitoring, the Service maintains the Canadian Ice Service Archive for climatology purposes, and contributes Canadian ice data to the World Data Center for Glaciology (Environment Canada, 2003).

Wildlife management monitoring. Environment Canada's Canadian Wildlife Service is responsible for the protection and management of migratory birds, nationally important wildlife habitat, and endangered species. It also conducts research on nationally important wildlife issues as well as deals with the international trade of endangered species (Environment Canada, 2007a). Responsibilities for provincial and territorial wildlife fall within the respective jurisdictions and the range of activities include conservation and management of wildlife populations and habitat within their borders, issuing licences and permits for fishing, game hunting, and trapping, guidelines for safe angling and trapping, and outfitting policies (Environment Canada, 2007a).

In summary, the following table (Table 16) offers a brief overview of programs presently available and operating at a federal level with a particular emphasis on program participation from Nunavut.

Table 16

Relevant Federal Environmental Programs and Nunavut Participation

Program	Nunavut
Climate and Weather Monitoring	Included
Environmental Assessments	Included when applicable to activities in the Territory
Ecological Monitoring and Assessment Network (EMAN)	EMAN-North is inactive – Nunavut is no longer collecting data under this program.
Water (levels, quality, other) Monitoring	Included
Permafrost Monitoring	Included – however, sites are inactive
Wildlife Management Monitoring	Included, certain species are being monitored

Environmental Monitoring and Management in Nunavut

Management of the environment and wildlife in Nunavut is a coordinated effort from the Government of Nunavut's Department of Environment, the Nunavut Planning Commission in addition to the Nunavut Wildlife Management Board.

Nunavut Planning Commission. The Nunavut Planning Commission, established under the Nunavut Land Claim Agreement Act is responsible for a variety of activities pertaining to environmental monitoring and wildlife in the Territory (Nunavut Planning Commission, 2006). The organization is responsible for land use plans and policies guiding resource use and development (water, wildlife, offshore areas) in the Territory. Members of this organization are nominated by Inuit organizations in addition to the Federal and Territorial governments (Nunavut Planning Commission, 2006)

The Nunavut Planning Commission also administers the Nunavut Environmental database, in partnership with the Arctic Science and Technology Information System, that collect publications and research projects about Nunavut, including environmental monitoring, climate change and health research. It presently has a collection of over 21,000 publications and can be accessed on-line (University of Calgary, 2009).

Wildlife management. Nunavut Wildlife Management has a legislated mandate for the management of terrestrial wildlife species in the territory. In addition to the Nunavut Wildlife Act, Wildlife Management is responsible for fulfilling Government of Nunavut's responsibilities under a wide range of federal legislation and international agreements and conventions, including on-going responsibility for the co-management of Nunavut wildlife as obligated under the Nunavut Land Claim Agreement Act. The following Acts are federal wildlife legislation applicable in Nunavut: Migratory Birds Act; Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act (WAPPRIITA); Species-At-Risk Act; Fisheries Act.

In the territory, there are several bodies or organisations that participate in the governance of the environment and wildlife such as the Nunavut Wildlife Management Board (NWMB). The ultimate responsibility for land and wildlife management is found with the Government of Nunavut and Federal agencies however, once NWMB makes recommendations, it is the responsibility of Territorial and Federal Governments to carry these out. The NWMB is accountable to Indian and Northern Affairs Canada, as the funding agency, and to the general public, as their key stakeholders. The NWMB is a co-management board, who meets in person four times a year (or as required by teleconference), with

representation from Inuit Organizations, the Government of Nunavut, and the Government of Canada. Table 17 outlines its duties and functions.

Table 17

Duties and Functions of the Nunavut Wildlife Management Board reproduced from NWMB Responsibilities (2008) webpage at:

http://www.nwmb.com/english/about_nwmb/responsibilities.php

NWMB duties and functions include:
Participating in research
Conducting the Nunavut Wildlife Harvest Study
Establishing, modifying or removing quotas and non-quota limitations on wildlife harvesting
Allocating wildlife resources (including shrimp and turbot quotas)
Approving plans for the management and protection of particular wildlife or wildlife habitats
Approving changes to boundaries of Conservation Areas that relate to the management and protection of wildlife and wildlife habitat
Approving the designation of rare, threatened and endangered species
Establishing qualifications for big game guides
Setting trophy fees
Identifying wildlife management zones and areas of high biological productivity, and making recommendations to the Nunavut Planning Commission on planning matters in that area
Advising governments, the Nunavut Impact Review Board, and others on compensation that should come from developers who damage wildlife habitat
Advising on ways to promote wildlife education, as well as training of Inuit for wildlife management
Providing advice and recommendations to the government on Marine Zones I and II, adjacent to the Nunavut Settlement Area
Participating in the negotiation or amendment of domestic inter-jurisdictional agreements
Identifying wildlife management research requirements
Funding research through the Nunavut Wildlife Research Trust Fund and the NWMB Studies Fund
Promoting the training and employment of Inuit in wildlife research.

Summary

In summary, Nunavut is characterized by a unique combination of geography, governance, health, and socio-economic conditions. This chapter presented a number of programs existing within health and environmental systems at the territorial and federal levels. It intended to summarize federal and territorial structures (health and environment) that interact or can potentially contribute to understanding environmental public health surveillance capacity in Nunavut to detect and monitor the health outcomes of a changing climate. Following chapters will provide the case study findings which take into consideration the unique combination of social and health indicators in Nunavut in addition to programs and agencies presently or potentially able to contribute data to environmental public health surveillance systems.

Chapter 5: Case Study Results for Public Health Surveillance and Environmental Monitoring Core Activities

This chapter presents the results of the case study on health and environment surveillance and monitoring activities required to track the health impacts of a changing climate in Nunavut. The collected information is divided into three sections: 1) case study results for health surveillance activities in Nunavut, 2) case study results for environmental monitoring activities in Nunavut and 3) a combination of health surveillance and environmental monitoring results with researcher notes on the interaction and capacity for both systems to detect and monitor the health outcomes of a changing climate in Nunavut. At the end of each section, a summary table is presented to demonstrate the presence of activities following the core functions of environmental public health surveillance as outlined by McNabb et al. (2002).

Data Collected

Key informant interviews were conducted between September 2006 and February 2008. A total of sixteen key informants, eleven from the health sector and five from the environmental sector were selected and interviewed, through a strategy of purposeful sampling and snowball effect. The interview data was triangulated with website searches, available reports and other related documentation. A total of 31 documents were consulted. By the nature of the case study information recorded, some presentation of information in this chapter is repetitive.

Section 1: Results for Health Surveillance Systems and Activities

The information collected for this section was obtained through key informant interviews within the Nunavut Health and Social Services department, Nunavut Vital Statistics Department, individual researchers as well as other organizations such as Inuit Tapiriit Kanatami. In addition to interviews, a combination of website searches and document reviews were performed. This chapter reports on health surveillance efforts and capabilities in Nunavut for indicators (Appendix B) related to environmental variables and their potential (indirect or direct) impact on health in light of climate and environmental change.

Patient records and primary health care delivery. Informants reported that primary care in Nunavut is predominantly provided by community health nurses. As per the Nunavut Community Health Report (GN, 2003), 82% of Nunavummiut are assessed by a nurse for their initial consultation and diagnosis. However, informants indicated the only exception to this pattern is in Iqaluit where a patient can have a physician consultation in outpatient physician clinics.

Informants reported that patient records are kept at the point of care, i.e. in the community where the consultation occurred. They also reported that copies of consultations are sent to the Government of Nunavut Information and Research Division of the Department of Health and Social Services in Iqaluit where they are verified for coding and completeness before they are entered in the database management software. Presently, informants reported that no central archiving system exists for Nunavut; therefore, records

are kept in their respective health centres as well as the Qikiqtani Regional Hospital in Iqaluit.

Informants described that patients requiring health services in a southern jurisdiction (i.e. Edmonton, Ottawa, and Winnipeg) have a patient record at the point of care clinic or hospital with copies of their dossiers sent to their respective community for discharge and follow-up instructions.

Mortality. One key informant shared that the Territory employs a Territorial Chief Coroner as well as lay coroners for each Nunavut community. Informants shared that the Territorial Chief Coroner investigates sudden and unexpected deaths together with the designate RCMP for a particular community if a criminal act is suspected. Also, an informant shared that the governing *act* for the investigation of sudden and unexpected deaths in the Territory is the *Nunavut Coroner's Act* (R.S.N.W.T., 1988).

Informants reported that uneventful deaths, meaning the event was not sudden or unexpected, are declared by a physician and coroner or, in special circumstances, by the nurse-in-charge for the community. Information from deaths is recorded on a death certificate and includes basic information such as name, age, sex. (Government of Nunavut Vital Statistics Department). Informants reported that a death certificate is typically filed within twenty-four to forty-eight hours after the occurrence of a death unless exigent circumstances exist, such as pending investigations. Also, they reported that deaths due to accidents (intentional and unintentional trauma, i.e., suicide, land- based accidents (all-

terrain-vehicle, snowmobile)) are investigated by the Royal Canadian Mounted Police (RCMP) and Chief Coroner for the Territory.

Informants report that all in-territory deaths are communicated to the Coroner (whether suspicious or not) by telephone or by paper copy of the death certificate. Also, they shared that the cause of death on a certificate lists the immediate cause of death followed by a secondary or contributing cause.

Respondents detailed that registration of death takes place where the death occurred; therefore, deaths in Nunavut are recorded in their particular community. However, respondents also shared that deaths of Nunavummiut that occur in other territories or provinces are recorded in that particular jurisdiction. Registration of death is then forwarded to the community Hamlet council office to issue a burial permit and subsequently forwarded to Nunavut's Vital Statistics Department.

Informants shared that autopsies are not performed in Nunavut; rather, the bodies are sent to southern jurisdictions such as hospitals in Winnipeg, Toronto and Ottawa (among others). They stated that if an investigation occurs, fluid samples can be taken in the Territory and sent to a central laboratory in southern Canada (Edmonton, Dynacare Labs) for analysis such as toxicology, drugs, and alcohol levels.

Informants shared that Nunavut originally formed the eastern part of the Northwest Territories (pre 1999) and specific Nunavut mortality data is only available from 1999 onwards. Therefore, informants reported that Nunavut has territory-specific data for the past

9 years and trend analysis is difficult due to the short time the territory has been collecting territory specific data in comparison to other jurisdictions.

Informants identified the Nunavut Department of Vital Statistics as the final recipient of mortality registration. They stated that coding on the registration forms follow the International Classification of Diseases 10 (ICD-10) from the World Health Organization. They also stated that software platforms being utilized to track vital statistic information are Oracle, Access and Excel. They reported that a paper copy of the registration is kept with the Vital Statistics Department in Nunavut in addition to being forwarded to Statistics Canada. Informants shared that requests for information pertaining to birth and deaths in Nunavut are ad hoc with Territorial and Federal departments issuing specific requests for required data. They also reported that no systematic reviews are being conducted at the vital statistic level, with the exception of census specific data.

Informants indicated that an annual report from the Coroner's office is published every year and information is presented for health endpoints such as the occurrence of suicide, cancer deaths in the past 5 years, investigations into Sudden Infant Death Syndrome (genetic testing) as well as others. At the time of the case study, no paper copy of the documentation was available for consultation.

Figure 7 illustrates the trajectory of mortality information for the Territory of Nunavut.

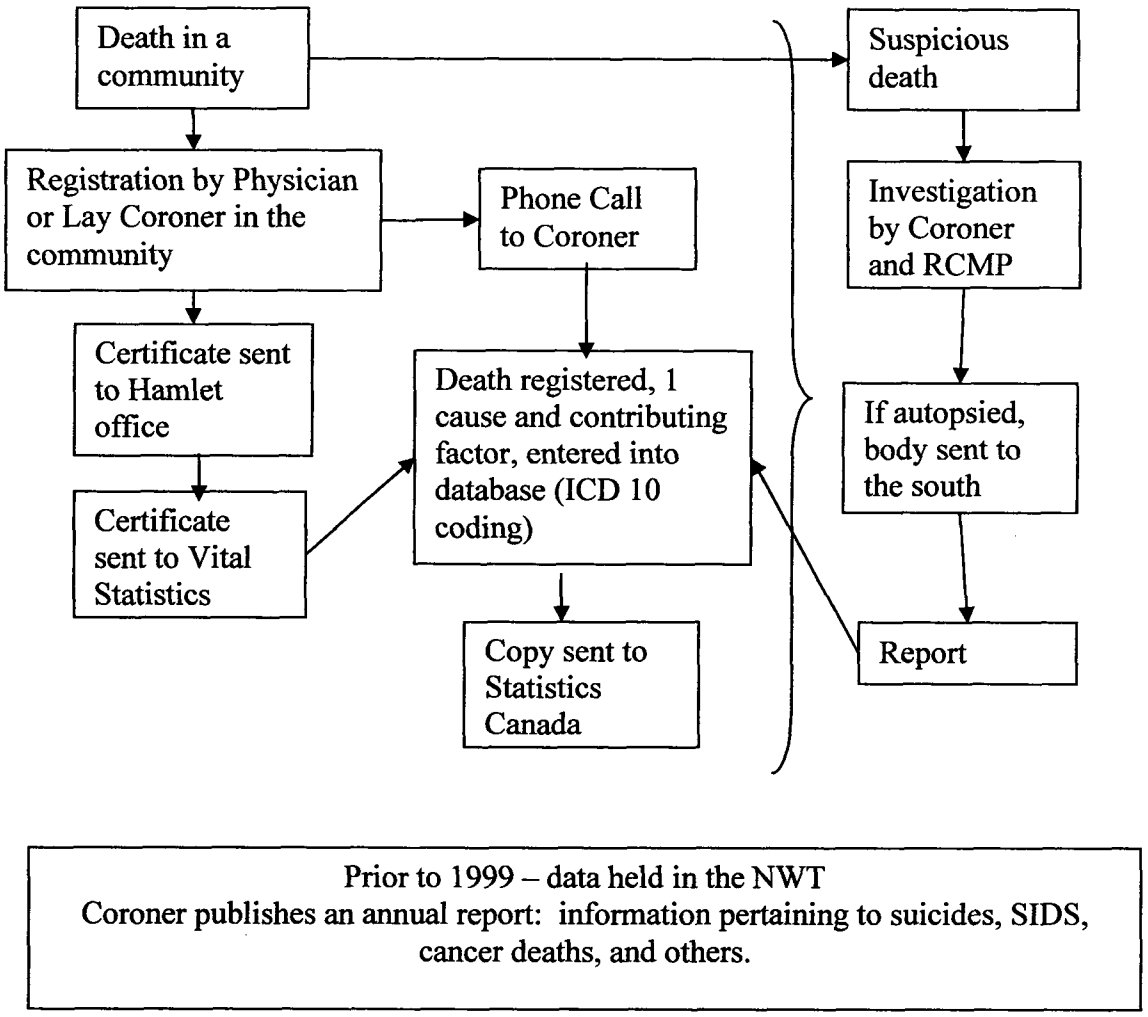

Figure 7. Information trajectory for mortality data in Nunavut

Injuries. Key informants indicated that morbidity data is recoded in patient records as per the ICD-10 classification from the World Health Organization. However, they also indicated they were unaware of any specific injury surveillance data beyond normal patient record coding. By conducting an online search, the researcher was able to access the Injury Surveillance On-Line database published by the Public Health Agency of Canada (Health

Surveillance and Epidemiology Division Centre for Health Promotion, 2008). This database reports injury statistics for the following categories:

1. Motor Vehicle Unintentional
2. Falls Excluding Fractures - Causes Unspecified.
3. Poisoning Unintentional
4. Other Unintentional
5. Suicide/Self-Inflicted
6. Homicide/Assault
7. Other Violence
8. Undetermined Intentional
9. All Other Injuries
10. All Injury Excluding Adverse Events

The following Figure (8) retrieved from the Injury Surveillance On-line database in January 2008, shows the leading causes of injury deaths for the Territories (NWT and Nunavut) are found in the following categories: suicide/self inflicted injury, other unintentional injuries, and, all other injuries. The website stipulates that data for these particular reports are often tagged with cautionary notes advising the reader that the information or data collected had sampling or data integrity issues.

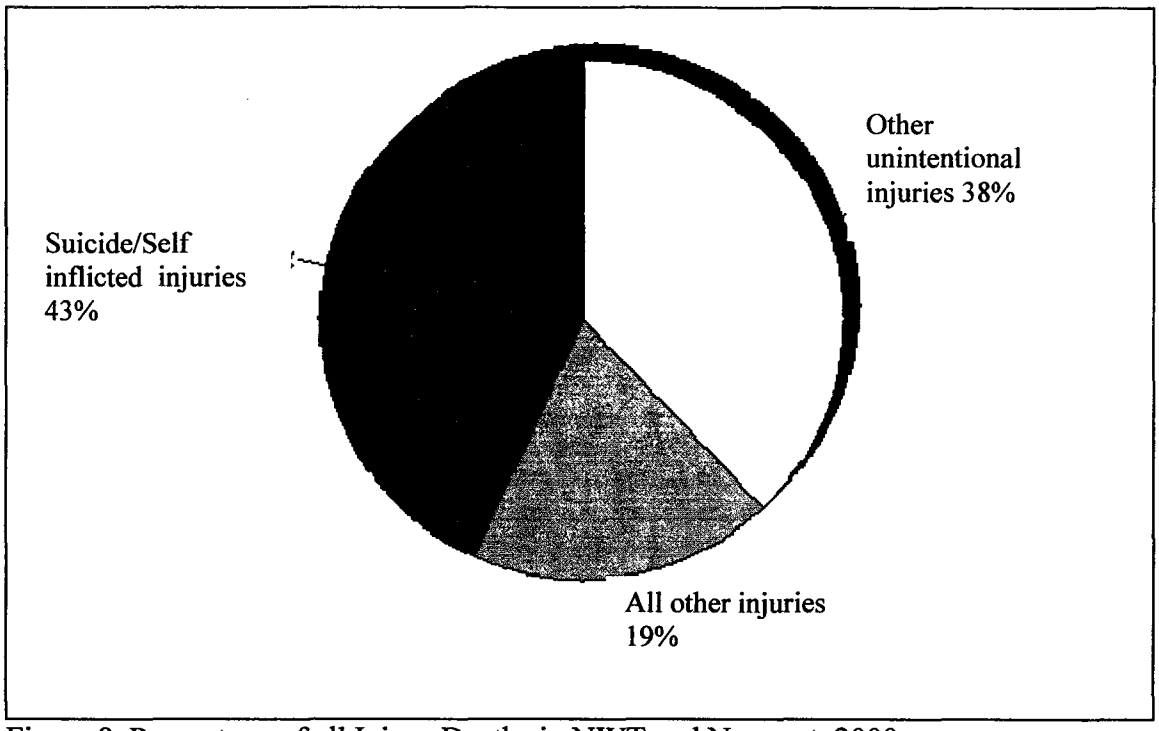

Figure 8. Percentage of all Injury Deaths in NWT and Nunavut, 2000

In addition to the injury surveillance database from the Public Health Agency of Canada, the researcher, through web based searches, also found other sources of injury surveillance information such as The Worker's Compensation Board (WCB) of the Northwest Territories and Nunavut's Annual Report. This WCB report details statistics for (formal wage earning sector) the number of work-related injury claims, lost-time, work-related fatalities and other information (Worker's Safety and Compensation Commission, 2006).

Disease and morbidity. Informants reported that Nunavut has a surveillance system in place for notifiable diseases as mandated by the Public Health Agency of Canada. These include systems for tuberculosis, influenza and some sexually transmitted infections. The full list of notifiable diseases for all Canadian provinces and territories can be found by

consulting the National Notifiable disease on-line database (Public Health Agency of Canada, 2008a). Informants indicated that depending on the health policy governing each notifiable disease, some diagnoses are reported to the territorial Medical Officer of Health within 24 hours and others up to 7 days later. Informants also reported that the laboratories in Rankin Inlet, Cambridge Bay and Iqaluit are equipped to test for electrolytes, basic blood analysis, urinalysis and cholesterol. In addition, the laboratories in Iqaluit can support thyroid testing, sexually transmitted infections such as gonorrhoea and chlamydia in addition to some microbiological analyses. Informants shared that Nunavut has a service agreement with Dynacare laboratories in Edmonton to conduct testing on all samples that cannot be tested in-territory.

Informants identified pandemic influenza surveillance as a best practice model for the Territory and described the trajectory of information. They noted, however, that this model used above average health resources (human resources time) to ensure the system functions effectively. A flow chart (Figure 9) illustrating influenza testing and tracking for the territory, as described by a key informant, is provided below.

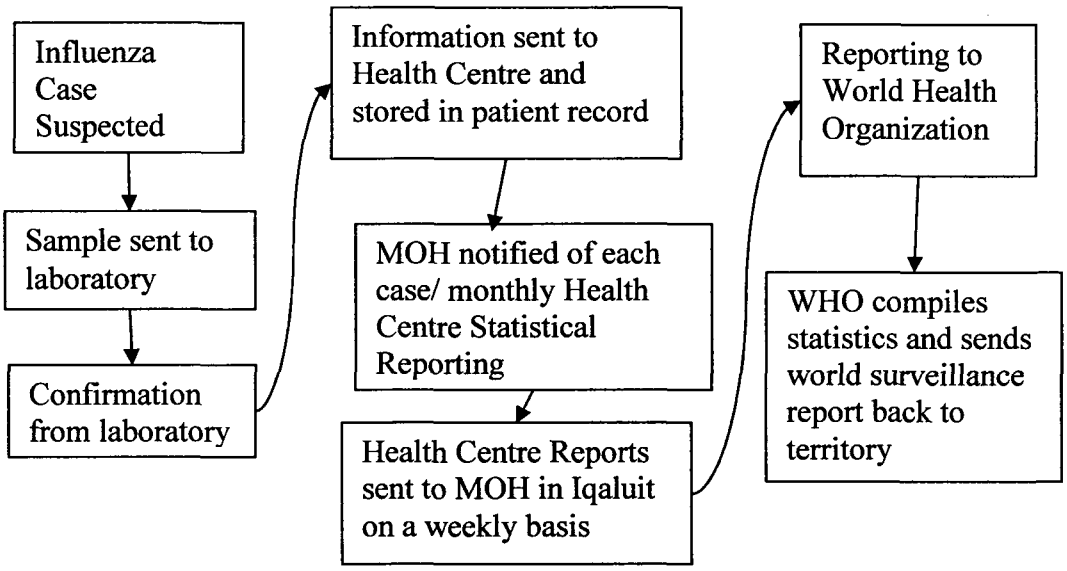

Figure 9. Information flow chart for pandemic influenza surveillance in Nunavut

Biomonitoring. Informants reported no official surveillance system for the biomonitoring of human tissues. However, they reported that data is collected, within the context of project-specific work such as the *Qanuippitali?" "How about us? How are we?" The 2007 Inuit Health Survey for Nunavut.* The survey's website (Nunavut Inuit Health Survey, 2007/2008) reports that the study's results are currently being analysed.

Determinants of health and community well-being. Indicators for the determinants of health as outlined by the Public Health Agency of Canada (2003) are as follows: income and social status, social support networks, education and literacy, employment/working conditions, social environments, physical environments, personal health practices and coping skills, healthy child development, biology and genetic environments, health services, gender and, culture. Although this list appears to be comprehensive, a preliminary discussion paper

on determinants of health from Inuit Tapiriit Kanatami (2007), details that the most important determinants of health, as they relate to Inuit, are: acculturation, productivity (employment), income distribution, housing, education, food security, health care services, social safety nets, quality of early life, addictions and, the environment (Inuit Tapiriit Kanatami, 2007).

Informants reported that sources of data contributing to the collection and monitoring for determinants of health and community well-being can be found through individual research publications and government surveys. Informants reported that the results of these research projects and surveys are circulated through channels such as Inuit organizations, online websites, journals as well as information portals.

Mental health. Informants reported that tracking and surveillance of mental health has traditionally been monitored in the same manner as other diseases. They stated that coding exists (ICD 10) for mental health endpoints, however, no sophisticated tracking or monitoring systems are currently utilized. Informants said that each mental health treatment or diagnosis is reported in the patient file and subsequently forwarded to the central data entry point in Iqaluit. Informants reported that they were unsure how the information was tracked however if endpoints such as depression or post-traumatic stress syndrome were tracked in the current database, reports could be generated from this central data entry point. Informants also reported the database includes suspected and confirmed clinical cases and is therefore not reliable for prevalence or incidence calculations.

Lost persons and search and rescue. The National Search and Rescue Secretariat website (2007) states that the administration for lost persons as well as search and rescue cases is a combined effort from the territorial and federal governing agencies. Search and rescue incidents can be divided into three categories: maritime, aeronautical and ground (National Search and Rescue Secretariat, 2007). Informants report that ground search and rescue responsibilities and declaration of lost and missing persons fall within the mandate of the RCMP (already described earlier in this chapter). An important note, from one informant, was made that a lost and missing person could potentially be a criminal act, and therefore the territorial RCMP is responsible for declaration. The fiscal and coordination responsibilities for search and rescue are discussed on the Federal Government's Search and Rescue Secretariat (SAR) website (National Search and Rescue Secretariat, 2007) and summarily represented in Table 18.

Table 18

Fiscal Responsibility for Search and Rescue Activities in Nunavut

Type of Search and Rescue	**Fiscal Responsibility**
Ground and in-land water coordination	Territorial Government
Air and marine coordination	Federal Government

Informants also reported for the case of local search and rescue operations, the RCMP will work with the Search and Rescue Teams in each community (typically certified Canadian Rangers) in addition to the Community Hunters and Trappers Organizations (HTO). These particular teams, in general, have appropriate equipment and ongoing training to respond to incidents that follow national Search and Rescue standards as set by the federal SAR Secretariat. Key informants indicated that teams for each community vary in size,

however, they are sent on the land in pairs to assist RCMP. Informants indicated that search and rescue reports were generated for each operation, however, no document was available for consultation at the time of the study.

Informants also reported that prevention and education programs for lost persons can be found in the form of advertising campaigns, local search and rescue teams speaking to youth regarding the importance of taking a GPS out on the land, and programs to improve local weather forecasting to include Inuktitut. At the time of the study, informants reported that the Government of Nunavut does not systematically collect information on lost persons as well as search and rescue operations.

Public health supporting activities. Informants shared that training for public health surveillance and environmental monitoring is conducted through professional licensing, i.e., through a specific professional certification. Informants reported that ongoing training and especially training at the interface of public health surveillance and environmental monitoring is only undertaken within special requests as well as territorial or regional (Kivalliq, Qikiqtani, Kitikmeot) priorities and fiscal flexibility. Informants also shared that high employee turnover in addition to very full employee workloads offer very little opportunity to provide additional ongoing and systematic training.

In summary, Table 19 provides a synopsis of surveillance activities related to the potential direct and indirect health impacts of climate change. It outlines where data and surveillance and monitoring efforts are present, partially present or unknown/unavailable. The assessment of presence was determined by: 1) information being collected for indicators

associated with climate related impacts; 2) the information collected through the surveillance/monitoring system is communicated to the appropriate levels for public health action. When an activity did not meet the above criteria, it was assessed as partially complete (when meeting only 1 of the 2 criteria) or unavailable/unknown (when no information was available to assess either criteria). Also, the table indicates where the activity is supported by formal and/or informal surveillance. Formal surveillance is characterized by long-term and systematic programs; informal surveillance is characterized by individual research and/or testing in addition to ad-hoc programs. Subsequently, this information will be discussed in chapter six in terms of environmental public health capacity and its ability to detect and monitor the health outcomes of a changing climate.

Table 19

Summary of Data for Select Climate Change Health Indicators

	Detection and measurement	Registration	Confirmation	Reporting	Analysis	Feedback
Mortality	● F	● F	● F	● F	● F	◒ —
Morbidity and Disease	● FI	● FI	● FI	● FI	● FI	◒ —
Injuries	● F	● F	● F	◒ F	● F	◒ —
Biomonitoring	◒ I	◒ F	◒ F	— —	◒ —	— —
Community Health and Well-being	◒ I	◒ I	◒ I	◒ I	◒ I	◒ I
Lost Persons	● F	● F	● F	◒ —	◒ —	◒ —

Legend
Present: ●
Partially present: ◒
Unknown or unavailable: —
F: Formal surveillance (legislated, systematic, long term)
I: Informal surveillance (research projects, individual citizen concerns, short term programs)
FI: A combination of surveillance efforts support the endpoint

Section 2: Results for Environmental Monitoring Systems and Activities

The integration of environmental monitoring with health surveillance data can serve several purposes such as: helping us understand present and emerging conditions for environment and health, contribute to understanding a better context for health risks and outcomes, guide the adoption of mitigation measures to reduce environmental risks and to develop indicators for public health systems, infrastructure and policies affecting Inuit health (Health Canada, 2004).

The information collected for this section was obtained through key informant interviews within the Nunavut Health and Social Services department, Nunavut Department of Environment as well as other organizations such as Inuit Tapiriit Kanatami. In addition to interviews, a combination of website searches and document reviews were performed. This chapter reports on environmental monitoring efforts and capabilities in Nunavut for indicators (Appendix B) related to environmental variables and their potential (indirect or direct) impact on health in light of climate and environmental change.

General Monitoring and Databases

Through an online search, two databases were identified and deemed important to mention as they refer directly to the dissemination (reporting) of surveillance data for environmental endpoints. Two significant assemblages of data were identified and are described briefly below.

Nunavut Environmental Database (Arctic Institute of North America, 2007)

- Publication and research projects reports and publications are catalogued on a variety of subjects such as permafrost, sea level and other environmental indicators.

Nunavut Wildlife Resource Centres Coalition Online Catalogue (Nunavut Wildlife Resource Centres Coalition, 2008)

- The main subject areas are wildlife research and management, fisheries research and management, environmental protection, conservation, contaminants, sustainable development, social research, and economic development.

Drinking water. The safety of drinking water in Nunavut is regulated by the *Public Water Supply Regulations (R.R.N.W.T., 1990)*, a subsection of the *Public Health Act*. Key informants indicated that the frequency and number of water samples are taken from each community according to the Public *Drinking Water Safety Regulations* (R.R.N.W.T., 1990). The bacteriological sampling, taken from the municipal drinking water source and water trucks, is determined by population size as per the Table 20

Table 20

Frequency and Amount of Water Samples Required by Nunavut's Water Regulations

Number of samples a month	Population
1	up to 500
2	501 to 2500
3	2501 to 3500
4	3501 to 4000
5	4001 to 4800
6	4801 to 5500
7	5501 to 6500

Presently, informants noted the Nunavut water regulations have been amended to include all raw, trucked and treated water. Informants indicated that environmental health officers, employees of the Territorial government, are responsible for drinking water monitoring and quality in their respective region. Informants also reported that analysis of water quality is performed in each region (Qikiqtani, Kivalliq, Kitikmeot) in their designate Territorial laboratories. Informants reported that some regions do not have in-house accredited laboratories and require verification of their results (double sampling) in a southern laboratory. Subsequently, they reported that results are entered into a database (excel format) located in each region and transferred to the Territorial hub in Iqaluit. Also, if sampling does not present any abnormalities as interpreted by the environmental health

officer from laboratory results, no follow-up is required with the exception of a hard copy fax to each community. The data is stored in the respective environmental health officer's office for each region.

Informants reported that a water sample presenting an abnormality requires a follow-up sample with confirmation from the southern laboratory (Ontario, Manitoba, Ottawa) able to use more advanced methods of testing. Informants also stated that unsatisfactory tests are communicated to the Chief Medical Officer of Health who in turn, takes appropriate next steps (e.g., releasing a boil water advisory, extra sampling required, etc). Informants also mentioned that messaging to a community warning that local treated drinking water is unsafe includes phone calls to the respective community health centre, hamlet office, schools and daycares in addition to public health posters and community radio announcements.

In terms of land-based non treated drinking water and salt water intrusion into freshwater resources, informants reported that Nunavut does not have formal surveillance systems in place. Informants did report, however, that water would be tested if samples and concerns arise in a particular community (informal surveillance system).

Sea ice and floe edge. Upon interviewing key informants, they indicated that most of the environmental monitoring occurring within the Territory falls within Federal jurisdiction. As an example, ice monitoring is the responsibility of Environment Canada's Meteorological Services, Canadian Ice Service.

In viewing the Canadian Ice Service website (Environment Canada, 2003), access to ice information services are typically aimed at a marine community, contain ice or iceberg charts/bulletins, ice model charting, satellite imagery and special forecasting. Particularly, the Canadian Ice Service website states that through partnerships with other organizations it provides floe edge information within selected regions of the Canadian Arctic. An example of the satellite imagery, available to some (not all) communities in Nunavut is presented in Figure 10.

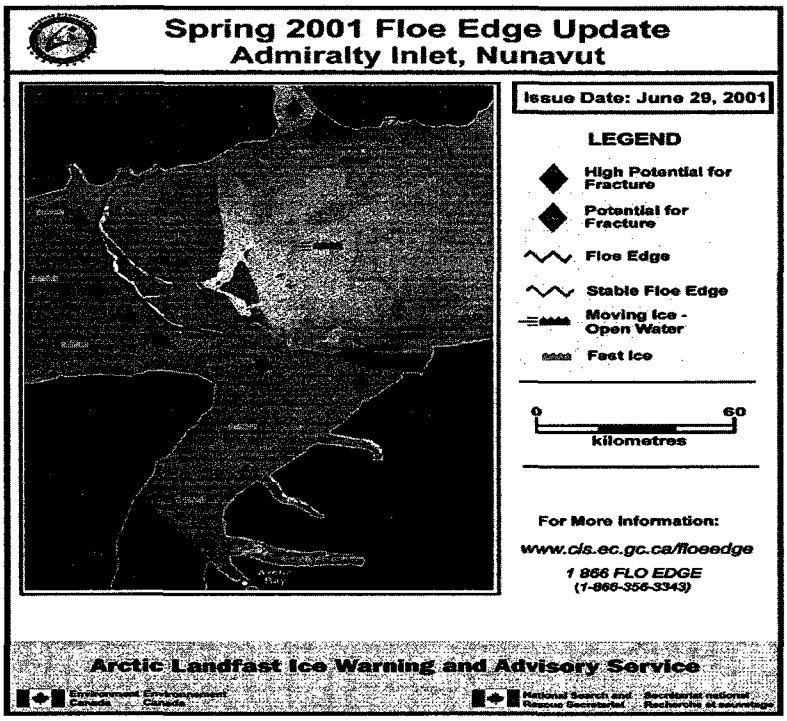

Figure 10. Example of satellite imagery indicating floe edge positioning and ice movement

Informants shared that dissemination and utilization of this floe edge information is through website access. In addition, the website states that seasonal summary documents are available and archived with the Canadian Ice Service (Environment Canada, 2003). Also, through website consultations (Laidler, 2008), the researcher was able to determine the

communities presently accessing and utilizing this type of ice monitoring system: Pangirtung, Cape Dorset, Igloolik, Arctic Bay, and Pond Inlet.

Informants indicated that community level monitoring for ice thickness, movement and composition are ad hoc and on a "community needs" basis as expressed by community leaders through different research projects such as siku-inuit-hila and sikulirijitt. They also indicated information from these research projects are often disseminated through websites, community radio, community presentations, and synthesis reports as well as academic publications.

Sea level. In Nunavut, informants indicated that sea level monitoring falls within Federal jurisdiction and were unable to share any information on the particular monitoring systems currently in place. By conducting website searches, it was found that the Federal Department of Fisheries and Oceans provides services related to the monitoring of water levels through its Canadian Hydrographic Service (CHS). The website (CHS, 2007) says this service operates a permanent network of tide and water level gauging stations throughout the Great Lakes and Hudson Bay, none of which are situated in an Inuit community. The monitoring system is briefly described in Table 21 below.

Table 21

Description of Central and Arctic Region's Permanent Gauging Network reproduced from: http://www.waterlevels.gc.ca/c&a/pgnetwork_e.html

Central and Arctic Region's Permanent Gauging Network
The Tides, Currents and Water Levels Unit operate a permanent network of tide and water level gauging stations. There are thirty-three stations on the Great Lakes and connecting rivers and one additional tidal station on Hudson Bay at Churchill, Manitoba. The gauging network was established to provide the data required by CHS for hydrographical surveys, the production of nautical charts and publications and the safety of navigation. This network of gauging stations are equipped with SUTRON 8200™ Data Loggers which record water level heights at 3 minute intervals using a Float - Counterweight driven encoder. These data are transmitted via telephone on a daily basis to a central collection station at our Burlington, Ontario office.

Federal sea level monitoring also includes Canadian tide tables for which predictions (times and heights) for over 700 stations are available with 15 stations located in Nunavut (Fisheries and Oceans Canada, 2008). The data provided by this service are high and low waters as well as hourly tide values given in graph, tabular and text form. This information can be retrieved by accessing a website or by calling a designated telephone number.

The Department of Fisheries and Oceans website also states it provides a data management and archiving service called the Marine Environmental Data Service. This service archives and controls data access of tides and water levels reported on a daily to monthly basis. It shares information with Environment Canada as well as the Global Sea Level Observing System (Department of Fisheries and Oceans, 2008). Requests to access this information must be completed online.

Following interviews and document reviews, it was still difficult to determine the levels and medium of distribution and access, if any, of particular sea and ocean level data by various user groups (hunters and trappers, municipal planners, policy groups).

Permafrost. During interviews with key informants, they shared that permafrost monitoring falls within Federal responsibility for the territory of Nunavut and therefore were not able to elaborate on any data collection or dissemination activities. Therefore, the information presented in this section is based on website consultations at the Federal level.

Natural Resources Canada's Geological Survey (GSC) performs services with respect to the monitoring, mapping, and modelling of permafrost in Canada (Geological Survey of Canada, 2008). GSC belongs to the Global Terrestrial Network for Permafrost (GNT-P) that also monitors the active layer of permafrost through the Circumpolar Active Layer Monitoring program (Circumpolar Active Layer Monitoring Network-CALM II, 2008). A list of CALM sites with archived and current data is available by website (Circumpolar Active Layer Monitoring Network-CALM II, 2008). In addition, Natural Resources Canada hosts a National Permafrost Database on both ground temperatures and permafrost thickness where data is accessible by website (Natural Resources Canada, 2007). Through website reviews, it was difficult to determine the levels of distribution and access, if any, of particular permafrost data by various user groups (hunters and trappers, municipal planners, policy groups).

Biota. Key informants indicated that select subsistence species were being monitored however they were unable to explain how the data sets, collection, and

dissemination were structured. A number of key informants referred the researcher to the Nunavut Wildlife Management Board (NWMB) and their publications for more information.

These NWMB website and on-line documents (Nunavut Wildlife Management Board, 2008) indicate that several species are monitored through environmental co-management boards, governments (Department of Fisheries and Oceans, Government of Nunavut) research organizations (Canadian Wildlife Services, Nunavut Research Institute) in addition to local organizations (Hunters and Trappers Organizations). The website shares important reports on monitoring studies of beluga and narwhal whales, Peary caribou, Arctic char, walrus, and Arctic fox as well as a vegetation mapping project. The reports share information on studies that monitor and measure quantity, migration routes as well as specific health endpoints of relevance for humans (e.g. level of contaminants) of certain biota populations (Priest, 2004). The Nunavut Wildlife Management Board website (2008) states it disseminates its findings through publications (online and hard copy), research compendiums, annual reports and community meeting notes.

Contaminants. Informants understood contaminants to be persistent organic pollutants such as those studied through the Northern Contaminants Program but also included select zoonoses that are important to the residents of the Territory.

Informants indicated that contaminant monitoring in Nunavut is primarily undertaken through the Northern Contaminants Program (NCP) lead by Indian and Northern Affairs Canada. Results from NCP funded research is published through the Canadian

Arctic Contaminants Assessment Reports (1997, 2002) and the Arctic Monitoring and Assessment Reports (1998, 2002) (Indian and Northern Affairs Canada, 2008).

The Indian and Northern Affairs website states that dissemination of information is geared towards Northern Aboriginal communities, Territorial governments, Indian and Northern Affairs Canada, Health Canada, Inuit Nunaat, and the Centre for Indigenous Peoples Nutrition and Environment in addition to the 8 circumpolar nations: Canada, USA (Alaska), Russia, Finland, Sweden, Norway, Greenland (Denmark), Iceland (Indian and Northern Affairs Canada, 2008).

In terms of zoonoses, key informants indicated that residents of a community (hunters, trappers, community members) who suspected food contamination such as trichinellosis (found in walrus and ringed seal meat) or another source of contamination can request to have animal samples sent from the Nunavut Public Health Department, for testing. However, they also stated that the official policies and procedures of the health department were not clear on this point and that situations were addressed through a case-by-case basis. Informants reported that dissemination of laboratory results is typically communicated through the community health centre, environmental health officer, and community radio.

UVA/ UVB radiation. Once more, informants indicated that the collection, monitoring and dissemination of environmental data such as UVA and UVB radiation fall under Federal jurisdiction of Environment Canada's Canadian Meteorological Service: *The Canadian Ozone and Ultraviolet Measurement Program* (Environment Canada, 2008a). The Environment Canada website states that it forecasts ultraviolet indices for selected Canadian

cities twice daily, every 12 hours (Environment Canada, 2008a). The website also indicates that dissemination of information is primarily done by website in addition to information being archived and accessible online with the National Climate Archives (Environment Canada, 2008c). By consulting Environment Canada's weather office website, it is noted that UV radiation forecasting is available for three Nunavut communities: Iqaluit, Resolute and Rankin Inlet (Environment Canada Weather Office, 2008).

In addition to UV monitoring, the Environment Canada website states it has ozone monitoring stations in Alert, Eureka and Resolute as shown in Figure 11. These stations are said to collect, track, and store information in their databases for researchers and communities to access via the internet. An important observation to make is the presence of a singular station located in an Inuit Community (Resolute).

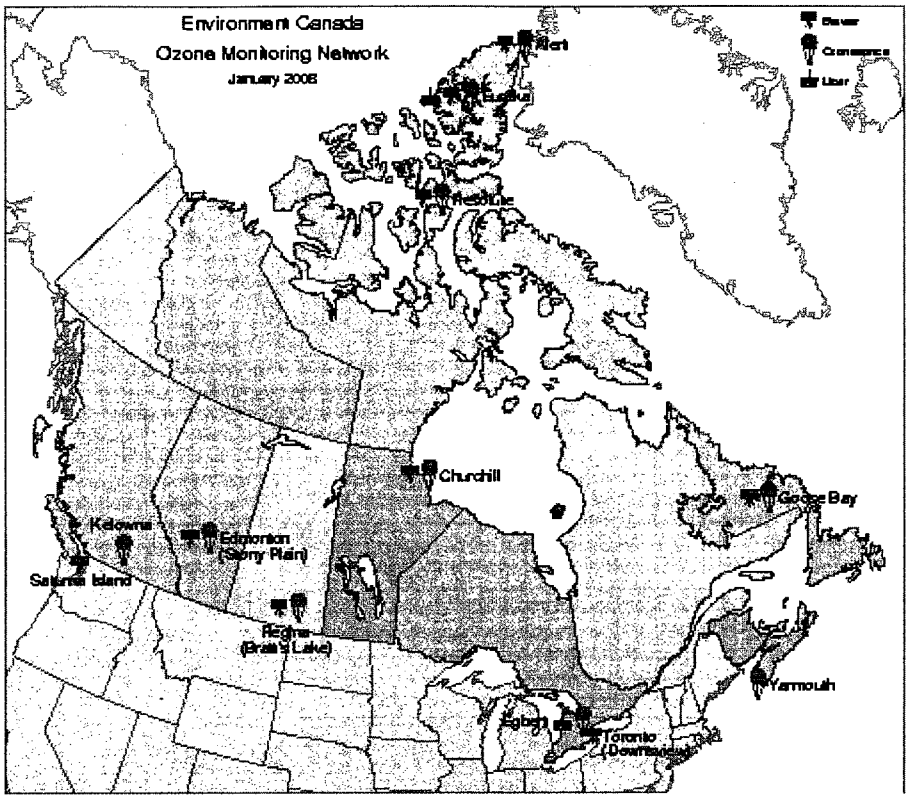

Figure 11. Observation Network for Ozone monitoring in Canada reproduced from: Environment Canada's website: http://exp-studies.tor.ec.gc.ca/e/ozone/ozonecanada.htm

Weather. Informants indicated that climate data is collected, by Environment Canada, in all Nunavut communities for typical data such as temperature, pressure, wind speed, wind direction, snow cover, relative humidity and precipitation. They also reported that Environment Canada in collaboration with NAV Canada (air navigation service provider) collects data sets from each of the community weather stations. Informants shared that Environment Canada uses, in some communities, un-staffed automated stations to record data such as temperature, cloud cover and wind speed. They also stated that all weather information is transmitted to meteorologists at the Arctic Weather Centre in Edmonton who provide forecasts for all Nunavut Communities.

Informants shared that weather information is disseminated through websites, newspapers, telephone, and local radio. They also share that weather warnings fall within Environment Canada's jurisdiction. Environment Canada weather information and warnings, from this automated system, are only available for Nunavut communities in English or French (Environment Canada, 2007).

In summary, Table 22 provides a synopsis of monitoring activities related to the environmental endpoints related to climate change. It outlines where data and surveillance and monitoring efforts are present, partially present or unknown/unavailable. The assessment of presence was determined by 1) information being collected for indicators associated with climate related impacts; 2) the information collected through the surveillance/monitoring system is communicated to the appropriate levels for public health action. When an activity did not meet the above criteria, it was assessed as partially complete or unavailable/unknown. Also, the table indicates where the activity is supported by formal and/or informal monitoring. Formal monitoring is characterized by long-term and systematic programs; informal monitoring is characterized by individual research and/or testing in addition to ad-hoc programs. Subsequently, this information will be discussed in chapter six in terms of environmental public health capacity and its ability to detect and monitor the health outcomes of a changing climate.

Table 22

Summary of Data for Select Climate Change Environmental Indicators

	Detection and measurement	Registration	Confirmation	Reporting	Analysis	Feedback
Drinking Water	● F	● F	● F	● F	● F	— —
Sea Ice & Floe Edge	◒ FI	◒ FI	◒ FI	◒ FI	◒ FI	— —
Sea Level	◒ FI	● FI	● FI	● FI	● FI	— —
Permafrost	◒ FI	◒ FI	◒ FI	◒ FI	◒ FI	— —
Biota	◒ FI	◒ FI	◒ FI	◒ FI	◒ FI	● FI
Biomonitoring	◒ I	● F	● F	● F	● F	— —
Contaminants	● FI	● FI	● FI	● FI	● FI	● FI
Radiation	◒ F	◒ F	◒ F	◒ F	◒ F	— F
Weather	● F	● F	● F	● F	● F	● F

Legend
Present: ●
Partially present: ◒
Unknown or unavailable: —
F: Formal surveillance (legislated, systematic, long term)
I: Informal surveillance (research projects, individual citizen concerns, short term programs)
FI: A combination of surveillance efforts support the endpoint

Section 3: Summary Table

Table 23 outlines health and environmental surveillance efforts in Nunavut related to key indicators associated with the direct and indirect health impacts from a changing climate. The table describes the connection and/or integration of both surveillance and monitoring to detect environmental public health endpoints associated with climate change. For the "researcher notes" section, informants were probed during the semi-structured interviews on

the current level of interaction between surveillance and monitoring activities specifically looking at abilities of each system to work in an integrated manner to attribute selected health outcomes to climate related change

Table 23

Direct and Indirect Health Impacts From a Changing Climate with Health and Environmental Surveillance Results Combined with Researcher Notes

Health Outcome	Health Surveillance	Environmental Monitoring	Researcher Notes
Heat and cold related morbidity and mortality	Yes, surveillance for morbidity and mortality exists in the Territory. Mostly formal surveillance.	Yes, weather and temperature related monitoring exists in the Territory. Mostly formal surveillance.	Data is being collected and reported for both health (mortality and morbidity) and environmental endpoints (weather, temperature). It does not appear that both data systems integrate to detect and monitor specific endpoints relating the outcomes to climate change.
Accidents while hunting and travelling, resulting in injuries, death	Yes, surveillance for morbidity and mortality exists in the Territory. Mostly formal surveillance.	Yes, ice and snow data is present in some communities and through individual researcher projects. Mostly informal surveillance.	Data is being collected and reported for both health (mortality and morbidity, injuries) and environmental endpoints in some communities (snow and ice conditions). It does not appear that both data systems integrate to detect and monitor specific endpoints

			relating the outcome to climate change.
Increased risk of skin cancer, burns, eye damage	Yes, surveillance for morbidity and mortality exists in the Territory. Mostly formal surveillance.	UV intensity is available for 3 communities. Formal surveillance for 3 communities.	Data is being collected and reported for both health (mortality and morbidity, injuries) and environmental endpoints in some communities (UV intensity). It does not appear that both data systems integrate to detect and monitor specific endpoints relating the outcome to climate change.
Transmission of infectious diseases	Yes, surveillance for morbidity exists in the Territory. Mostly formal surveillance.	Yes, through individual research projects. Mostly informal surveillance.	Data is being collected and reported for both health (morbidity,) and environmental endpoints in some communities (e.g. biota monitoring). It does not appear that both data systems integrate to detect and monitor specific endpoints relating the outcome to climate change.
Increased psychosocial stress	Yes, surveillance for morbidity exists in the Territory. Mostly formal	Yes, permafrost, ice, access to subsistence food species and other environmental endpoints are being monitored	Data is being collected and reported for both health (morbidity) and environmental endpoints (permafrost, snow,

	surveillance.	throughout the Territory through federal agencies, programs, and individual research projects. A mix of formal and informal surveillance.	access to country food) in some communities. It does not appear that both systems integrate to detect and monitor specific endpoints relating the outcome to climate change.
Emergence of new diseases	Yes, surveillance for morbidity exists in the Territory. Mostly formal surveillance.	Yes, through research projects, community residents, hunters and trappers as well as other can bring any sample to the Environmental Health Officer for testing. Mostly informal surveillance.	Data is being collected and reported for both health (morbidity) and environmental endpoints (emerging biota diseases) in some communities. It does not appear that both systems integrate to detect and monitor specific endpoints relating the outcome to climate change.
Diarrheal and other infectious diseases	Yes, surveillance for morbidity exists in the Territory. Mostly formal surveillance.	Yes, surveillance exists for water quality monitoring in the Territory. Mostly formal surveillance. Informal surveillance exists for land-based non treated water sources.	Data is being collected and reported for both health (morbidity) and environmental endpoints (water quality). Both systems appear to interact on a systemic basis for local treated drinking water sources.
Respiratory and cardiovascular	Yes, surveillance for	Yes, air quality and	Data is being collected

diseases	morbidity exists in the Territory. Mostly formal surveillance.	lifestyle is being monitored through individual research projects as well as specific Statistics Canada Surveys. Mix of formal and informal surveillance.	and reported for both health (morbidity) and environmental endpoints in some communities (air quality, lifestyle). It does not appear that both data systems integrate to detect and monitor specific endpoints relating the outcome to climate change.
Exposure to environmental contaminants	Yes, surveillance for morbidity exists in the Territory. Mix of formal and informal surveillance.	Yes, environmental contaminants are monitored through the Northern Contaminants Program. Mostly formal surveillance.	Data is being collected and reported for both health (morbidity) and environmental endpoints in some communities (contaminant monitoring). It does not appear that both data systems integrate to detect and monitor specific endpoints relating the outcome to climate change.

In summary, the major findings identified through this Table (23) reveal that the health outcomes associated with the impacts of climate change are being detected and monitored through a variety of programs and systems. The Table (23) also highlights the presence of formal and informal data mechanisms contributing to both health and environmental surveillance systems. In addition, through the "researcher notes" section, the Table (23) demonstrates that very few health surveillance and environmental monitoring systems are currently integrating both health and environmental data to detect and monitor specific health impacts of climate change.

Chapter 6: Discussion and Recommendations

This chapter discusses the capacity of environmental hazard surveillance and health outcome surveillance using the core surveillance activities, as defined by McNabb et al.'s (2002) conceptual framework, particularly with respect to the series of indicators that are thought to play a role in understanding the influence of climate change on population health. As well, it examines the existing or potential interactions between the environmental and health systems in Nunavut in terms of its ability to detect and track health outcomes currently and potentially associated with a changing climate in northern Canadian Aboriginal communities. The chapter will also provide a discussion on the gaps and implications (policy and research) for environmental public health surveillance in Nunavut. As outlined in Chapter 1, the thesis objectives are:

1. Identify, document, and describe present health surveillance and environmental monitoring capacity in one northern Canadian Territory (Nunavut);
2. Analyze environmental and health system capacity in a remote northern Aboriginal region to detect and monitor the health impacts of a changing climate by identifying strengths and weakness of present environmental public health surveillance systems;
3. Recommend areas for improvement to strengthen current environmental and public health surveillance capacity in the case study region (Nunavut) to be able to better respond to projected climate change influences on human health.

In order to meet these objectives, a discussion of surveillance system "capacity" is informed by the following key questions:

1. What components of surveillance and monitoring systems exist?

2. Do the systems function in a way that allows capturing of information required to monitor climate and health issues?
3. If system components are missing, are there other compensatory actions in their absence?
4. What measures could improve performance and productivity of the surveillance system and the program(s) that it supports?

McNabb et al. (2002) define detection/measurement as a circumstance that identifies a health/environmental event or case. In general, the case study demonstrates that over half of health and environmental indicators related to climate change are being detected or monitored in Nunavut. They are detected and monitored through national and territorial governments in addition to community mechanisms. The research also notes that events are detected and measured through a balance of formal and informal mechanisms.

Confirmation is defined as evaluation of results (epidemiological, laboratory, etc.) that preceded registration (McNabb et al. 2002). In general, the research demonstrates that over half of the health and environmental indicators related to climate change are being confirmed through epidemiological and formal evaluations if an endpoint is detected/measured. It is mostly performed through formal surveillance mechanisms with the exception of a few endpoints that use surveys and local observations (informal surveillance data).

Furthermore, the research shows that over half of the health and environmental indicators related to climate change are being registered through formal and standardized procedures. Specific examples include ICD-10 coding for morbidity events detected through health centres

and water level databases through Environment Canada services. An important observation is the presence of traditional surveillance/monitoring data reporting if an indicator is being detected/measured. Therefore, if an indicator is detected, it is often registered in some fashion through health or/and environmental surveillance mechanisms.

Reporting is characterized by the movement of collected data from lower levels of health and environmental systems to higher ones (McNabb et al., 2002). The research demonstrates that health outcomes, particularly mortality and morbidity, are being reported to higher levels through formal and informal data mechanisms. Also, several environmental endpoints associated with climate change are reported through a balance of formal and informal mechanisms.

Another activity associated with effective surveillance is characterized by the analysis of data producing results for interpretation. The research demonstrates, for health outcomes, that mortality and morbidity outcomes are being analysed through a formal system of health surveillance, however, for other endpoints such as biomonitoring, community health and lost persons, the presence of "analysis" was partially present or difficult to assess. Juxtaposed, is the presence of formal and informal analysis for several of the environmental endpoints associated with climate change.

Feedback is characterized by the flow of information from higher levels (public health authorities, governments, wildlife boards) to lower ones (citizens, primary health care personnel, hunters & trappers) (McNabb et al. 2002). From the case study results, this activity was difficult to assess as very little information was collected through the key informant interviews and

document reviews. Once the surveillance/monitoring data for health and environmental endpoints were detected, registered, confirmed, reported and analysed, the results showed very little feedback mechanisms for the transfer of higher level authority level messages to the community and citizen levels.

Using Table 23, an assessment of the connection of data for both health outcomes and environment endpoints associated with health and a changing climate was performed. Specifically, the research looked at the environmental public health surveillance system's capacity by utilizing the core surveillance activities proposed by McNabb et al. (2002). One of the most important observations of this research is that several of the surveillance and monitoring elements needed to connect climate and health already exist within the Territorial infrastructure. However, through an analysis of the present systems (health and environment) the research demonstrates that the association of health outcomes and environmental endpoints are not typically assessed. Nonetheless, examples of areas where the systems integrate health and environmental data are local treated water sources, notifiable diseases (e.g. rabies) and food security (persistent organic pollutants). Through key informant interviews and document reviews, the findings demonstrated that health and environmental endpoints (e.g. safe drinking water) that have the support of legislation will often present with integrated formal surveillance activities. Two examples, drinking water and zoonotic diseases, are used to describe this observation.

Drinking water is regulated by the *Public Water Supply Regulation* in the Territory. It is provided through the Nunavut Community and Government Services infrastructure and the quality is monitored through Nunavut's Department of Health and Social Services. In reviewing

the core surveillance activities for a public health system, municipal treated water quality is being adequately detected, registered, analyzed and reported at relevant levels of community (department to citizen). Another example, zoonotic diseases as mandated by territorial and federal legislation, shows that Nunavut detects registers, confirms, analyses and reports on these endpoints (disease prevalence). Therefore, morbidity and mortality endpoints, of which infectious diseases are a component of, are being tracked by the public health and environmental systems in Nunavut.

Throughout the case study findings, the research established the presence of both formal and informal surveillance mechanisms generating data associated with climate change and health outcomes. Formal surveillance system activities were often performed and mandated by territorial and federal governments. However, the presence of surveys, research projects, and community based surveillance offered compensating mechanisms that are important to highlight when assessing the capacity for health and environmental system to detect and monitor the health outcomes of a changing climate. Andresen et al. (2004) noted that a variety of approaches exist for situations with insufficient data surveillance (traditional) data. They note (Andresen et al., 2004) that innovative strategies (use of surveys, different sampling methodologies, community-based participatory research) are required to address the current and future needs of public health authorities in low-frequency populations. Some examples of informal sources of surveillance data for Nunavut include surveys from Statistics Canada, academic research projects in addition to community observations. Capacity within Nunavut exists if these types of innovative and informal approaches are considered and applied to an environmental public health surveillance system.

The research highlighted the presence of community observations as an important compensating factor to traditional surveillance data. Groce et al. (1996) noted that traditional healers are often familiar with the diseases commonly found in their surroundings, aware of any increases, and repeatedly among the very first to identify cases of new diseases. Also, Oum et al. (2005) noted that community-based surveillance systems (syndromic approaches to the identification of diseases) were effective and efficient (sensitive, positive predictive, useful) in providing information on disease outbreaks in rural Cambodia. Information collected through the case study, showed that community based observations contributed data to public health systems and subsequent health action. The case study findings also noted, from key informants, the presence of a strong informal surveillance network and its capacity to perform quick acute epidemic type response to public health concerns. The example of land-based water sources and wildlife zoonotic diseases are one example.

Surveillance of land-based water sources are not part of the traditional environmental public health surveillance system in Nunavut. However, informants strongly noted, due to smaller community networks, relationship to the environment, and social construct, that any sample from land-based sources would be analyzed if a community member suspected abnormalities. In addition, animal health is also monitored through various organizations by informal systems such academic institutions, regional wildlife organizations, Hunters and Trappers Organizations as well as community members. Key informants noted that any abnormal animal samples detected by hunters and trappers, community members, or others can be analysed through public health or environmental systems. Informants also noted, for the two examples provided above, that results from the sampling would be disseminated, within quick

timeframes, through community communication channels therefore being able to quickly respond to community health concerns.

From the case study results, the research demonstrated that health outcome surveillance systems and environmental monitoring systems in Nunavut are conducted through parallel approaches. Both systems are generating information, formally and informally, associated with the health outcomes of a changing climate however very little integration exists between the two data sets. This finding is consistent with the research literature on environmental public health surveillance stating that monitoring of environmental endpoints are often directed towards regulatory compliance (Kyle, Balmes, Buffler, & Lee, 2006) with little integration with the health sector (Kotchian, 1997; McGeehin et al., 2004). Thus, capacity exists within both systems however they are not presently being connected. The example of extreme weather events and health outcomes is one example.

It is the responsibility of Environment Canada, in partnership with NAV Canada, to detect, register, confirm, analyse and report on weather events for Nunavut. As such, extreme weather or climate events are tracked and reported through the same departments. When a community member seeks medical treatment following an extreme climate event, whether gradual climate extremes or more complex event driven, a registration of that medical consultation is made in their patient record. At the moment, there appears to be no medical coding that associates an extreme weather event to a health outcome (ICD 10 coding). As such, it is difficult for health surveillance systems to correlate and identify patterns of health outcomes (negative or positive) with extreme climate/weather events. Using the McNabb et al. (2002) conceptual framework for an effective surveillance system, mortality and morbidity data in

addition to weather data exists for all identified core activities. As such, both systems function in a way that allows capturing of information required to monitor extreme weather events and health issues. If Nunavut identifies a need for the correlation of extreme weather events with health outcomes as a community or territorial priority, data exists and pilot studies could be designed to study the impact of these extremes on Nunavummiut.

Research Limitations

The following section will provide and overview of the research limitations, case study boundaries, in addition to strengths and weaknesses of the research approach. For this particular research, the case study was bounded by a single health surveillance and environmental monitoring system serving over twenty five Inuit communities in the territory of Nunavut. The case study assessed the capacity of an environmental public health surveillance system using the case example of climate change and health impacts. It does not attempt to present a comprehensive review of all health surveillance or environmental monitoring endpoints that can/are being examined in the territory of Nunavut. However, the research served as an overview of important and existing core surveillance activities using specific endpoints related to both climate and health. It identified the presence of core surveillance activities and types of data produced through a particular health and environmental system (formal and informal), however, the research does not pronounce itself on the quality of data reported through each category and core surveillance activity. In addition, since the case study is bounded by the identification of a specific environmental public health surveillance system in a precise contextual setting (northern Aboriginal communities), it does not draw conclusions that extend to other jurisdictions such non-Aboriginal community settings. Although difficult to generalize

case study findings to other settings, the approach and design of this particular case study can be replicated and utilized to collect similar data in other jurisdictions.

Contributions and Future Research Recommendations

From the case study, a number of health and environmental literature contributions, policy, and research recommendations emerge to be able to contribute to a better understanding of the impacts of climate change on Nunavummiut health.

The case study emphasizes the need to include informal data such as census information, health surveys, academic research projects, in addition to other program data upon developing environmental public health surveillance systems in resource constrained settings. The research suggests that evaluation models should include the acknowledgement and inclusion of informal data as important sources of information able to positively influence and increase capacity within current surveillance systems. Specifically related to the case study, environmental health surveillance systems require support from community citizens and stakeholders, key-decision makers and availability of skilled staff to complete the essential functions of an effective system (Hann et al., 2004). As such, the Territory of Nunavut could develop a consultation process in order to identify priority climate change and health issues. The consultation could be designed to rank key climate and health issues in Nunavut using the following factors (Makecki et al., 2008, p. 549): environmental health importance, public health importance, stakeholder and public concern, data information availability, data type and quality, technical capacity and feasibility, meaningful public health action, and, connection to policy development. Since the literature indicates that surveillance systems should be strongly linked to public health action

(McNabb et al., 2002), the development of a consultation process involving decision makers and community stakeholder would be a wise initial approach.

The case study also demonstrated that several of the core activities associated with effective surveillance systems were present within the Territory. Data is available for both environmental endpoints and health outcomes (formal and informal data) potentially associated with climate change. However, the case study also showed that very little integration between health and environmental surveillance was being performed to detect and monitor the health impacts of a changing climate in Nunavut. Findings from the case study contribute to confirm literature findings stating that the assessment of environmental health endpoints are conducted through parallel approaches with very little data integration (Kotchian, 1997; Malecki et al., 2008; McGeehin et al., 2004). As such, an assessment of the feasibility to physically link, format and complete an exchange of data, for health related climate impacts, could significantly contribute to a better understanding of the empirical association between climate events and the direct/indirect health outcomes.

Lastly, Bekkedal et al. (2008. p. 592) have proposed that partnerships are required to facilitate the sharing of data between the health and environmental sectors. They also propose that these partnerships are very important in creating standardized methods of data collection. As such, this study reinforces the need to investigate the most appropriate partnerships and linkages between all levels of municipal, territorial, federal governments, local Inuit organizations, academic institutions as well as any other entity able to contribute data to EPHS systems.

Conclusion

Since the world is experiencing record forms and paces of environmental change (ACIA, 2005; IPCC, 2001, 2007) and climate change is significantly adding to the spectrum of environmental hazards for human populations in many regions around the world (McMichael et al., 2006), particularly in polar regions with high density of rural remote and Aboriginal communities (ACIA, 2005), environmental public health surveillance and access to information (determinant of adaptive capacity for health) emerges as a key component able to positively contribute to the reduction of vulnerability to health impacts associated with climate change. Particularly, since Nunavummiut are already reporting adaptive responses (Furgal, 2008), information reported through environmental public health surveillance systems could potentially influence the appropriateness of adaptive strategies, especially in resources constrained settings, related to effective public health action and policy.

Nunavut's health care system is mainly centralized however informed by each community's health data for decision making. Its funding is mainly contribution agreements through the federal government and subject to the same accountability for the five pillars of the *Canadian Health Act* as other provinces and territories. Environmental management in Nunavut is somewhat different in the sense that the federal government is still within the process of devolution for particular environmental responsibilities. Therefore, several federal agencies such as Environment Canada, Department of Fisheries and Oceans in addition to Indian and Northern Affairs Canada are mainly responsible for most of the traditional monitoring currently underway in the Territory. Health and environmental data that enables the environmental public health surveillance system come from a variety of settings. For this particular reason it is important to

understand the data processes from several perspectives – from Territorial and Federal Governments, local Community Health Centres and Inuit Organizations (Hunter and Trappers Organizations, Nunavut Tunngavik Incorporated), local hospitals, research institutes (Nunavut Wildlife Management Board, Nunavut Research Institute) as well as southern hospitals referral systems and primary care centres.

The thesis explored the current capacity within northern health surveillance systems and environmental monitoring systems to detect and monitor the health impacts of a changing climate among northern Aboriginal populations using Nunavut as a case study example. In Nunavut, the health and environmental systems which are utilized and activated on a daily basis generate the data from which public health trends, tracking, infrastructure, policy and planning are derived. The system functions in a way that allows capturing of information required for monitoring climate and health issues – thus, indicating that capacity, within the system exists. However, both the environmental monitoring and health surveillance systems in Nunavut appear to be working in silos with very little to no formal linkages relating climate impacts to health outcomes. Due to this silo approach, several of the health outcomes associated to climate change is not being formally linked to better understand their empirical relationships. In turn, this lack of formal linkage influences adaptive capacity as Nunavut is not accessing all the information potentially at their disposal for planned health adaptation to climate change. Exceptions to this rule (silo approach) appear to be taking place where both health and environmental systems share legislated reporting requirements e.g. water quality and reportable diseases.

Lastly, another observation important to the understanding of surveillance capacity in Nunavut is the presence of both formal and informal activities in response to the environmental public health needs of Nunavummiut. Although, both environmental and health systems appear to be operating in parallel, Nunavut and the Federal government already perform many of core activities described by McNabb et al.'s (2002) conceptual framework for effective surveillance.

As such, several areas where climate related health outcomes are associated in the literature can potentially be detected and monitored through environmental public health surveillance data currently in place for the Territory. The next steps in this research are the identification of priorities related to climate and health in Nunavut; identification of partnerships that will allow a corporation between health and environmental monitoring systems; in addition to exploring the feasibility to physically linking and formatting health and environmental data for use in program and policy development.

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Appendix A

Semi-structured interview guide

SECTION : HEALTH (physical, mental, lost persons)
H1. General questions

H1a. What is your role within the public health system ? (KI, I)

H1b. Discuss/what is the state of the interface between the public health surveillance and environmental monitoring systems ? (strengths, weaknesses, does it exist ?) (KI,I))

H1c. Do the health personnel within your region have the opportunity to train in matters of environment and health ? (KI,I)
(who, what are the courses...)
H2. Mortality

H2a. Who has the authority to declare a death? (coroner, MD, nurse)

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2b. What information is reported precisely ? (date, sex, etc..) (Is it possible to obtain a blank copy of the declaration form)

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	

Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2d. By whom and how is the cause of death confirmed ?
What laboratories are utilized under what circumstances? (needed?)

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2e. Where are the (confirmed) data sent?
At what frequency of transmission?
Is data entry verified? (OMIT?)
Question for the archivist -
What difficulties do you encounter with the entry of data pertaining to these endpoints?

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2f. If analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2g. Is there any exchange of feedback within the components of the surveillance system (H-L and L-H) regarding the data sent or received ?

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to infectious diseases	
Deaths due to suicides	

H2h. How are public health messages disseminated ?
Who has the authority to do so?

Deaths due to respiratory problems	
Deaths due to non-intentional trauma	
Deaths due to CV problems	
Deaths due to cancers	
Deaths due to suicides	
Deaths due to infectious diseases	

H2i. (KI)Tell me about prevention and/or education programmes for communities addressing any of the above indicators?
(I)Do you know if there are prevention and/or education programs addressing any of the above indicators?
(what are they, who ?)

H2j. Director of P and E : Can you name the five most important prevention and/or education programmes for your region (in descending order of priority if possible) and say why ?
(COVERS ALL CATEGORIES OF HEALTH INDICATORS)
H3. Injuries (intentional and non-intentional)

H3a. Who has the authority to declare an injury? (MD, nurse)

Intentionnels	
Non-intentionnels	

H3b. What information is reported precisely ? (Is it possible to obtain a blank copy of the form on which it is recorded)

Intentionnels	
Non-intentionnels	

H3c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

Intentionnels	
Non-intentionnels	

H3d. Who confirms the diagnosis (or evaluation assessment?)?
What laboratories are utilized under what circumstances? (needed?)

Intentionnels	
Non-intentionnels	

H3e. Where are the (confirmed) data sent?
At what frequency of transmission?
Is data entry verified ? (OMIT?)
Question for the archivist -
What difficulties do you encounter with the entry of data pertaining to these endpoints?

Intentionnels	
Non-intentionnels	

H3f. If analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

Intentionnels	
Non-intentionnels	

H3g. Is there any exchange of feedback within the components of the surveillance system (H-L and L-H) regarding the data sent or received ?

Intentionnels	
Non-intentionnels	

H3h. How are public health messages disseminated ?
Who has the authority to do so?

Intentionnels	
Non-intentionnels	

H3i. (KI) Tell me about prevention and/or education programmes for communities addressing any of the above indicators?
(I) Do you know if there are prevention and/or education programs addressing any of the above indicators?
(what are they, who ?)
H4. Morbidity

H4a. Who has the authority to declare a case of the following diseases? (MD, nurse)

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4b. What information is reported precisely ? (Is it possible to obtain a blank copy of the form on which it is recorded)

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4d. Who confirms the diagnosis?
What laboratories are utilized under what circumstances?

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4e. Where are the (confirmed) data sent?
At what frequency of transmission?
Is data entry verified ? (OMIT?)
Question for the archivist -
What difficulties do you encounter with the entry of data pertaining to these endpoints?

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4f. If analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4g. Is there any exchange of feedback within the components of the surveillance system (H-L and L-H) regarding the data sent or received ?

Notifiable diseases (ex) infectious diseases respiratory diseases	

Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4h. How are public health messages disseminated ?
Who has the authority to do so?

Notifiable diseases (ex) infectious diseases respiratory diseases	
Chronic diseases (ex) cardiovascular diseases health problems related to diet shift for alternative sources (diabetes.)	
Diseases of interest to the region (ex) Toxoplasmosis	
Other diseases (ex) vitamin deficiency, anemia, skin cancer, etc.	

H4i. (KI) Tell me about prevention and/or education programmes for communities addressing any of the above indicators?
(I) Do you know if there are prevention and/or education programs addressing any of the above indicators?
(what are they, who ?)

H5. Mental disorders

H5a. Who has the authority to declare a case of depression or PTSD ? (MD, nurse, psychologist)

H5b. What information is reported precisely ? (Is it possible to obtain a blank copy of the form on which it is recorded)

H5c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

H5d. Who confirms the diagnosis?
What laboratories are utilized under what circumstances?

H5e. Where are the (confirmed) data sent?
At what frequency of transmission?
Is data entry verified ? (OMIT?)
Question for the archivist -
What difficulties do you encounter with the entry of data pertaining to these endpoints?

H5f. If analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

H5g. Is there any exchange of feedback within the components of the surveillance system (H-L and L-H) regarding the data sent or received ?

H5h. How are public health messages disseminated ?
Who has the authority to do so?

H5i. (KI) Tell me about prevention and/or education programmes for communities addressing any of the above indicators?
(I) Do you know if there are prevention and/or education programs addressing any of the above indicators?
(what are they, who ?)

H5j. For other mental health disorders, is the way surveillance information is managed similar to that for PSTD and depression ? If there are significant differences across mental health disorders please describe.

H5k. Are you aware of any information collection or studies being carried out pertaining to perceptions of well-being in the region? If yes, are these part of the public health surveillance system?

Detection/ measurement	
Registration	

Confirmation	
Reporting	
Analyses	

H6. Lost persons

H6a. Who has the authority to declare a person as lost or missing ?

H6b. What information is reported precisely ? (Is it possible to obtain a blank copy of the form on which it is recorded)
H6c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

H6d. Who confirms the person as lost ?
When is the person confirmed as lost ?

H6e. Where are the (confirmed) data sent? (link to public health?)
At what frequency of transmission?

Question for the archivist – non applicable ??

H6f. IF analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

H6h. How are public health messages regarding lost persons disseminated ? (messages based on lost persons surveillance data)
Who has the authority to do so?

H6i. (KI) Tell me about prevention and/or education programmes for communities addressing lost persons ?
(I) Do you know if there are prevention and/or education programs addressing lost persons ? (what are they, who ?)

H6j. Tell me about search and rescue capacity in the region?
Who`s responsibility is it ? Who is involved ? Training? Data ?
H7. Biomonitoring (human)

H7a. Name of organization conducting the biomonitoring:

H7b. What biomonitoring data is collected, in what tissues and at what frequency?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7c. At what frequency ?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7d. Where and how is this data stored?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7e. Where/To whom is this data sent?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7f. How often is this data sent (frequency)?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7g. If analysed, who analyses and interprets this data ? (indicate if not analysed)

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7h. Where/to what organizations are the analysed data disseminated ?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

H7i. How, if at all, is this analysed data used in the formulation of public health messages?

Contaminants in tissues (metals, organochlorines)	
Seroprevalence (for certain parasitic and viral diseases)	

SECTION : HEALTH (social, community)

H7a. What data is collected and at what frequency?

SOCIAL (2.7)

1) demographic data (population, sex and age distribution)	
2) income (monetary and non-monetary; adjusted for cost of living, individual and family)	
3) Food security (access to food, availability of food, quality of food)	
4) Housing : number of residents per	
5) other social data : marital status, language, ethnicity, education,	

COMMUNITY WELLNESS (2.8)

1) Criminal activity	
2) Practice of traditional activities	
3) Community based cultural events	

4) Housing : number of residents per	

H7b. By what organization?

SOCIAL (2.7)

1) demographic data (population, sex and age distribution)	
2) income (monetary and non-monetary; adjusted for cost of living, individual and family)	
3) Food security	
4) Housing : number of residents per	
5) other social data : marital status, language, ethnicity, education,	

COMMUNITY WELLNESS (2.8)

1) Criminal activity	
2) Practice of traditional activities	
3) Community based cultural events	
4) Housing : number of residents per	

H7c. Where and in what form is this information stored ? (databank, paper or electronic and physical location)

SOCIAL (2.7)

1) demographic data (population, sex and age distribution)	
2) income (monetary and non-monetary; adjusted for cost of living, individual and family)	
3) Food security	
4) Housing : number of residents per	

5) other social data : marital status, language, ethnicity, education,	

COMMUNITY WELLNESS (2.8)

Wednesday, August 24, 20051) Criminal activity	
2) Practice of traditional activities	
3) Community based cultural events	
4) Housing : number of residents per	

H7d. If analysed, who analyses and interprets these data ? (indicate if not analysed)
Where/to whom are the analysed data sent ? (eg Stats Canada)
At what frequency ?

SOCIAL (2.7)

1) demographic data (population, sex and age distribution)	
2) income (monetary and non-monetary; adjusted for cost of living, individual and family)	
3) Food security	
4) Housing : number of residents per	
5) other social data : marital status, language, ethnicity, education,	

COMMUNITY WELLNESS (2.8)

1) Criminal activity	
2) Practice of traditional activities	
3) Community based cultural events	
4) Housing : number of residents per	

H7e. (If applicable) Is there any exchange of feedback within the components of the surveillance system (H-L and L-H) regarding the data sent or received ?

SOCIAL (2.7)

1) demographic data (population, sex and age distribution)	
2) income (monetary and non-monetary; adjusted for cost of living, individual and family)	
3) Food security	
4) Housing : number of residents per	
5) other social data : marital status, language, ethnicity, education,	

COMMUNITY WELLNESS (2.8)

1) Criminal activity	
2) Practice of traditional activities	
3) Community based cultural events	
4) Housing : number of residents per	

SECTION ENVIRONMENT

E1. Drinking Water, Fresh Water

E1a. What is your role in terms of environmental monitoring?

E1b. Where are the monitoring stations within the _____region?

E1c. What data is collected and at what frequency?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1d. Where and how is this data stored?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1e. Where/To whom is this data sent?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1f. How often is this data sent (frequency)?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1g. If analysed, who analyses and interprets this data ? (indicate if not analysed)

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1h. Where/to what organizations are the analysed data disseminated ?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1i. How, if at all, is this analysed data used in the formulation of public health messages?

DRINKING WATER (1.3)

Drinking water quality in municipal and local natural source (fecal, total coliform)	
Drinking water availability (local natural source)	
Salt water intrusion (presence/absence)	

FRESH WATER LEVELS (1.10)

Levels of fresh water in locally important waterways (spawning rivers, natural drinking source)	

E1j. Do you know whether there are sources of water that are regularly used for drinking but are not presently monitored ? Is there any link between the use of these sources of drinking water and public health ?

E2. Ice, Sea, Permafrost, Erosion

E2a. What is your role in terms of environmental monitoring ?

E2b. Where are the monitoring stations within the (insert region) region ?
(for the case of local infrastructure, it is not monitoring stations per se but observations of damage to infrastructure)

E2c. What data is collected and at what frequency?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
Permafrost Active Layer	
Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2d. Where and how is this data stored?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
Permafrost Active Layer	
Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2e. Where/To whom is this data sent?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
Permafrost Active Layer	
Damage to infrastructure : drinking water system	

Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2f. How often is this data sent (frequency)?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

1) Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available	
2) Permafrost Active Layer	
Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2g. If analysed, who analyses and interprets this data ?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
2) Permafrost Active Layer	
3) Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2h. Where/to what organizations are the analysed data disseminated ?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	

Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
Permafrost Active Layer	
Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E2g. How, if at all, is this analysed data used in the formulation of public health messages?

ICE (1.2)

Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out, length of time for freezing, salinity)	
Glacier Ice (location, leading edge location, size)	
River Ice (thickness, distribution, date in-out)	
Lake-ice (thickness, distribution, date in-out, length of time for freezing)	

SEA (1.9)

Coastal level in sentinel locations	
Currents in sentinel locations (local rep)	

PERMAFROST (1.6) and EROSION (1.7)

Continuous/Discontinuous permafrost zones (limits of continuous zone, depth where data is available)	
Permafrost Active Layer	
Damage to infrastructure : drinking water system	
Damage to infrastructure : sewage	
Damage to infrastructure : health services buildings	
Erosion in sentinel locations (measures or community observations)	
Shoreline erosion	

E3. Weather, UV radiation

E3a. What is your role in terms of environmental monitoring?
E3b. Where are the monitoring stations within the (insert region) region ?

E3c. What data is collected and at what frequency?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow(mean monthly and other snow characteristics)	
Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3d. Where and how is this data stored?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow (mean monthly and other snow characteristics))	
4) Wind velocity, direction (max, min, avg)	
5) Duration of fishing, hunting and recreational seasons (perceived by community residents)	
6) Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3e. Where/To whom is this data sent?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow (mean monthly and other snow characteristics))	
Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3f. How often is this data sent (frequency)?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow (mean monthly and other snow characteristics))	
Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3g. Who analyses and interprets this data ?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow (mean monthly and other snow characteristics))	
Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3h. Where/to what organizations are the analysed data disseminated ?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	
Precipitation (rain, snow (mean monthly and other snow characteristics))	
Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E3i. How, if at all, is this analysed data used in the formulation of public health messages?

WEATHER (1.1)

Temperature (air, mean weekly, monthly)	
Extreme events (warm and cold events)	

Precipitation (rain, snow (mean monthly and other snow characteristics))	
4) Wind velocity, direction (max, min, avg)	
Duration of fishing, hunting and recreational seasons (perceived by community residents)	
Indicators of weather predictability	

UV-B RADIATION (1.8)

Incidence of UV-B in community (seasonal)	

E4. Biota, Contaminants

E4a. What is your role in terms of environmental monitoring ?
E4b. Where are your monitoring stations within the (insert region) region

E4c. What data is collected and at what frequency ?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	
Level of radionuclides in animal tissues (priority radionuclides, priority food species)	
Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	

Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild meat	

E4c. Where and how is this data stored?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	
Level of radionuclides in animal tissues (priority radionuclides, priority food species)	
Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	
Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild	

meat	

E4d. Where/To whom is this data sent?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	
Level of radionuclides in animal tissues (priority radionuclides, priority food species)	
Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	
Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild meat	

E4e. How often is this data sent (frequency)?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	
Level of radionuclides in animal tissues (priority radionuclides, priority food species)	
Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	
Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild meat	

E4f. Who analyses and interprets this data ?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	

Level of radionuclides in animal tissues (priority radionuclides, priority food species)	
Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	
Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild meat	

E4g. Where/to what organizations are the analysed data disseminated ?

CONTAMINANTS & POLUTION (1.4)

Level of contaminants in water and animal tissue (organics, metals, priority food species, PCB, Hg, Pb)	
Hazardous or toxic substances released in ambient air (levels in local air sampling)	
Level of radionuclides in animal tissues (priority radionuclides, priority food species)	

Identification of contaminant risk areas (dewline)	
Microbiological contamination of traditional foods	
Indoor air quality	
Local ambient water quality (emphasis on sources of raw drinking water)	

BIOTA (1.5)

New species reported within the region (species sited and identified, year and location, scale: regional or community)	
Priority animals and wildlife populations (#s, trends, seasonal distribution) e.g. caribou	
Priority fish and marine mammal populations (#s, trends, seasonal distribution) e.g. arctic char	
Priority migratory bird population (#s, trends, seasonal routes)	
Changes in insect population and distribution (#s, appearance of new species)	
Surveillance of zoonostic diseases (incidence, cases)	
Priority plant species (#s, trends, distribution)	
Phytoplankton and zooplankton production (primary productivity in marine areas)	
Observed changes in animal health and other abnormalities in wildlife (e.g. skinnier seals)	
Reported changes in taste and consistency of wild meat	

E4h. How, if at all, is this analysed data used in the formulation of public health messages?

SECTION FOR ORGANISATIONS (ITK, NTI, LIA, KRG)

O1a. Organization :

O1b. Does your organization interface with the public health surveillance system, and if so how? Through what projects/departments? Reports available ?

O1c. Is traditional knowledge accessed as part of any monitoring activities ?

Appendix B

List for Climate and Health Indicators in Northern Communities (Furgal et al. 2002)

1. ENVIRONMENTAL INDICATORS

1.1 WEATHER – GENERAL :

- Temperature (air) (mean weekly and monthly)
- Extreme events (incidence of annual extreme warm and cold days)
- Precipitation (rain, snow) (mean monthly and any other characteristics)
- Wind velocity and predominant direction (max, min, average)
- Duration of fishing, hunting and recreational seasons - perceived by community residents
- Indicators of weather predictability

1.2 ICE

- Sea-ice (thickness, annual fast-ice edge distribution, annual date-in, annual date-out in local bay or nearest location, length of time for freezing, salinity)
- Glacier-ice (location, leading edge location, size)
- River-ice (thickness, distribution, date-in, date-out)
- Lake-ice (thickness, distribution, date-in, date-out, length of time for freezing)

1.3 DRINKING WATER

- Drinking water quality (fecal and total coliform) in municipal and local natural source
- Drinking water availability (availability of local natural sources)
- Salt water intrusions in ground water supplies (presence/absence)

1.4 CONTAMINANTS AND POLLUTION

- Level of contaminants in water and animal tissues (priority contaminants - organic and metals, priority food species) (PCB, Hg, Pb)
- Hazardous or toxic substances released in the ambient air (levels in local air sampling)
- Level of radionuclides in animal tissues (priority radionuclides, priorty food species)
- Identification of "contaminant risk areas" (e.g. Dewline)
- Microbiological contamination of traditional foods
- Indoor air quality data
- local ambient water quality (emphasis on sources of raw drinking water)

1.5 BIOTA

- Fauna : Priority animals and wildlife populations (numbers, trends, and seasonal distribution) – Caribou (George River herd)
- Fauna : Priority fish and marine mammal populations (numbers, trends, seasonal distribution) – ringed seal (North Atlantic and Eastern Arctic populations), Arctic char (local stocks)
- New species reported within the region (species sited and identified, year and location, scale: regional or community)
- Fauna : Priority migratory bird populations (numbers, trends, seasonal migration routes) – species dependant upon data availability
- Changes in insects population and distribution (changes in local insect population numbers,

appearance of new species) – dependant upon data availability
- Fauna : Surveillance of zoonotic diseases (incidence, cases)
- Flora : Priority plant species (numbers, trends, distribution)
- Phytoplankton and zooplankton production (primary productivity in marine areas)
- Observed changes in animal health (e.g. skinnier seals) and other abnormalities in wildlife – qualitative
- Reported change in taste and consistency of wild meat (potentially related to previous indicator)

1.6 PERMAFROST
- Continuous and discontinuous permafrost zones (limits of continuous zone and depth where data is available)
- Permafrost active layer (depth and changes over time)
- Adequacy of health supporting infrastructure : drinking water system, sewage, health services buildings (permafrost shifts and damage to infrastructures; costs; continuance of service)

1.7. MODIFICATION OF LANDSCAPE NOT RELATED TO PERMAFROST
- Erosion in sentinel locations (measures or reported from observation of community representatives)
- Shoreline erosion

1.8 UV-B RADIATION
- Incidence of UV-B in community (seasonal) – nearest location

1.9 SEA :
- Coastal level in sentinel locations
- Currents in sentinel locations

1.10 FRESH WATER - LEVELS
- Levels of freshwater in locally important waterways (spawning rivers, natural drinking sources)

2. HEALTH INDICATORS

Physical Endpoints

2.1 DEATHS
- Deaths due to respiratory problems
- Deaths due to non-intentional trauma
- Deaths due to intentional trauma (i.e. suicide)
- Deaths due to CV problems
- Deaths due to cancers
- Deaths due to infectious diseases

2.2 INJURIES
- Description by occurrence : intentional and non-intentional

2.3 DISEASES and physical responses

- Incidence of infectious diseases (diarrheal diseases, bacterial and parasitic diseases – botulism and trichinellosis)
- Incidence of respiratory diseases
- Incidence of cardiovascular diseases
- Incidence of zoonotic diseases (HPS, WEE, EEE, Lyme disease, etc.)
- Incidence of seafood related diseases (préciser : voir CCAF 1)
- Incidence of health problems related to diet shift for alternative sources (diabetes, vitamin deficiency, etc.)
- Incidence of ocular problems (cataracts, infections)
- Incidence of skin cancers
- Incidence of sun blisters and burns
- Incidence of snow blindness
- Perception of physical wellness and vitality

2.4 BIOMONITORING

- Levels of contaminants in human biological tissues (metals, organochlorines)
- Seroprevalence (for certain parasitic and viral diseases)

2.5 LOST PERSONS

Mental Endpoints

2.6 PSYCHOLOGICAL/MENTAL IMPACTS

- Quality of life indicator
- Mental health disorders (mood disorders, anxiety disorders (PTSD))

Social Indicators

2.7 SOCIAL IMPACTS ASSOCIATED WITH HEALTH OUTCOMES

- Cost of living (heating, food including travel)
- Food security (measure of and cost of)
- Cost of equipment for harvesting maintenance, repair and replacement
- Cost of home maintenance and repair wrt natural disasters and events (eg. Spring flooding)

2.8 COMMUNITY WELLNESS

- Incidence of various types of crimes
- Practice of traditional activities
- Community based cultural events

3. ACTION INDICATORS

- Education and prevention programs on UV-B exposure (e.g. hats, sunscreens, etc.)
- Communication and education programs on botulism and trichinellosis hazards

- Existence and adequacy of warning systems for extreme weather events and natural disasters
- Existence and adequacy of community search and rescue teams and emergency response program
- Programs to improve food quality and to promote traditional food consumption (including prevention of new seafood diseases)
- Existence and adequacy of system to ensure access to safe and healthy traditional foods (e.g. community freezers)
- Availability of pyschological assistance following natural disasters
- Vaccination campaigns against infectious diseases

Appendix C

Analysis Matrix

Analysis of health and current surveillance and monitoring capacity in Nunavut						
Possible Health Impacts: endpoints and determinants	**Detection**	**Registration**	**Confirmation**	**Reporting**	**Analyses**	**Feedback**
Heat or cold exposure illnesses or injuries	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	N/A	Yes, in medical file. Or, specifically tracked and reporting requirements are needed at the territorial or federal level (e.g. comparable health indicator's report)	Not unless specifically warranted to tracking and trending information.	Only through update coding (WHO).
Death	Yes, the event will be detected by a physician, nurse, law enforcement agent or coroner.	Yes, through the certificate of death with the Vital Statistics Department	Yes, if an autopsy is performed	Yes, to the Vital Statistics Department and Statistics Canada.	Yes, however data is not recorded to track climate change impacts or trends (causations)	Applications for death certificates are available online. (Appendix xx)
Non Intentional Injuries	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, however the event can be recorded in the client file, or, through specific ICD 10 coding	Yes, if lab, x-ray or specific tests are ordered by the health care provider.	Medical File, or, in case of work related injuries – also with WCB	Yes, however data is not recorded to track climate change impacts or trends (causations)	Yes, if tracked by WCB.

Intentional injuries	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, in the patient health record.	Yes, if lab, x-ray or specific tests are ordered by the health care provider.	Yes, in medical file and possibly judicial file.	Yes, however data is not recorded to track climate change impacts or trends (causations)	No.

Suicide	Yes, the event will be detected by a physician, nurse, law enforcement agent or coroner.	Yes, through issuance of the death certificate from the Vital Statistics Department.	Yes, if an autopsy is performed to confirm cause of death.	Yes, in patient file, through community and territorial reports and Statistics Canada.	Yes. Through publication reports.	N/A
Property loss/damage influencing Income and Social Status		Yes, if reported to the local law enforcement or Municipal agents if it is a criminal act/act of disaster.	Yes, if an investigation or an insurance evaluation is performed.	Yes, judicial reporting and Municipal reporting.		
Infectious disease	Yes, detected at the health center by a nurse or physician.	Yes, for notifiable diseases.	Yes, through appropriate lab/x-ray testing.	Yes, through medical file and central records keeping in Iqaluit.	Yes.	Yes, through revisions to the notifiable diseases list.
Stress induced mental disorders	If the client seeks medical consultation at the health center or hospital, the event may be detected.	Only if specifically coded through ICD 10.	N/A	Yes, in medical file.	Yes, however data is not recorded to track climate change impacts or trends (causations)	No

Stress induced psychosocial disruption	Partial, through crime and social services data.	Partial, crime stats, medical reports	N/A	Partial through crime statistics.	Partial, through report and publications however data is not recorded to track climate change impacts or trends.	?
Missing persons event	Yes, determined by the local law enforcement agents.	Yes, in report or database from the SAR/RCMP	N/A	Yes	Yes	Yes, through the Northern Search and Rescue Secretariat.
Changes in food security: **-Amounts**	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes
-Traditional activities	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes
-Nutritional impacts	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes
-Access and travel security	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes
-Socio-economic factors						

-Amount of replacement foods and associated diseases	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes
	Yes, several studies and on-going research.	Yes, through research methodology	N/A Confidentiality	Yes by publication, report	Yes	Yes

Animal health	Yes, if detected by the Hunters and Trappers organizations bringing and reporting samples from the land or wildlife agents, or individual research studies.	Partially, reported through the department of environment wildlife officers (exact format unknown) & department of health if foods are being consumed (e.g. tainted walrus meat)	Yes	Yes, to public health officials and general public if required.	Yes, NCP reports.	No
Emergence of new disease	If the client seeks medical consultation at the health center or hospital, the event may be detected.	Yes, tracked and coded through the patient record. E.g. HTLV 1	Yes, through appropriate lab/x-ray testing.	Only if number of cases are sufficient to warrant further action.	Yes	Through policy and procedures review.
Access to health services	Yes.	Yes	N/A Confidentiality	Yes, through publications/reports	Yes	Yes
Airstrip safety	Yes	No	No	No	No	No

and access						
Exposure to chemicals	If the client seeks medical consultation at the health center or hospital, the event can be detected.	Yes, only if coded through ICD 10.	Yes, through appropriate lab/x-ray testing	Yes, in medical file or through WCB if work-related event.	Not unless specifically warranted to tracking and trending information.	Only through updated coding.

Chronic & acute respiratory tract	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing.	Yes, in patient file, through community and territorial reports and Health Canada.	Yes, however data is not recorded to track climate change impacts or trends (causations)	Yes
Chronic cardio-vascular	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing	Yes, in patient file, through community and territorial reports and Health Canada.	Yes, however data is not recorded to track climate change impacts or trends (causations)	Yes
Chronic diabetes	If the client seeks medical consultation at the health center or hospital, the event may be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing	Yes, in patient file, through community and territorial reports and Health Canada.	Yes, however data is not recorded to track climate change impacts or trends (causations)	Yes
Skin cancer	If the client seeks medical consultation at the health center or hospital, the event will be	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing	Yes, in patient file, through community and territorial reports and Health Canada	Yes, however data is not recorded to track climate change impacts or trends (causations)	Yes

	detected.					
Allergies	If the client seeks medical consultation at the health center or hospital, the event will be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing.	Yes, in patient file.	Not unless specifically warranted to tracking and trending information	Yes
Eye damage	If the client seeks a consultation at the health center or hospital, the event will be detected.	Yes, through the patient health record at the point of care and ICD 10 coding	Yes, through appropriate lab/x-ray, testing.	Yes, in patient file.	Not unless specifically warranted to tracking and trending information	Yes

Appendix F

Key Informant Communications Material

ArcticNet
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Info Sheet

ARCTICNET PUBLIC HEALTH RESEARCH INITIATIVE

Surveillance and Management of Climate Change Impacts in the North:
Implications for northern public health policy and infrastructure

This project is aimed at improving public health monitoring of climate and environmental changes and the impacts these are having on the health of Inuit communities.

Several northern studies have documented climate changes and the impacts these are having on northern residents including to their health. A recent study involving Labrador Inuit Women has demonstrated circumstances in which environmental change may be influencing aboriginal health. Participants expressed examples such as the timing of ice freezing and break up impacting their hunting activities and access to resources as well water access changing out on the land. The adoption of an environmental monitoring and health tracking system would enable the Inuit and related organizations to answer questions such as: Are there environmental changes occurring that are impacting health in any or all four Inuit Regions. This information will serve to help protect health in Inuit Communities.

ArcticNet connects well-established Centres of Excellence in the natural, medical and social sciences, and their partners in northern communities, federal and provincial agencies and the private sector to study the impacts of climate change in the Arctic. ArcticNet researchers collaborate with the best research teams in the USA, Japan, Denmark, Sweden, Norway, Poland, the United Kingdom, Spain and Belgium. (See http://www.arcticnet.ulaval.ca/) **The proposed project is one of 27 under the newly established Arctic research program on environmental change in the North, called ArcticNet. Of these projects, only a small number are public/community health initiatives.**

The purpose of this project is to work with Northern managers, organisations and individuals. The first step will assess and subsequently facilitate ***capacity building*** in support of surveillance and management of climate change health impacts in the North. Such capacity building could include recommendations relating to technology, training, human resource

Population Health in Ottawa. The purpose of the research is to identify and assess the current state of public environmental health surveillance in Northern Canada.

My participation will consist essentially of participating in one 30-45 minute telephone interview. The session has been scheduled for *(Date and time of session)*. I will be asked to share my experience, knowledge and opinion regarding the current state of public health surveillance infrastructure in my region. As a follow-up to the interview, a second contact may be identified to clarify discussed items – this second contact could take up to 15-20 minutes in duration. I understand that the contents will be used in a report outlining public health surveillance in the North and that my confidentiality will be respected. No personal identifiers such as my name will be utilized in the body of the report but my name will appear in the acknowledgements section of the report if, and only if, I have given my authorization below. My responses may be quoted however my anonymity will be guaranteed. All information will be stored under lock and key at the Institute of Population Health at the University of Ottawa for a maximum of 7 years after publication. After such time, all materials will be destroyed.

I am free to withdraw from the project at any time for any reason and to refuse to answer any questions I do not wish to answer.

If I choose to withdraw, I want all data gathered from me until the time of withdrawal to be destroyed. *( )*
Even if I withdraw from the study, I accept that the data gathered from me be used without identifying the source. *( )*

If I have any questions with regards to the ethical conduct of this study, I may contact the Protocol Officer for Ethics in Research, University of Ottawa, Tabaret Hall, 550 Cumberland Street, Room 159, Ottawa, ON K1N 6N5, tel.: (613) 562-5841 or ethics@uottawa.ca

Please initial one of the following options:

I authorize the inclusion of my name in the acknowledgements section of the final report. ( )

I do not authorize the inclusion of my name in the acknowledgements section of the final report. ( )
I wish to see the draft report before I decide if I want to authorize the inclusion of my name in the acknowledgements section. ( )

There are two copies of the consent form, one of which I may keep. If I have any questions about the conduct of the research project, I may contact the researcher Isabelle Champagne-Shields or her supervisors: Dr. Don Wigle (613) 225-2912 email don.wigle@sympatico.ca or Professor Doug Angus (613) 562-5800 ext 4720 email angus@management.uottawa.ca

By signing below, I agree to participate in this study.

_____ _____

Participant's Authorization Date