An Assessment of the Interface Between Scientists and Policy Makers in the Context of Climate Change in Canada's Arctic

By

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A thesis submitted to the Faculty of Graduate Studies in partial fulfillment of the requirements for the degree of

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ABSTRACT

Bringing scientists and policy makers together in an effective manner to inform decision making is an ongoing challenge. This is particularly significant in regard to the development of Canadian policies that address climate change issues because of the complex nature of climate change and the changing relationships that are evolving between scientists and policy makers. Many factors and stakeholders contribute to the development of policies that address climate change issues. The focus of this thesis is the relationship between scientists who undertake research in Canada's arctic and government policy makers at the federal level working on policies to address climate change in Canada's arctic. The research assumption put forward in this thesis was that the interface between scientists and policy makers is underdeveloped and functioning poorly.

Using a qualitative case study approach, the research assessed responses from scientists conducting research in Canada's arctic and government policy makers who may respond to the arctic research findings. The research was conducted using semi-structured interviews to gain a better understanding of the interactions that occur between these two groups. It identified challenges related to the process of scientific findings informing policy development, government policy priorities influencing research agendas, and the potential for improving the interface between the scientists and policy makers.

The results indicated that the there is a gap in the interface between climate change scientists in Canada's arctic and government policy makers who formulate arctic policy. Critical challenges affecting the interface were communication and a common understanding of each others processes. The "language" (i.e., words and style of written and verbal communication) and level of detail used by ArcticNet scientists differs from that used by policy makers, which leads to misinterpretation and sometimes indifference between the two groups. This is consistent with current literature on the topic of the science - policy interface. The science and policy processes of scientists and policy makers are not well understood by each other and this impedes the building of relationships between academia and government to address a common interest.

This is an important aspect for moving forward to address climate change issues because new models of science informing policy are emerging. Climate change science networks such as ArcticNet provide an opportunistic tool for the Canadian government to advance effective policies on climate change, but success will depend on the strength and effectiveness of the interface between the two. The thesis ends with recommendations for bridging the gap, namely: create a stand alone independent science assessment body of arctic science; develop formal mechanisms to bring scientists and policy makers together in a structured format; utilize more plain language summaries and synthesis of research findings; increase use of existing boundary organizations and translators; formulate communication strategies that will include use of media; and develop outreach and education for arctic climate change science and policies.

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GLOSSARY OF TERMS

Science-policy interface:

The interactions that occur between scientists and policy makers to incorporate scientific information into government decision making for policy development and to convey the policy needs of government to scientists.

Policy maker:

A government bureaucrat that is involved in the development of policies to address climate change issues in Canada's arctic.

Scientist:

A researcher within ArcticNet who is undertaking research within the Canadian arctic in the physical, biological or social sciences.

Climate change policy:

Policy developed by the federal government that is informed by climate science, natural science and social science to address issues related to climate change mitigation and adaptation.

CHAPTER 1: INTRODUCTION

1.1 Background

The matter of bringing together scientific knowledge and political decision making presents one of the oldest challenges to popular governance (Dahl, 1989). In the context of public policy, policy development can be described as an applied social science discipline that uses reason and evidence to clarify, appraise and advocate solutions for public problems (Canada Research Institute, 1999). It involves a process of problem or issue identification, assessment and analysis, and review of options and alternatives, which leads to a decision for action. Science on the other hand can be defined as "knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method; such knowledge or such a system of knowledge concerned with the physical world and its phenomena" (Merriam-Webster, 2008). A more holistic definition of science is that science is "the field of study which attempts to describe and understand the nature of the universe in whole or part" (Siepmann, 1999). In general it can be said that science is a system of acquiring knowledge using observation and experimentation to describe and explain natural phenomena.

Scientific knowledge feeds into the decision making process for policy development through different forms of study, investigation and theoretical explanation. Sound science is necessary for informed public policy but it must be presented in the proper format for decision making (Watson, 2005). It is also possible for policy to influence the

direction of scientific research. Bringing scientific research and policy development together in an effective manner to influence decision making is a matter of much discussion and debate in this era of increased knowledge and public participation in government processes. This is especially true in regard to the development of Canadian environmental policy and in particular, those policies that respond to issues related to climate change. To influence decision making on this complex issue, the underlying causes of environmental change and the process of decision making must be well understood (Watson, 2005).

Canada has gained a reputation as a country with vast, unspoiled natural resources and a public that is outspoken and knowledgeable regarding environmental issues. This gives the impression that Canada's environmental policies are performing well and stated policy goals and objectives are being addressed (Lee and Perl, 2003). The reality is that the sustainability of Canada's environment may be at risk because public policies are not always well aligned with the real problems (Lee and Perl, 2003). Knowledge that can influence decision-making on environmental policy includes not only scientific considerations, but also the institutional settings that give rise to the policy (Wilson, 1981).

While many factors contribute to development of environmental and climate change policy, the focus of this research is on the relationship between scientists undertaking research in Canada's arctic and federal policy makers who may use the research to develop policy. Ideally, this relationship would be a two-way, open communication of

facts and figures, methods of analysis, and outcomes and values between the scientists, policy makers and other stakeholders with the aim of increasing coherence between scientific knowledge and policy needs (Airnet, 2006). The research assumption put forward in this thesis was that the interface between scientists and policy makers is underdeveloped and functioning poorly. Some questions this assumption evoked were: What are the challenges faced by policy makers and scientists that impede effective incorporation of scientific information into policy; and how can the challenges be addressed and the interface be bridged? This research contributes to the growing body of literature on the science - policy interface.

1.2 Arctic Climate Change Research

A great deal of research is underway in Canada and other parts of the world to address climate change and how humans can adapt to the changes it is anticipated to bring. One research community with particular relevance for this thesis proposal is ArcticNet Inc. Incorporated in 2003, ArcticNet is a network of scientists and managers in the natural, human health and social sciences with partners in Inuit organizations, northern communities, federal and provincial governments, and industry. This network of people work together to study the impacts and opportunities of climate change and globalization in the coastal Canadian arctic. Research projects under ArcticNet are organized into four research themes where researchers and their partners are focused on producing Integrated Regional Impact Studies (IRISes) on the consequences of change on society and ecosystems in the coastal Canadian High Arctic, Eastern Arctic and Hudson Bay (ArcticNet, 2007). These three areas of study will add to the present knowledge base for

the development of policy and strategies for adapting to the changing arctic environment, which constitutes the fourth area of study for ArcticNet (ArcticNet, 2007). This thesis contributes to this fourth area of study.

1.3 Purpose

The purpose of this research was to examine the interface between scientists and policy makers in the context of climate change in Canada's arctic.

1.4 Objectives

The objectives of the research were:

1) To explore the ways in which scientists convey their research findings on climate change in Canada's arctic to federal policymakers;
2) To assess the ways in which policymakers at the federal level convey their policy priorities for climate change in Canada's arctic to scientists and how this may influence research agendas;
3) To identify the challenges effecting the interface between scientists conducting research in the Canadian arctic and federal policy makers who may respond to the research; and,
4) To propose recommendations to improve the interface between these two groups of scientists and policy makers.

1.5 Methods

The research design consisted of a qualitative approach using a case study strategy of inquiry. Qualitative data collection methods included (1) literature review, (2) primary document review, and (3) semi-structured interviews with scientists conducting research in Canada's arctic and policy makers at the federal level working on policies to address climate change in Canada's arctic. These methods allowed a descriptive and exploratory research approach to better understand the interface between climate change scientists and policy makers and in turn, helped to inform the development of recommendations to improve the interface.

1.6 Organization

This thesis is organized into six chapters. The first chapter provides the reason for undertaking the research, the purpose and objectives. The second chapter provides a literature review of (a) the key concepts and ideas related to environmental policy, specifically climate change policy, in Canada, (b) the status of current climate change science, with a focus on Canadian Arctic research, (c) the federal government policy development process, and (d) the status of current thinking in regard to the interface between climate change science and policy development. The third chapter provides details on the chosen research method. The fourth chapter presents the results while the fifth chapter presents a discussion of the results. The last chapter, chapter six, provides conclusions and recommendations, and suggestions for future research in this area.

CHAPTER 2: CLIMATE CHANGE POLICY DEVELOPMENT AND THE INTERFACE WITH SCIENTISTS

2.1 Introduction

A literature review was conducted on pertinent topics related to policy development processes for Canadian environmental and climate change policy, the state of current climate change policy in Canada's arctic and the interface between scientists and policy makers. This chapter provides a summary of current thinking on these issues. The review was used as a foundation to build upon in examining the science policy interface issue. The literature review consisted of:

- a review of journal articles, relevant books, government reports and documents related to the history of environmental and climate change policy development processes, and the science policy interface; and
- a review of relevant websites related to ArcticNet and federal climate change policy development in Canada's arctic.

2.2 Environmental Policy in Canada

The 1960's were the beginning of the environmental movement in North America. A significant piece of literature that empowered this movement was "Silent Spring" by Rachel Carson. Her persuasive writing stimulated many people to gain a greater awareness of the impact that modern development was having on the environment and on people. She could be considered one of the early pioneers of scientists bridging the interface with policy makers. These last few decades of research and innovation have

resulted in a tremendous increase in knowledge and understanding about ecological and environmental concerns and how these issues are integrated with other aspects of society – economic and social. This has created the need for new policy instruments and new processes for developing these tools to meet the challenges of the integrated nature of the problems with which we are now faced.

Over the past 20 years, climate change and global warming have become this country's most critical environmental issues and have taken on a life of their own in the context of Canadian environmental policy. Volumes of research have been, and continue to be, conducted on this issue from the perspective of many disciplines – natural science, social science, economics, health and so on. Governments in Canada – federal, provincial and local – have been developing and implementing policies in an attempt to mitigate and adapt to climate change impacts. In order to comprehend climate change policy one needs to first understand it in the broader context of environmental policy in Canada.

Canada is considered a leader by other countries in the development of environmental policy and its commitment to environmental protection, yet in reality the efforts to implement these policies fall short. This is due in part to uncertainties and disagreements between the various levels of government (VanNijnatten and Boardman, 2002). The legal foundation for environmental policy in Canada is found within *The Canadian Constitution Act,* 1867. The Act lays out the distribution of powers between the federal and provincial governments. Environmental matters have shared jurisdiction but the actual boundaries between the federal government and provinces are not always clear

(VanNijnatten and Boardman, 2002). This uncertainty has important policy implications for Canada. As we will see later in the literature review, this is especially relevant for climate change policy.

There are two types of powers that are relevant to environmental decision making – those related to property ownership (proprietary powers) and those related to law making and legal jurisdiction (legislative powers). Proprietary powers give governments ownership of lands, waters, resources and facilities. Section 109 of the Constitution gives provinces ownership and control of lands and minerals situated within the province and as owners, the right to lease or sell (*The Constitution Act*, 1867). The distribution of legislative powers is found in Section 91 of *The Constitution Act,* 1867. Federal legislative powers include peace order and good judgement, public debt and federal property, trade and commerce, taxation, navigation and shipping, sea coast and inland fisheries, Indians and lands reserved for Indians, federal works, Criminal law and declaratory powers. Provincial legislative powers include management and sale of public lands, non renewable natural resources, forestry, electrical energy, direct taxation to consumers, municipal institutions, local works and undertakings, property and civil rights, and all matters of local or private nature.

To address the uncertainty with blurred boundaries and overlapping jurisdiction, the government has attempted to implement coordination and harmonization efforts. For example, the Canadian Council of Ministers of the Environment (CCME) and Canadian

Council of Resource Ministers were established to address environmental policy issues across provincial jurisdictions with the federal government.

At the federal level, several key policy implementation tools are in use. *The Canadian Environmental Protection Act* (CEPA) regulates the use of toxic substances. The purpose of the Act is to contribute to sustainable development through pollution prevention, applying the precautionary principle. The central issue related to this is whether uncertain science should postpone adoption of cost-effective measures or adoption of any measures. There is some debate between environmentalists, industry and government regarding the issue. Under the Act, only toxic substances can be regulated, therefore they have to be proven to be toxic and put a list before they can be regulated. Regulatory options under CEPA are pollution prevention, virtual elimination and economic instruments and market-based approaches such as deposits and refunds, and tradable units. Other legislative tools for federal environmental policy include the *Canadian Environmental Assessment Act, Species at Risk Act*, and the *Fisheries Act*.

2.3 Climate Change Policy in Canada

Climate change is now on the political agenda of governments all over the world and is considered to be a very complex issue. A multitude of stakeholders are impacted and involved in trying to address this issue. This includes numerous federal government departments, provincial governments, many different types of industry (from insurance to energy), forestry, environmental organizations, non-environmental organizations, and the public.

2.3.1 International Influence

Much of the literature points to the influence international negotiations and commitments have had on Canadian domestic climate change policy. The origins of climate change on Canada's political agenda can be traced back to the 1992 United Nations Framework Convention on Climate Change (UNFCCC). Canada's role in the negotiations was that of a mediator between the United States and the European Union whose interests in this agreement were divided (VanNijnattan and Boardman, 2002). The UNFCCC loosely committed signatories to reduce carbon dioxide and other greenhouse gas emissions. Canada signed and ratified the agreement in 1992. The UNFCCC came into force in March 1994. The globalized nature of industries responsible for the emission of green house gases contributed to the pressure on Canada to commit to initiate domestic policies beyond what would have been done if climate change were solely a domestic affair (VanNijnattan and Boardman, 2002).

2.3.2 Intergovernmental Panel on Climate Change

Because of the complexities of climate change, policymakers need objective sources of information about its causes, its potential environmental and socio-economic consequences and the adaptation and mitigation options to respond to it. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to provide decision-makers and others interested in climate change with an objective source of information about climate change (IPPC Website, 2008). The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and

by the United Nations Environment Programme (UNEP) (IPPC Website, 2008). The IPCC is open to all member countries of WMO and UNEP. Hundreds of scientists all over the world contribute to the work of the IPCC as authors, contributors and reviewers. As a United Nations body, the IPCC work aims at the promotion of the United Nations human development goals. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation (IPPC Website, 2008).

IPCC reports are neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio-economic factors. They aim for high scientific and technical standards, reflecting a range of views, expertise and wide geographical coverage. The information provided in the reports is based on scientific evidence and reflects existing viewpoints within the scientific community. The comprehensiveness of the scientific content is achieved through contributions from experts in all regions of the world and all relevant disciplines including, where appropriately documented, industry literature and traditional practices, and a two stage review process by experts and governments.

Because of its intergovernmental nature, the IPCC is able to provide scientific technical and socio-economic information in a policy-relevant but policy neutral way to decision makers. When governments accept the IPCC reports and approve their summary for

policymakers, they acknowledge the legitimacy of their scientific content. The IPCC provides its reports at regular intervals and they immediately become standard works of reference, widely used by policymakers, experts and students. The findings of the first IPCC Assessment Report of 1990 played a decisive role in leading to the United Nations Framework Convention on Climate Change (UNFCCC), which was signed at the Rio de Janeiro Summit in 1992 and came into force in 1994. It provided the overall policy framework for addressing the climate change issue. The IPCC Second Assessment Report of 1995 provided key input for the negotiations of the Kyoto Protocol in 1997. The Third Assessment Report of 2001, as well as Special and Methodology Reports, provided further information relevant for the development of the UNFCCC and the Kyoto Protocol. The Fourth Assessment Report of IPCC, released in 2007, made the bold statement that greenhouse gases caused by man were causing climate change to change. The IPCC continues to be a major source of information for the negotiations under the UNFCCC (IPCC Website, 2008).

2.3.3 Kyoto Protocol

The Kyoto Protocol was adopted at the third Conference of the Parties to the UNFCCC (COP 3) in Kyoto, Japan, on December 11, 1997. While the Convention encouraged developed countries to stabilize greenhouse gas emissions, the Protocol committed them to do so. Because it affects virtually all major sectors of the economy, the Kyoto Protocol was considered to be the most far-reaching agreement on environment and sustainable development ever adopted. Canada is a signatory to the agreement which came into force on February 16, 2005.

The Protocol requires developed countries to reduce their greenhouse gas emissions below levels specified for each of them in the agreement. These targets must be met within a five-year time frame between 2008 and 2012, and add up to a total cut in greenhouse gas emissions of at least five per cent (5%) against the baseline of 1990 (UNFCCC Website, 2008). Some scientists have doubted the scientific basis of the Kyoto Protocol, claiming that there is not a clear connection between increases in greenhouse gas emissions and climate change. The Fourth Assessment Report of the IPCC ended that discussion with a statement that put the reality of human-induced climate change beyond any doubt (UNFCCC Website, 2008). Governments endorsed the IPCC's Fourth Assessment Report by consensus; many considered it to provide a solid foundation for sound political decision-making.

The Kyoto Protocol was generally seen as an important first step towards a truly global emission reduction regime that would stabilize greenhouse gas concentrations at a level to avoid dangerous climate change. As a result of the Protocol, governments have been and are continuing to put legislation and policies in place to meet their commitments. A carbon market has been created and businesses are making more investment decisions taking climate change into account. The Protocol was to provide the basis for any new international agreements on climate change. The first commitment period of the Kyoto Protocol expires in 2012. By then, a new international framework must be in place that can deliver the stringent emission reductions necessary as indicated by the IPCC. (UNFCC Website, 2008)

2.3.4 Canada's Response to the Kyoto Protocol

Immediately following the conclusion of the Kyoto Protocol in 1997, Canada's first ministers met and agreed that climate change was an important global issue and that Canada must do its part to address it. They directed federal, provincial and territorial ministers of energy and environment to put in place a national process to examine the impacts, costs and benefits of the Protocol's implementation and the various implementation options open to Canada (Environment Canada Website, 2008). On April 29, 1998 Canada formally signed the Kyoto Protocol on climate change signaling its intention to ratify the Protocol when Canada had a national strategy and the international mechanisms were agreed on. Canada's target was to reduce its greenhouse gas emissions to six (6) per cent below 1990 levels for the period from 2008 to 2012.

Many activities and initiatives have been undertaken by the federal government since 1998 in response to the Kyoto protocol. In 1998, Federal, provincial and territorial ministers of energy and environment approved a process to develop a national implementation strategy on climate change. The Climate Change Action Fund (CCAF) was established, with $150 million over three years to help develop Canada's response to the Kyoto Protocol. Federal, provincial and territorial governments launched a national process to develop a National Strategy on Climate Change to respond to its Kyoto commitments. A National Climate Change Secretariat was established to provide overall support and coordination of the process. The Office of Energy Efficiency was established

within Natural Resources Canada to focus and accelerate Canadians' awareness of and involvement with energy efficiency.

In 1999, the Government of Canada committed $1.6 million over three years to develop a Municipal Buildings Retrofit Program. The government released several reports related to climate change: *Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends*, as required under the UNFCCC; *Canada's Perspective on Climate Change*, providing an overview of the science of climate change and Canada's actions to date; and *Canada's Emissions Outlook: An Update*, providing an updated outlook for greenhouse gas emissions over the next 20 years.

In 2000, the Government of Canada announced $625 million over the next three to four years for programs designed to accelerate climate change research and science and curb Canada's greenhouse gas emissions. This included over $150 million to renew the Climate Change Action Fund for three years. Canada announced its five-year Action Plan with $500 million towards concrete measures to reduce greenhouse gases by about 65 megatonnes each year. Canada released the *National Implementation Strategy on Climate Change* which included the First National Business Plan.

In 2002, Canada released *A Discussion Paper on Canada's Contribution to Addressing Climate Change* which outlined options for reducing Canada's emissions to Kyoto levels. This was followed by the release of a *Climate Change Plan for Canada*, the result of

consultations with provinces and territories, industry, and non-governmental organizations.

In 2005, the Government of Canada released *Moving Forward on Climate Change: A Plan for Honouring our Kyoto Commitments,* its implementation plan. This plan was shelved with the election of the new Conservative government in 2006.

In 2007, Canada announced its plan for reducing greenhouse gas and air pollution emissions from industry. It also outlined planned regulatory measures to reduce emissions from the transportation sector, actions on consumer and commercial products, and actions to improve indoor air quality. To ensure Canada meets its global climate change obligations under the Kyoto Protocol, Canada passed the *Kyoto Protocol Implementation Act* in 2007.

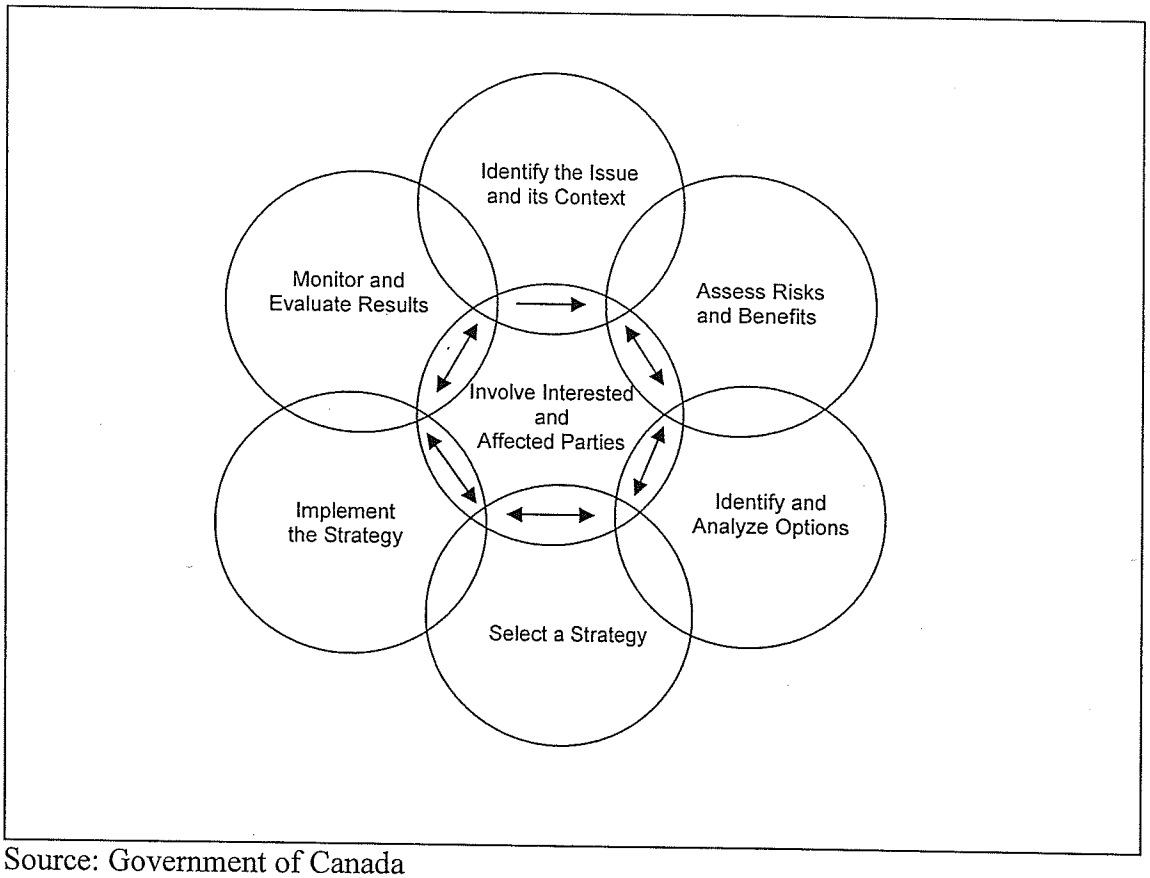
In March of 2008, the Government of Canada announced details on its plan originally announced in 2007 to reduce greenhouse gas emissions. This plan included mandatory reductions for industry, along with additional new measures to address two of Canada's key emitting sectors: oil sands and electricity. The government indicated through its press releases that tough federal regulation of industry's greenhouse gas emissions will help achieve the Government's commitment to a 20% reduction in Canada's overall emissions by 2020, and will be the most important driver of change for moving Canada to a low-emission economy (Environment Canada, 2008). Also in 2007, Canada committed its support for the International Polar Year (IPY) program which will help

create a more complete understanding of the arctic region that can be applied to address policy issues related to the environment and people living in this area. More detail on this program is presented in section 2.5.1.

2.4 Policy Development Process in Government

Public policy development and implementation is a key function of government. It is a management process in which policy needs and issues are identified and ranked, proposals to address the needs are developed and approved, implementation is provided for, and results are evaluated (Ontario Ministry of Natural Resources, 1995). The process occurs at different levels within the federal government. The Prime Minister and Cabinet and committees of Cabinet play the primary role in setting policy direction. The public service (the bureaucracy) support and work the processes that facilitate realization of the government's policy direction.

The policy process can be described as cyclical and iterative. There are different models for policy development and decision making processes at all levels of government - federal and provincial and municipal - and these models all contain similar components. The federal government policy development process is illustrated in Figure 1 (Government of Canada, 2005).



Source: Government of Canada

Figure 1: Policy Development and Decision Making Framework

Typically, the policy development process for government unfolds as follows: In the first step of the policy development cycle, the policy maker at the bureaucratic level will undertake a process to clearly define the nature of the issue and the context it is within. Considerations for the policy maker are:

- Where is the policy direction coming from (Cabinet, Minister, other)?
- What is its priority?
- Where does the responsibility lie for the policy?
- Who else shares an interest in this issue?
- What are the outcomes being sought by government.

The policy maker may establish a team or working group within the department to assist with this part of the process. Team members may consist of other policy makers, experts within and from other departments, and operational staff, all internal to government. Once the problem or direction is clearly identified and understood by the team, an in-depth analysis of the issue is undertaken. This step would involve consideration of who the various groups and stakeholders are (possibly other government departments or agencies, non-government stakeholders, regional stakeholders), how they may be impacted, and what the risks and benefits are of moving forward with this proposed policy direction. The analysis includes economic, social, environmental, financial, technological, political, and legal considerations, as well as public view of acceptable risk. This is a key step in the process where data must be collected and analyzed. Existing research data should be investigated and brought into the process. The involvement of interested parties and stakeholders to provide information is, theoretically, to be woven throughout the entire policy development process. In reality, the decision on whether there is stakeholder and/or public consultation is at times dictated by existing legislation and at other times determined through an internal policy decision to do so. Consultation may occur with varying degrees and at varying levels throughout the process.

The policy development team identifies policy options that outline the pros and cons of each alternative and their effectiveness in achieving the desired outcome. Some of the considerations for the policy team in identifying options are effectiveness, cost, implementation issues, time, risk mitigation and management and impact on other stakeholders, and alignment with other government priorities. Based on the assessment of

options, the policy makers will usually recommend one of the options and provide their rationale for that choice. This rationale may also include a recommendation for which policy instrument (legislation, regulation, program, policy/guidelines) may be preferred to deliver the policy, if this direction has not already been given by Cabinet or the minister. Implementation and communication strategies are provided to support the choice. The information obtained in this process will be written up as a policy discussion paper and forwarded up the chain of command to the minister, who will be briefed by the lead policy staff. If there is support from the minister, the discussion paper may be redrafted by the policy maker as a cabinet Submission and the minister will present to Cabinet. Sometimes the minister may lobby his/her Cabinet colleagues prior to going to Cabinet to gain support for the recommended policy. Cabinet may either approve the policy submission or direct that further information is required before a final decision can be made. If approval is given by Cabinet, the originating department prepares and delivers the appropriate communication materials and implements the policy. Implementation of the policy is monitored and evaluated by the department to assess its effectiveness in meeting the desired outcome. This evaluation provides the policy maker with information for suggesting improvements.

The Ontario government describes the relationship between science and policy as part of the science and technology continuum (Ontario Government, 1995). This suggests that policy programs are an important part of the science and technology continuum and that policy makers are important clients of the science and technology units within government. The model indicates that the policy development process is to reflect the

input of science and technology people from within government in the finished policy products and suggests that this input should be sought at an early stage in the policy development process. This means policy makers engaging directly with science and technology staff to clarify the nature of the policy issue, to provide their input into the policy proposal and to play a role in the implementation of the policy. In recent years, the trend within government has been moving toward science and technology teams including representatives from policy oriented branches and vice versa (Ontario Government, 1995; Environment Canada, 2007).

2.4.1 Levels of decision making

Review of the literature indicates that decision making on policy issues can take place at different levels – individuals and local communities (micro level), sub-national or administrative planning units (meso level), national (macro level), multi country or broad regional (super macro) or international or global (mega level) (Bangladesh Centre for Advanced Studies, 2006). The Bangladesh Centre for Advanced Studies (BCAS) advocates that knowledge and information developed within these levels need to be integrated into policy to make the knowledge useful and effective. This concept is illustrated by the table below.

Table 1: Multi-level Decision Making and Integration

Level	Sector	Examples
Mega	Global and International	Climate change, trade, sustainable development, biodiversity
Super macro	Multi country, broad regional	Cross jurisdictional/ broad regional water basins management, multinational environmental agreements
Macro	National	Climate change, natural resource management, poverty reduction, information sharing
Mega	Sub-national/ecosystem or administrative planning	Adaptation to climate change, natural resource management, water programs, infrastructure
Micro	Individual and community	Local action for environment, local natural resource management, livelihoods

Source: Bangladesh Centre for Advanced Studies, 2006

The literature is less clear on how integration of the varying levels of decision making and sharing of information should take place.

Research has been undertaken that examines how different players in society may influence the policy development process. Findings from that work indicate that the level of success in influencing public policy varies from group to group, based on a number of themes. These include: strength and power in numbers, the strong voice of business, getting the ear of politicians, having a plan, handling the media in a manner that does not attack the bureaucrats, getting the bureaucrats on side, information sharing and partnerships (Lunergan, 2002). Government responses to these themes suggest that alliances and coalitions are useful and that the organizations should work towards more

cooperative relationships with government-funded agencies, since all parties are really interested in the same final result, public policy that meets everyone's needs (Lunergan, 2002).

There has been some work done to assess if policy decisions have been incorporating science information in a consistent manner. The question around this is not so much whether the science information dictated that policy decision, but rather was the policy decision consistent with the science information. Shaw, Everest and Swanston (2000), in their study of land management planning, put forward the following evaluation criteria to assess how scientific information was used by policy makers to make decisions.

- All relevant science information made available was cited in the decision.
- Science information was understood and correctly interpreted.
- Resource risks associated with decisions were acknowledged and documented.

All three criteria needed to be met before a decision could be considered being consistent with available science information.

2.5 Climate Change Science

Global warming is caused by greenhouse gases being released into the atmosphere. The data points to the burning of fossil fuels, primarily from the energy and transportation sectors, as the cause for a significant increase in greenhouse gases concentrations in our atmosphere. According to NASA data, the Earth's average surface temperature has increased by about 1.2 to 1.4°F in the last 100 years (Environmental Protection Agency, 2006). Other climate changes are also occurring such as rainfall patterns, snow and ice

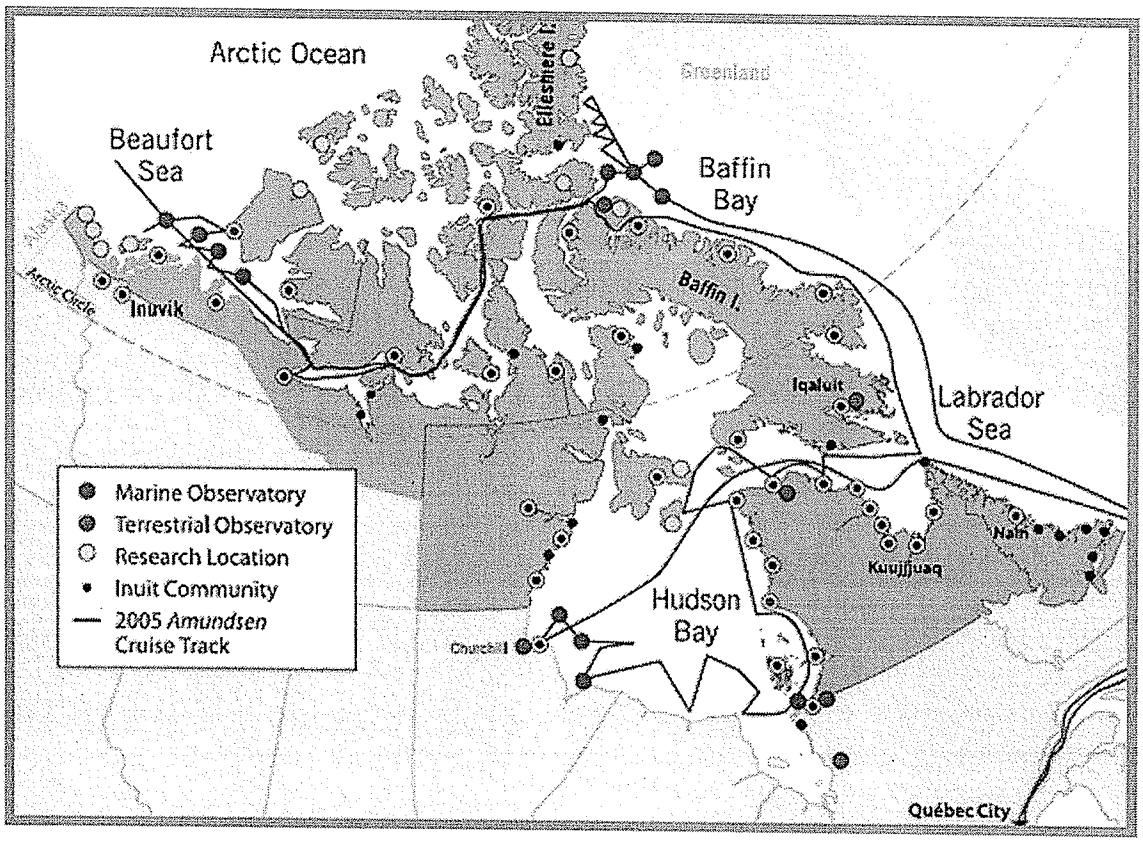
cover, and sea level (Environmental Protection Agency, 2006). If greenhouse gases continue to increase, climate models predict that the average temperature at the Earth's surface could increase from 3.2 to 7.2°F above 1990 levels by the end of this century (Environmental Protection Agency, 2006). Scientists are fairly certain that human activities are changing the composition of the atmosphere, and that increasing the concentration of greenhouse gases will change the planet's climate. Uncertainties remain about how much it will change, at what rate it will change, or what the exact effects will be (IPCC, 2007).

2.5.1 Climate Change Research in Canada's Arctic

The 2007- 2008 International Polar Year (IPY) began in March 2007 and signified the largest ever international coordinated program of scientific research focused on the Arctic (Government of Canada, 2008). This program involves thousands of scientists from 60 nations around the world participating over a 24-month period. The objective of the IPY is to create a more complete understanding of the arctic region that can be applied to address policy issues related to the environment and people living in this area. With nearly 25 per cent of the arctic region within its boundaries, Canada is seen as a key international partner in the IPY. The Government of Canada has committed $150 million over the next six years to IPY which will be jointly managed by departments of Indian and Northern Affairs and Northern Development, Environment, Fisheries and Oceans, Health, Industry, and Natural Resources Canada. The government funding focuses Canadian research in the arctic on two key priority areas: climate change impacts and adaptation, and the health and well being of Northern Canadians (Government of

Canada, 2008). Other components of Canada's IPY program consist of a training program to engage young scientists and a communications and outreach program to raise awareness of arctic region issues and celebrate northern achievements.

Forty four Canadian research projects were selected in 2007 for IPY funding by the Government of Canada (Indian and Northern Affairs Canada, 2007). The Canadian Coast Guard icebreaker, Amundsen, was announced as the major platform for the scientific research that will take place in the arctic, representing an over 18 million dollar investment over fifteen months by the Canadian government (Department of Fisheries and Oceans, 2007). Three main research missions are to be conducted on the ship: the Circumpolar Flaw Lead (CFL) Study, the Inuit Health Survey, and the continuation of the work of ArcticNet, a Network of Centres of Excellence of Canada. The CFL study is being led by ArcticNet researchers at the University of Manitoba (Department of Fisheries and Oceans, 2007). The map below illustrates the area of research being undertaken in the arctic by ArcticNet scientists.



Source: ArcticNet

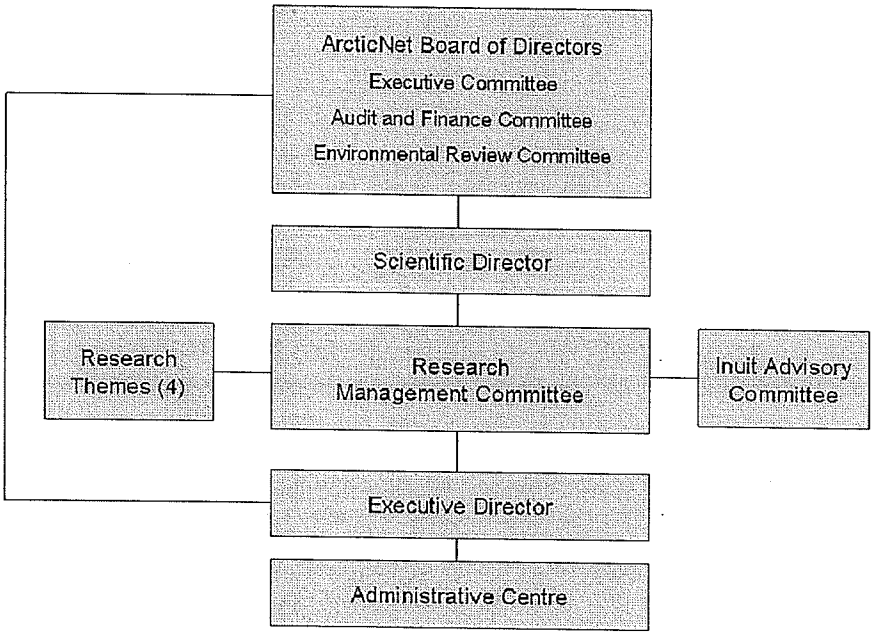
Figure 2: Map of ArcticNet Research Effort

2.5.2 ArcticNet

ArcticNet, one of sixteen Network of Centres of Excellence of Canada (NCE)[1], was created in 1993 to bring together scientists and managers in the natural, human health and social sciences with their partners in Inuit organizations, northern communities, government and industry to help Canadians face the impacts of climate change and globalization in the Arctic. Over 95 ArcticNet researchers and 370 graduate students, postdoctoral fellows, research associates and technicians from 28 Canadian universities

[1] The NCE program is overseen by three Canadian federal granting agencies, the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Social Sciences and Humanities Research Council of Canada (SSHRC).

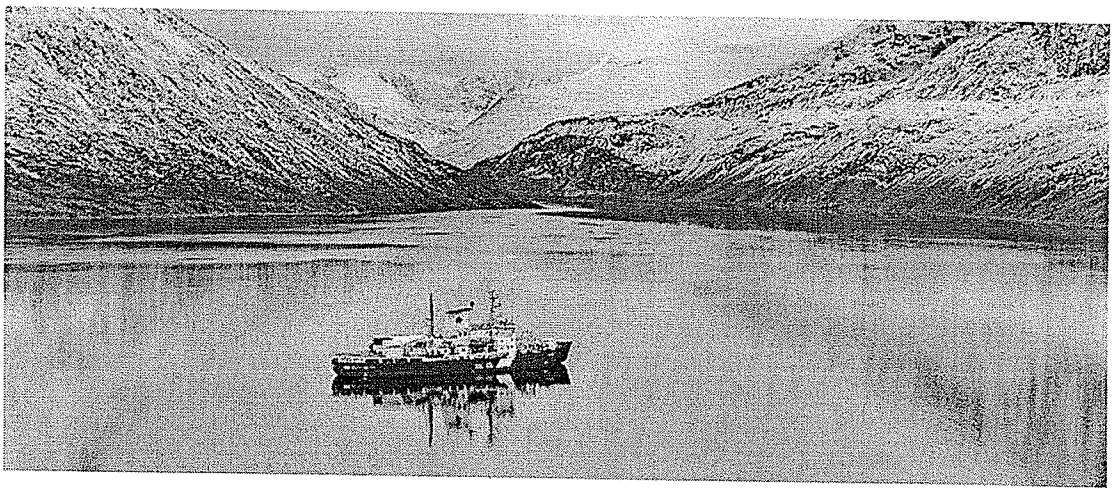
and five federal departments collaborate on 30 research projects with over 150 partner organizations from Canada, Denmark, Finland, France, Germany, Hungary, Sweden, Japan, Norway, the United Kingdom, Spain, USA, and Russia (ArcticNet Annual Report, 2007). The structure of ArcticNet is presented in Figure 3.



Source: ArcticNet

Figure 3: ArcticNet Organizational Structure

The central objective of ArcticNet is to translate researchers' growing understanding of the changing arctic into impact assessments, national policies and adaptation strategies. (ArcticNet, 2007). ArcticNet strives to directly engage Northerners in the scientific process through a bilateral exchange of knowledge, training and technology (ArcticNet, 2008). Many of ArcticNet's research projects are conducted aboard the research icebreaker, the Amundsen.



Source: ArcticNet

ArcticNet has 30 current projects, organized into four research themes. These themes are:

- Theme 1 - Climate Change Impacts in the Canadian High Arctic: a Comparative Study Along the East-West Gradient in Physical and Societal Conditions. This theme contains seven (7) research projects.
- Theme 2 - Food, Water and Resources in the Shifting N-S Thermal Gradient of the Terrestrial Eastern Canadian Arctic. This theme contains eight (8) research projects.
- Theme 3 - Managing the Largest Canadian Watershed in a New Climate: Land-ocean Interactions in Sub-Arctic Hudson Bay. This theme contains seven (7) research projects.
- Theme 4 - Adapting to Change in the Canadian Arctic: Knowledge Transfer, Policies and Strategies. This theme contains eight (8) research projects.

This thesis constitutes part of the research being undertaken under Theme 4 - Adapting to Change in the Canadian Arctic: Knowledge Transfer, Policies and Strategies. The focus of this theme is to provide directly relevant information to aid policy and decision

makers in the development of policies and strategies for adapting to a changing arctic environment (ArcticNet, 2008). Project 4.7 – Science Policy Interactions – is one of the project areas under Theme 4 whose aim is to create and maintain open dialogues providing a means of communicating ArcticNet research results of relevance and priority to the north (ArcticNet, 2008). Essential to achieving this open dialogue is an understanding of the processes and knowledge transfer and its use by policy and decision makers (ArcticNet, 2008). The goal of Project 4.7 is to put research findings in the appropriate societal and political framework addressing identified priorities and information needs (ArcticNet, 2008). Project 4.7 researchers, such as the writer of this thesis, can make recommendations and assist with implementing means to improve the knowledge transfer process in ways that result in positive actions being taken (ArcticNet, 2008).

Source: ArcticNet

2.6 Science - Policy Interface

The science - policy interface can be described as the interactions that occur between scientists and policy makers to incorporate scientific information into government decision making for policy development and to convey the policy needs of government policy makers to scientists.

2.6.1 Obstacles Affecting the Interface

The literature points to a number of common obstacles affecting the science - policy interface. The capacity for effective communication and dialogue between the science and policy communities is one of the most commonly cited problems. The nature of the science process and how it is changing, and the policy process and how it incorporates science are other challenges with the science - policy interface that are also commonly referenced. Policy makers understand that policy development requires scientific expertise but that this expertise does not necessarily mean certainty. Policy makers thus are required to make decisions under conditions of uncertainty (Engels, 2005).

The literature appears to present differing points of view on how science and policy should interact. There are many who suggest that science must remain separate from policy (Manning, 2002). The example cited by Manning is the work of the International Panel on Climate Change (IPCC), which provides regular assessments of scientific information for policy makers, but plays no direct role in policy development. Manning, suggests that it is not the business of scientists to argue for or against such issues as

ratification of the Kyoto Protocol, but it is their business to ensure all stakeholders in policy decisions have equal access to the relevant scientific information (Manning 2002).

There are others who propose scientists and policy makers need to engage each other more closely and establish better relationships in the development of environmental policy. Plain language websites and information documents are being prepared by some research groups to help address information gaps. Science – policy workshops are being held as way to enhance the dialogue between the scientific and policy making communities. For example, Natural Resources Canada (NRCan) undertook an initiative in 2007 whereby over 40 researchers, experts and policy makers from NRCan Canadian Forest Services section and the Ontario Ministry of Natural Resources came together in a forum to discuss climate change adaptation from both a national and provincial level. NRCan (2008) suggests that as a result of the workshop, potential future research collaborations were identified to help bridge some of the science and policy knowledge gaps impeding climate change adaptation. NRCan also declared that cooperative relationship between the two levels of government was further strengthened during the workshop by commitments that were made to continue sharing and exchanging research data, information and resources as climate change adaptation research continues to evolve.

The literature points to cultural and institutional factors that influence science-policy relationships. Incentives for scientists and policy makers to engage with each other appear to be lacking. Scientists are considered experts in their area of research and

publish in academic literature which is not usually read by non-academics. Policy makers on the other hand do not usually specialize in one area and so establishing relationships with scientists on particular topics is difficult. (TheKnowledgeBridge, 2006). The literature also suggests that scientists and policy makers both lack the training needed to develop skills in effective communication between the two disciplines. There appears to be a need for some type of 'specialist' who can bridge the gap through "science translation and synthesis". The report by TheKnowledgeBridge, *Science Meets Policy 2005*, suggests the following overarching recommendations for improving the effectiveness of the science –policy interface:

- Create incentives for researchers and policy makers to engage with each other;
- Policy makers to seek dialogue with researcher throughout policy cycle;
- Support training, education and secondments;
- Support inter-disciplinarity; and
- Maintain a longer-term perspective.

Specific recommendations related to planning and managing research programs were:

- Identify clear policy needs for research;
- Scientific criteria for project selection needs to be balanced by policy relevance criteria; and
- Increased engagement and stakeholder dialogue.

Recommendations related to dissemination and uptake of research were related to the need for intermediaries and translators; they include:

- Synthesis to bring together knowledge around a topic;
- Communication aimed at non-academic audiences;
- Quality and transparency in processes; and
- Accessible databases.

The Knowledge Bridge was founded by Alister Scott and Grové Steyn in 2001 to address the need to bridge the gap between specialists and others to bring relevance to knowledge through engagement and communications (TheKnowledgeBridge, 2006).

Researcher Anita Engels (2005) draws upon the movie "The Day After Tomorrow" as a depiction of the science - policy interface, the moral of the story being we should listen to scientists earlier and follow their advice. She suggests that communication with policy makers is time consuming and frustrating for scientists. Her research indicates that science is undergoing fundamental institutional changes and that the public is acquiring new forms of control and influence over the production of scientific knowledge (Engels, 2005)

2.6.2 Principal-Agent and Boundary Organization Theories

Guston (1996) suggests the problem of the science policy interface is one of delegation and presents an analytical framework known as "principal – agent" theory (also known as ideal contracting theory) to examine this problem. By "delegation" Guston means "how do non-scientists get scientists to do what we all as citizens have decided" (Guston, 1996). The principal – agent theory, as applied to the science - policy interface issue, suggests that the state or government is considered the principal that requests the agent,

the scientific community, to perform certain tasks because the principal is not capable of performing them directly. The agent performs the delegated task out of self interest but with some of the consequential benefits going to the principal as well (Guston, 1996). Guston (1996) suggests there is an asymmetry of information between those who conduct the research and those who would govern it and that this is the central problem of the science - policy interface. Guston further agues that even though the principal – agent theory creates a clear dichotomy between the government and research community, it does not impose or determine a boundary between non-science and science. He presents the principal – agent theory as a way to clarify the institutional arrangements that are chosen for the science - policy interface.

Jasanoff (1994) states that scientists have drawn seemingly sharp boundaries between science and policy in order to prevent non-scientists from challenging or reinterpreting claims labelled as "science" and she further indicates the creation of these boundaries seems crucial to the political acceptability of scientific advice. Guston (2001) suggests there is a blurring of the boundaries between science and politics rather than an intentional separation, and suggests this can lead to more productive policy making. He presents the concept of "boundary organizations" as the interface of participants from the scientific community and government. This concept borrows from the principal – agent theory discussed above in that the relationships between these two groups may be understood as delegations of authority from principles to agents within or between organizations (Guston, 2001).

Miller (2001) describes boundary organizations as " those social arrangements, networks and institutions that increasingly mediate between the institutions of science and the institutions of politics". Over the past fifteen years or so the subject of climate change led to the emergence of what Miller (2005) calls the "climate regime" which is a suite of social political, scientific and economic networks and institutions, both formal and informal, that have emerged in response to human threats to the earth's climate system. The IPCC would be an example of a boundary organization within the climate regime. These organizations help to interpret and manage the production of scientific knowledge and its incorporation into policy making; they facilitate the transfer of useful knowledge between science and policy. Miller introduces the concept of "hybrid management" which refers to people, artifacts and institutions that mix elements from science and politics. He suggests boundary organizations need to be able to put scientific and political elements together, take them apart, establish and maintain boundaries between different domains and coordinate activities taking place in multiple domains (Miller, 2005). These theories have application to the science - policy interface in the context of climate change.

2.6.3 Science – Policy Interface in the Context of Climate Change

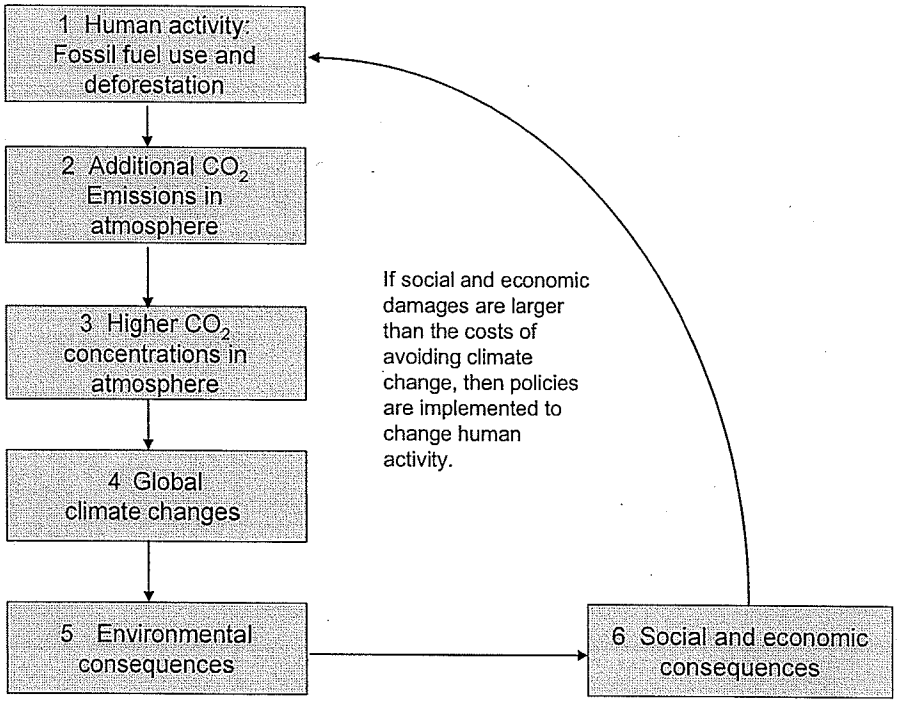
Climate change is on the international political agenda because of science. Warnings and forecasts of climate change researchers have elevated this issue to one that all governments globally must now address. Canada is considered a leader in research and technology yet agreement on climate change policies has been difficult, most likely

because the issue is now bigger than just science, it is also economic, political, social and health.

Climate science plays several roles in the policy development process. Firstly, it describes the problem. Secondly, it provides a theoretical underpinning for observations and forecasts by explaining the physical processes through which climate change occurs. Thirdly, climate research provides guidance on how to respond to climate change. These roles imply a particular relationship between science and policy that is often discussed in terms of an epistemic community (Haas, 1992). Haas introduced this notion of epistemic communities and called them "a network of knowledge based experts with an authoritative claim to policy relevant knowledge within the domain of their expertise" (Haas, 1992). Those belonging to epistemic communities need not agree on everything but their ability to have political authority and influence action depends on their ability to reach consensus (Bocking, 2004). IPCC would be an example of an epistemic community.

In the science - policy process, Sohngen (1998) suggests that climate change science and policy involves many questions that are linked, as illustrated in Figure 4. His model presents each box as a piece of the science - policy system. The first four boxes represent physical scientists' attempt to determine the relationship between CO_2 concentrations in the atmosphere. The scientists develop extensive models to predict future climate based on predicted CO_2 concentrations. Box number five represents the work of natural scientists who assess how a changing climate will affect natural systems. Box number

six captures the response of social and economic systems to the impacts of potential climate change. Policy enters into this system because there is feedback between the social and economic consequences and human activity. If the predicted damages from climate change are large enough, society may decide to reduce CO_2 emissions and these emissions can only be reduced by altering human activity (Sohngen, 1998). Thus policy is needed to bring about action in this regard.



Source: Sohngen, 1998

Figure 4: Links Between Scientific Inquiry and Policy Analysis in Understanding the Climate Change Question

The time lags inherent in the climate systems are an important aspect affecting the effectiveness of various policy options. There are long lag times between the accumulation of rising concentrations of greenhouse gas emissions in the atmosphere and the induced change in the climate that may last from decades to millennia (Leggett,

2007). The gases remain in the atmosphere for a long time, some up to tens of thousands of years and continue to influence the climate as long as they are there.

There are a number of key factors that determine policy outcomes and affect the role scientific evidence plays in public policy for climate change. Leggett (2007) states that the uncertainties of climate change is a key factor and raises a number of questions for science and policy, which in many cases, remain unanswered: What do policy makers need to know from science in order to continue to address climate change? Are research priorities aligned with needs? Are appropriate mechanisms in place for communication between researchers and decision makers? Do researchers know what decision makers need from them? Can needed information be provided to decision makers in a timely manner and at a desired level of confidence? Since all uncertainties cannot be eliminated, are risk decision tools and management regimes in place or planned to facilitate best use of scientific information for different types of decisions? Is there a process to incorporate learning over time? Do communication channels exist to ensure relevant decision makers have access to useful and reliable information to make decisions? Are effective cooperative mechanisms in place to gain efficiencies and share insights and yield results?

Another important factor determining policy outcomes and affects the role scientific evidence plays in public policy for climate change is the structure of government. The Government of Canada has implemented a "Framework for Science and Technology Advice: Principles and Guidelines for the Effective Use of Science and Technology Advice in Government Decision Making, consisting of six principles and 10

implementation measures. The Government of Canada has also been restructuring some of its departments to better address science - policy issues. For example, Environment Canada has created a Science and Technology Branch that pulls together all scientific researchers of the department into one area. The research then can be better compiled and communicated to the appropriate policy area when needed. Science advisors from this branch also sit on science - policy teams as part of the policy development process. Industry Canada also has placed a focus on emerging policy challenges that have arisen over the past few years such as global climate change and strengthening the science policy interface (Industry Canada, 2006).

2.7 Conclusion

This chapter provided an overview of the evolution of environmental and climate change policy in Canada and a discussion on the policy development process used in the federal government, using models to illustrate the decision making process. It also discussed climate change science with a focus on the research occurring in the Canadian arctic. The current state of thinking on the science policy interface was also presented. The review was based on a mix of government and academic literature. The majority of the literature is from the past 15 years, as the issue of climate change has become more significant over this time period.

The literature clearly suggests that processes, both in science and policy, need to undergo change to address the growing need for a better interface between scientists and policy

makers. The literature points to a number of key factors that affect the science - policy interface in the context of climate change:

- capacity for effective communication and dialogue between the science and policy communities;
- nature of the science process and how it is changing, this includes uncertainties associated with scientific evidence;
- the nature of the policy process and how it incorporates science; and
- incentives for the science and policy communities to engage with each other.

This research investigates many of these issues and provides discussion on the findings relative to the literature and recommendations for future action. Some questions brought out by the literature review were: What role does ArcticNet play in regard to the science-policy interface; where does it sit in regard to the boundaries between science and policy? Is this role different than any other science network? How does the policy maker community look upon networks such as ArcticNet?

CHAPTER 3: METHODS

3.1 Introduction

A qualitative approach was used for this research because it enabled the researcher to gain insight into the attitudes, behaviours and value systems of people, which is necessary to better understand the interface between climate change scientists and policy makers. Qualitative research allows the researcher to "tell the story" from the participants' viewpoint with rich, descriptive detail that puts results into a human context (The Knowledge Base, 2008). The research took place in the natural setting of where the participants worked, it used multiple methods that are interactive and humanistic, it allowed for emergent patterns of understanding rather than being prefigured, and it was interpretive, all of which are characteristics of qualitative research (Creswell, 2003).

The research strategy used was a case study focusing on ArcticNet, a Network Centres of Excellence Project. The case study strategy of inquiry allows the researcher to retain the holistic and meaningful characteristics of real life events, such as organizational processes (Yin, 2003) Case studies are the preferred strategies when "how" and "why" questions are being posed, when the researcher has a need to understand complex social phenomenon (Yin, 2003). ArcticNet was selected as the case study because it is a unique and complex group that brings together academic and government scientists, community members, government and industry to help Canadians face the impacts of climate change. These characteristics set it apart from more typical networks of scientists often referred to in the science – policy literature. A case study approach provided for an in-

depth analysis and understanding of the processes used by the ArcticNet community of scientists for how they interact with policy makers.

The qualitative approach consisted of the following data collection methods: (1) literature review, (2) primary document review, and (3) semi-structured interviews with ArcticNet scientists conducting research in Canada's arctic and federal policy makers developing policies who may respond to the research. These methods allowed a descriptive and exploratory research approach to better understand the interface between climate change scientists and policy developers and in turn, helped to inform the development of recommendations to improve the interface.

3.2 Literature Review

The literature review was presented in Chapter 2 and provided a review of relevant topics on policy development processes for Canadian environmental and climate change policy, the state of current climate change policy in Canada's arctic and the science-policy interface. The review was used as a foundation to build upon in examining the science policy interface issue. The literature review consisted of:

- a review of journal articles, relevant books, government reports and documents related to the history of environmental and climate change policy development processes, and the science-policy interface; and
- a review of relevant websites related to ArcticNet and federal climate change policy development in Canada's arctic.

3.3 Primary Document Review

Primary document review can provide valuable information to help inform the analysis of how scientific research data is communicated or conveyed to policy makers. As well, it can also provide information on government processes and advice given in the policy development process. These documents were used to provide background information to assist the researcher in focusing the interview questions and examining the research and policy development processes that have occurred.

Types of documents reviewed include: a selection of ArcticNet research studies and reports, government climate change action plans, government policy documents that were in response to climate change, government and scientific educational materials, IPPC and other international and national reports, newsletters, and evaluations addressing climate change.

3.4 Semi-Structured Interviews

Semi structured interviews were conducted for data collection. This method was considered appropriate for the research because asking questions through the interview process is widely accepted as a cost-efficient and (sometimes the only) way of gathering information about past behaviour and experiences, private actions and motives, and beliefs, values and attitudes (Foddy, 1993). An interview is a method that provides for the gathering of verbal data through a focused line of questioning. The purpose of conducting interviews for this research was to find out from the participants: their understanding of how climate change policy needs are conveyed to scientists and

whether or not they see policy playing a role in setting the scientific research agenda and if so how; their understanding of how scientific research results from the arctic are conveyed to policy makers who address climate change issues in the arctic; and what the challenges are for the interface between arctic scientists and policy makers.

The semi-structured interviews were directed at two groups of participants - ArcticNet scientists conducting research in the Canadian arctic and policy makers at the federal level involved in developing policies that address climate change issues in Canada's arctic. ArcticNet participants were selected from within each of the four research program themes under ArcticNet. Policy makers were selected from government departments and agencies at the federal level that engage in Arctic climate change policy issues, these were Environment Canada, Natural Resources Canada, Fisheries and Oceans Canada, and the Canadian Council of Ministers of the Environment (CCME). Twenty four participants were initially contacted to participate in the interviews, twelve each from the scientist and policy maker communities. This sample size was chosen because the researcher determined it was an appropriate number of participants that could practically be interviewed to allow the research to be completed within a reasonable timeframe. Nine interviewees responded from the policy community and eight responded from the science community, for a total of 17 participants. This is not considered a statistically valid sample and therefore generalizations of results to scientists and policy makers in general cannot be drawn. The results may only be interpreted as a census of the participants sampled.

Obtaining responses from those selected to participate was challenging and very time consuming. On several occasions the interview dates had to be rescheduled because of participants' unavailability on the originally scheduled date. These challenges of getting adequate and timely participation may be an indication of a low level of interest in this research area by participants. However, once the participants were engaged in the actual interview their interest level was very high and many were quite passionate about the topic and what they had to say about it.

The interviews were conducted over the telephone from October 2007 to February 2008. Each interview lasted from 30 to 60 minutes, depending on how much the participant had to say. The participants were asked questions, as laid out in the Interview Schedule (Appendix A), to gain a better understanding of the interactions between scientists and policy makers with regard to climate change in Canada's arctic. The interview questions were both closed and open ended. The participants were probed for further detail and clarification of their answers in regard to the questions, as well as any new topics or ideas they raised. At the conclusion of the interview the participants were given the opportunity to provide any further comments regarding the topic.

Each participant was initially contacted by email with a formal letter of introduction to seek their interest in participating and scheduling of the interview. This was followed-up with a copy of the consent form (attached as Appendix B), which was faxed or emailed to the participant The consent form was approved by the University of Manitoba Research Ethics Board and conforms to required guidelines; it provided the participant

with a description of the research and purpose of the interview. Prior to the interview process, the consent form was reviewed with the participant to ensure clarity about the purpose of the research, anonymity and confidentiality measures that would be taken, the intent to record the participant responses and to answer any initial questions regarding the interview process. Interviews were recorded using an audio recording device. The researcher also made some hand written notes summarizing the participants' comments, which were verified using the audio recordings. Each interview was coded to protect the identity of the participant.

The researcher for this thesis has an extensive background in natural resource and environmental policy development and is the Director of Sustainable Resource and Policy Management with the Manitoba provincial department of Conservation, which has regular interactions with some of the federal departments and agencies whose staff were interviewed. It was clarified by the researcher when the participants were contacted that the research being conducted was not in any way connected to the policy work of Manitoba Conservation. It is the opinion of the researcher that her role with Manitoba Conservation did not appear to hinder the sharing of information by policy maker participants; it seemed the opposite occurred in that the participants seemed willing to share more information than was anticipated. This may have been due to the policy maker participants feeling they were speaking the same "language" as the researcher. The researcher's background did not appear to have any influence on the science participants' responses.

3.5 Science and Policy Participants

Participants interviewed for this research consisted of scientists from ArcticNet conducting research in Canada's arctic and policy makers involved with the development of policies at the federal level to address climate change in Canada's arctic. Table 2 presents demographics of the participants pertaining to gender and level of education.

Table 2: Participant Demographics

Demographics	ArcticNet Scientists	Policy Makers	Total
Total Participants	8	9	17
Female	5 (63%)	6 (67%)	11 (65%)
Male	3 (37%)	3 (33%)	6 (35%)
Ph. D	4 (50 %)	2 (22%)	6 (35%)
Masters	4 (50 %)	6 (67%)	10 (59%)
Undergraduate	0 (0%)	1 (1%)	1 (6%)

The table shows that 11 of the 17 participants interviewed were female (67%), with five of eight in the scientist group being female (63%) and six of nine in the policy maker group being female (67%). Sixteen of the seventeen participants (94%) had a high level of educational backgrounds at the Masters or PhD level, ten of seventeen or 59% with a Masters Degree and six of seventeen or 35% with a Ph.D. When comparing academic and government experience between the two participant groups, the majority of policy makers interviewed (seven out of nine or 78%) indicated they had no academic background, while two of nine (22%) indicated they had some academic background.

The figures for the scientist group were similar in the opposite manner with the majority (six of eight or 75%) indicating they had no government background and two of eight (25%) indicating they had some government background. See Figure 5.

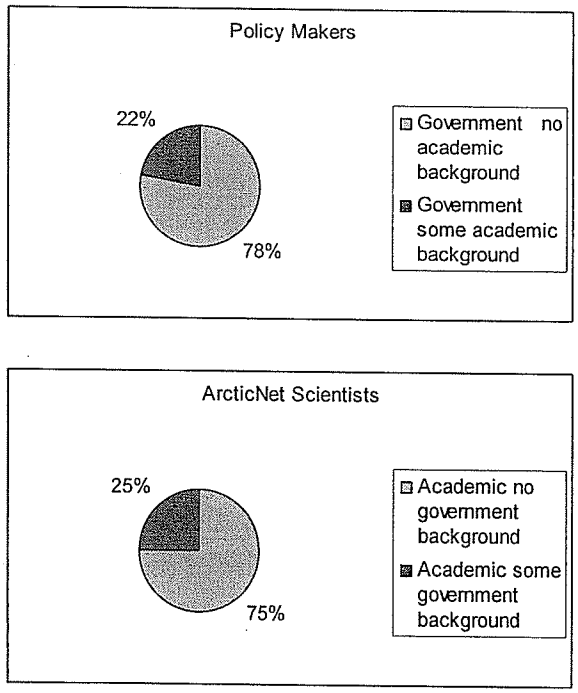


Figure 5: Academic versus Government Background of Participants

All participants indicated that their current work addressed climate change priorities and information needs of government, regardless if they were in the scientist group or policy maker group.

3.6 Data Analysis

The data was analyzed using the content analysis technique. Content analysis enables researchers to sift through large volumes of data with relative ease in a systematic

fashion (Neuendorf, 2001). This is a systematic and replicable technique that compresses many words into fewer content categories, based on rules of coding (Stemler, 2001). It can be a useful technique for allowing researchers to discover and describe the focus of individual, group, institutional, or social attention (Weber, 1990). Qualitatively, content analysis can involve any kind of analysis where communication content (speech, written text, interviews and images) is categorized and classified.

All of the interviews were transcribed from the recording device and then the responses were coded to each area of questioning. The information was then reviewed and categorized into major theme areas by highlighting key words and phrases using different colours for each theme area. Themes related to communicating research results, conveying policy needs, influencing research agendas, and the challenges of the interface between ArcticNet scientists and policy makers. The theme areas were listed in tables. After transferring and comparing the data, some new themes and sub-themes emerged. The data do not contain any references to individuals.

Once the data were compiled, an overall analysis was conducted and conclusions were drawn. The audio tapes and handwritten notes were destroyed to ensure anonymity of the participants. Quotes from the data were used to support the analysis and represented both majority and marginal views.

CHAPTER FOUR: AN OVERVIEW OF THE INTERACTIONS BETWEEN SCIENTISTS AND POLICY MAKERS

4.1 Introduction

This chapter presents the results of the research and an analysis of the data. Section 4.2 provides an analysis of the sources of information used by the participants to inform them on the topic of climate change. The ways in which ArcticNet scientist participants convey their research findings on climate change in Canada's arctic to federal policymakers is provided in section 4.3. Section 4.4 presents an overview of the ways federal policymaker participants convey policy priorities for climate change in Canada's arctic to scientists and how this may influence research agendas. Section 4.5 presents a summary of the impacts and challenges affecting the interface between scientists in the Canadian arctic and federal policy makers who may respond to the Arctic research and their thoughts on possible solutions to improve it.

4.2 Obtaining Information on Climate Change

This section provides an analysis of the various ways in which the scientist and policy maker participants obtained information regarding climate change in Canada's arctic regardless of the type of information needed. This analysis will be helpful in better understanding the processes used by these two groups to look for information on climate change and whether there are any similarities. This in turn may provide some insight into the challenges with the interface between the two groups. Participants identified

numerous ways of obtaining the information they needed on climate change (see Figure 6).

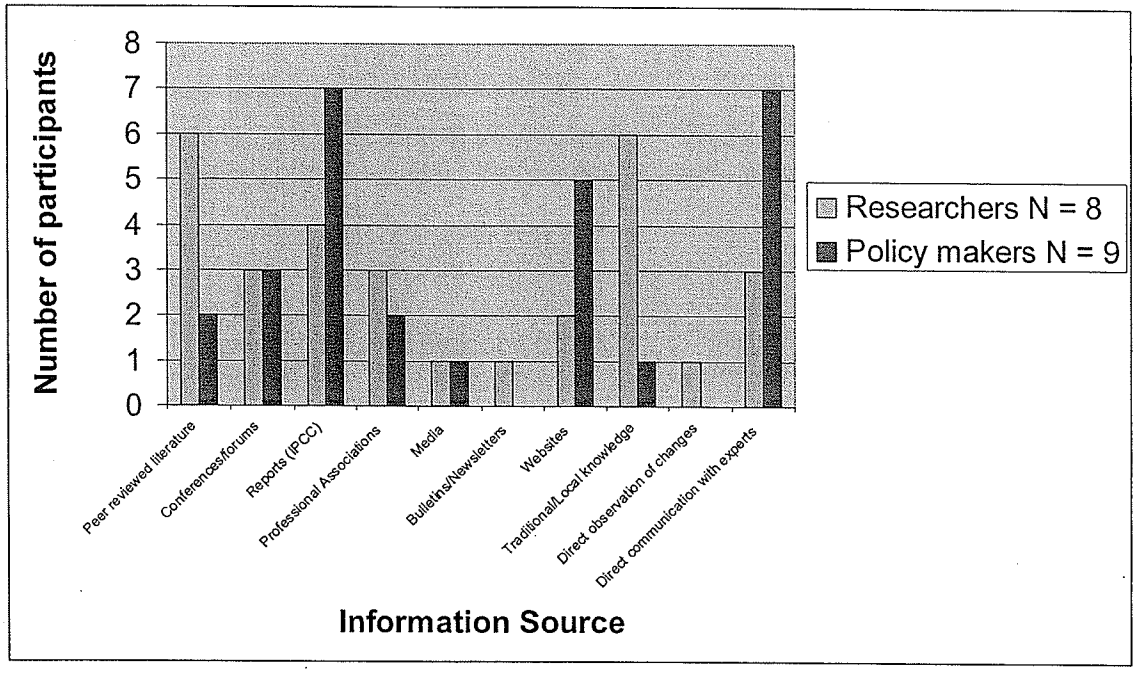


Figure 6: How Information on Climate Change is Obtained

The primary information sources indicated by ArcticNet scientist participants were peer reviewed journals (75% or six of eight ArcticNet participants identified this source) and use of traditional and local knowledge (75% or six of eight ArcticNet participants identified this source). This was followed by use of reports, specifically IPCC Assessment Reports where four of eight ArcticNet participants (50%) identified this source.

Seven of nine of the policy maker participants (78%) identified use of reports (IPCC and others) and direct communication with experts as their primary sources of information on climate change. It was clarified by the policy maker participants that the experts referred

to in this instance were almost entirely internal to government. This was followed by use of websites as the next most popular source of information (identified by five of nine or 56% of participants). Peer reviewed journals (the most dominant source of climate change information used by scientists - 75%), was used as a source by only two of nine (22%) of the policy makers.

> "The peer reviewed literature is the primary vehicle for communication amongst the scientists actively involved in climate change research. Conferences of course are the other one, we have multiple conferences a year where we discuss and disseminate research findings and get into discussion about which directions, magnitudes and consequences we're finding in different sectors of the arctic range biosphere. And I think we also get informed a lot at the hemispheric scale by the Intergovernmental Panel on Climate Change." - T. Gibson field notes, February 4, 2008

The data shows that the primary ways of obtaining information by each group are quite different, and in fact polar (no pun intended) opposites. This in part may be contributing to a gap in the interface between the two groups.

When policy makers where asked what key resources were available to them to influence their thinking on the topic of climate change, six of nine (67%) identified the use of research institutions and experts, both internal and external to government.

> "In my group we do it almost exclusively through information we're given by operational leads in the department, those people that regulate northern activities or provide science services in the north, and then a little bit by external stakeholders." - T. Gibson field notes, November 23, 2007

Five of nine (56%) identified media and four of nine (44%) identified journals and reports. When compared to the previous data on how information on climate change is obtained, the results differ in that now the media plays a much larger role when the

notion of influencing their thinking on climate change is introduced. Figure 7 provides a summary of the responses.

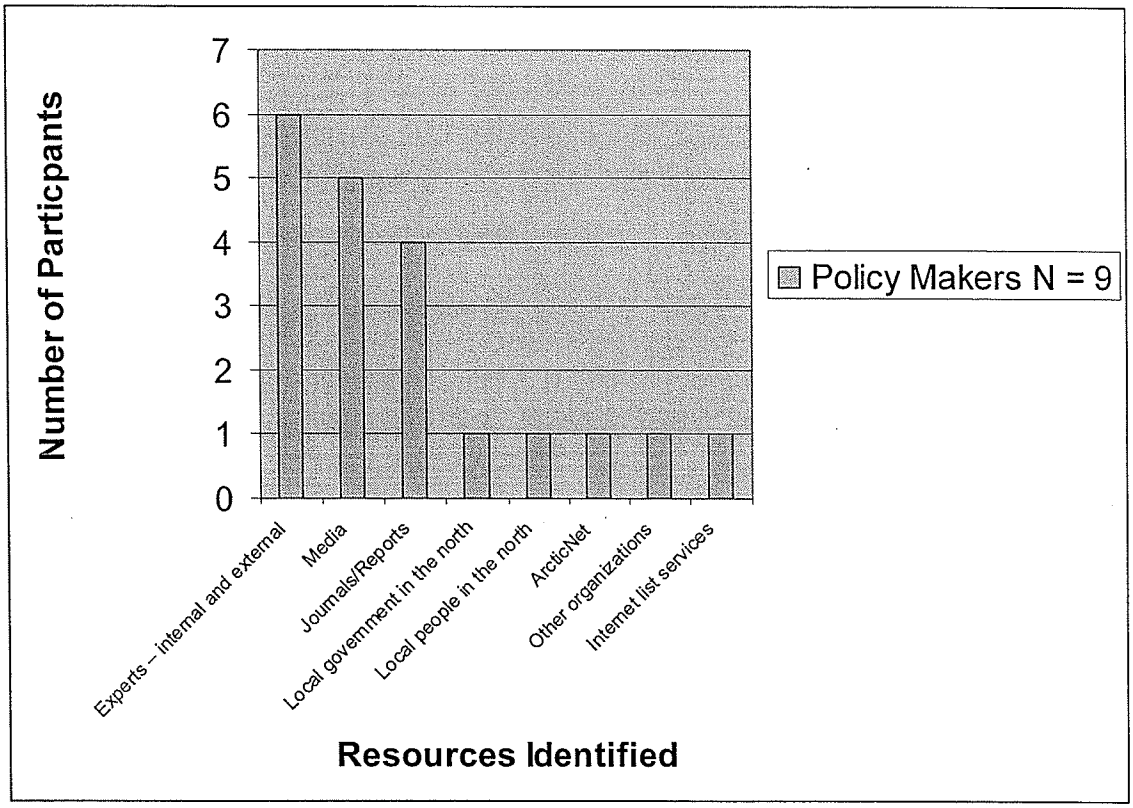


Figure 7: Resources Identified by Policy Makers to Influence Thinking on Climate Change

4.3 Science Research Informing Policy

This section considers the role that science research in Canada's arctic may play in regard to informing policy that addresses climate change. It presents an analysis of participants' understanding of how research results are brought to the attention of policy makers and whether the state of the interface between the two groups plays a role in the extent to which findings inform policy.

4.3.1 Relying on Science for Policy

Relying on science for policy development is a widespread viewpoint held by many and most may consider it a given. All participants were asked to provide their views on this issue to establish solid evidence for this study and create a consistent basis for further discussion. Sixteen of the seventeen participants (94%) indicated that it was important to rely on science for development of policies that address climate change. One participant did not answer the question directly. When commenting on the question, many noted that climate change is a very complex issue and that science provides the basis for stating that we have a problem and telling us what is going on in the arctic; this in turn helps drive the policy issues. A few scientists made the distinction between climate science and science dealing with human impacts and adaptations for climate change in the arctic, stating all of these types of science were necessary for policy development on climate change issues. Another view was that science gives another perspective to the policy issue but is not the only factor to consider, other perspectives are important as well. These viewpoints were reflected by the following statement:

> "You need the science for climate change, but not only that, you need the science for how people are affected, you need the science for how they see themselves and how they deal with it, how they prioritize it. Climate science by itself is far from sufficient for climate policy. To contribute to policy related to climate change in Canada we need science that really integrates the knowledge we have of the political process. I deliberately start with that, I don't start with the climate science because so many people do and what that means is that we only look at those attributes that are chosen by the climate scientists. Since when are they the only thing that effects policy. I think the evidence is that it isn't. So we need that looks at the political process, political science, that looks at economic and social." - T. Gibson field notes, January 10, 2008

All policy makers interviewed stated that where it was available, they incorporated arctic science findings into their policy work on climate change. But in nearly all instances this

was through the use of government scientists and their data. It was acknowledged by several of the policy makers interviewed that there was a need to cultivate relationships with senior scientists in research organizations outside of government.

4.3.2 Conveying Research Results to Policy Makers

ArcticNet scientists interviewed indicated they communicate their findings generally through a variety of methods, as presented in Figure 8. The most dominant methods identified were through peer reviewed journal articles, conferences, media coverage and interviews, and talking directly to communities and organizations.

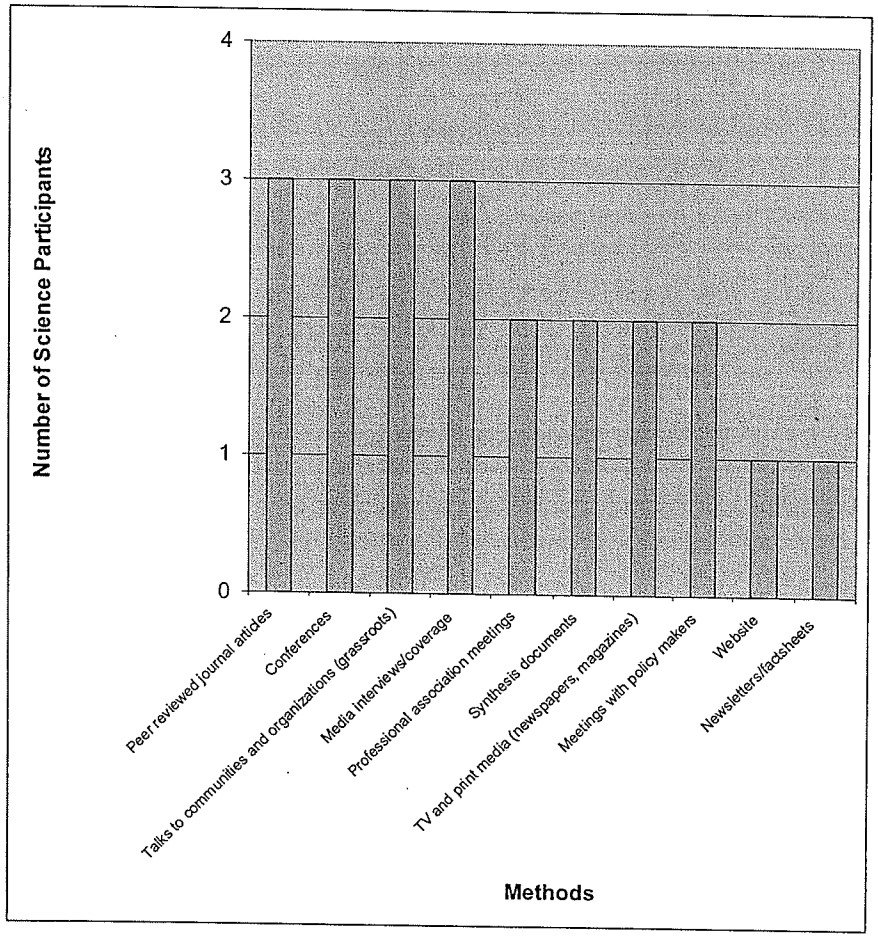


Figure 8: How Research Participants Communicate Findings Generally

All participants were asked whether or not research findings dealing with climate change in Canada's arctic needed to be conveyed to policy makers, and if so, how were they brought to the attention of or made available to the policy makers. The majority or seven of eight (88%) of ArcticNet scientists interviewed felt it was important that their research results be conveyed to policy makers, one did not answer the question directly so it was difficult to evaluate the response. When policy makers were asked the same question, seven of the nine interviewed (78%) indicated they felt a need for science research results on the arctic to be conveyed to policy makers, two of nine (22%) did not respond to the question.

When asked if they communicated directly with policy makers, only four of eight or 50% of the scientists interviewed indicated they had direct communication with policy makers in regard to their research findings. Scientists interviewed stated any direct communication occurred only if they knew who to contact and through very informal channels, such as through emails, phone calls or one-on-one meetings, and these interactions happened only occasionally. The primary reasons given by the scientist participants for not having direct communication with policy makers were because they do not know who to contact and they do not know what the proper path of communication was or if the policy makers even wanted to be contacted. This is supported by the following statement:

> "It's probably mainly because people are busy doing their own thing. For one thing, it's not a very good excuse but that's what it boils down to is being busy. And also, just not having the right contacts or who to contact. Who do we

> actually go through? Someone like myself, I'm not sure I'd even feel comfortable going to or sending a letter to or information to someone who has no heads up on what I'm doing or where I'm coming from or something like that. I don't know the path of communication." - T. Gibson field notes, February 15, 2008

Those scientists interviewed that did communicate directly indicated the contact was focused more at a local or provincial government rather than federal level. These contacts were usually through email, phone calls and one-on-on or small group meetings. Some suggested there may be layers within the academic science network where research is funneled up the chain to a level where direct communications could take place between senior scientists and policy makers.

All of the policy makers interviewed (nine of nine or 100%) indicated they communicated directly with scientists, but that these scientists were internal to government and not academic scientists. These contacts were usually through small group or "team" meetings with the scientists. It was also noted by some of the policy makers that these internal communications were fraught with frustration because they did not always achieve the outcomes they expected from the discussions with government scientists. Reasons for their frustrations were cited as conflicts in personality types, not enough times to develop a common understanding of desired outcomes and lack of clarity in the process to be followed.

> "I would say I always come out of the meetings not getting exactly what I need but knowing a little bit more than I do before coming into the meeting but still being a little bit confused would probably be the best summary of it. I find it hard to find people in the department that have enough of a comprehensive view of the science to really communicate our overall science needs and our science desires. So I think there's a lot that could be done to improve communication for policy making." - T. Gibson field notes, November 23, 2007

Five of eight (63%) of the ArcticNet scientists interviewed were of the opinion that, generally speaking, research findings were conveyed through direct communication by ArcticNet senior scientists with government officials. These communications were considered to be through written correspondence to senior government officials or in-person presentations to Assistant Deputy Ministers and Deputy Ministers. Three of eight (38%) identified the use of policy relevant documents that synthesize research in lay language and sharing their results with local arctic communities and governments who in turn use it to influence the federal government as how they thought research findings were conveyed.

Responses from the policy makers interviewed were quite varied, with six of nine (67%) indicating that they thought scientists, both government and academic, conveyed their finding on climate change in the arctic through policy relevant documents and reports which synthesize the research in lay language. This is consistent with policy makers' responses regarding where they obtain their sources of information on climate change in the arctic. Responses are summarized in Figure 9.

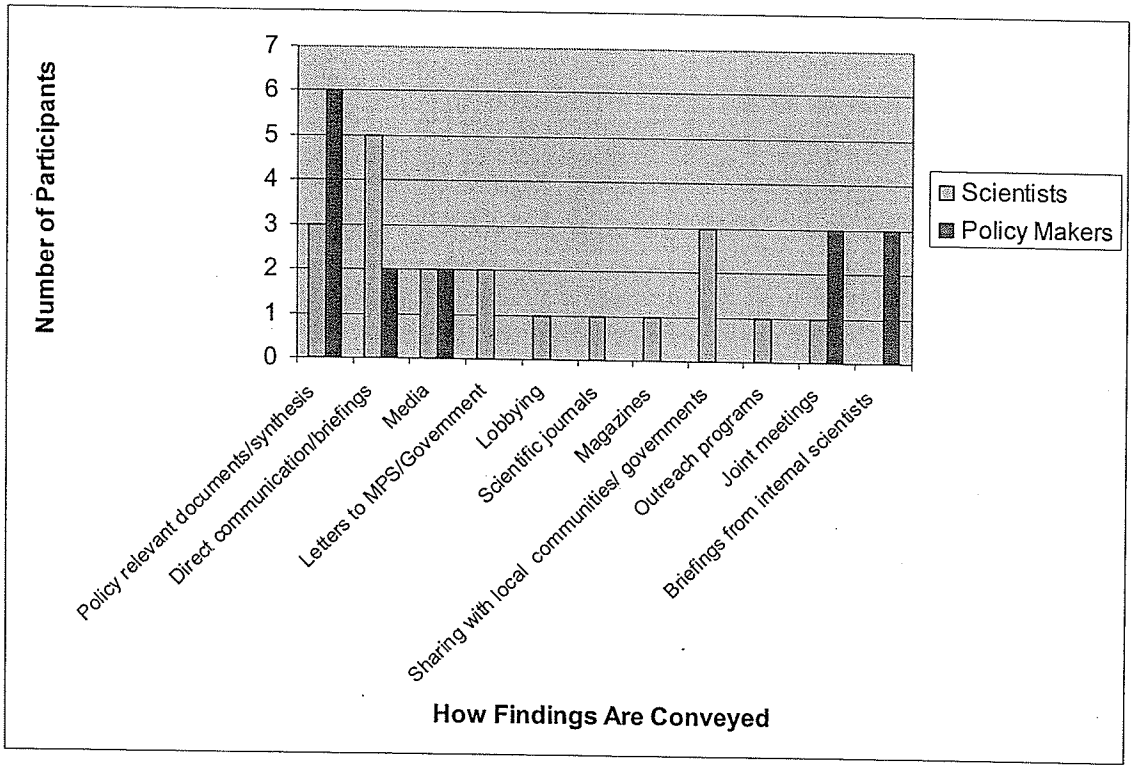


Figure 9: Participants Views of How Research Results Are Conveyed to Policy Makers

The data show that policy relevant documents and reports that synthesize research in a lay language was thought to be the most prevalent vehicle for conveying research findings to federal policy makers, although the percentage of policy makers that identified this was higher than that of the scientists. There was quite a discrepancy between the two groups however in regard to their assessment of the role senior scientists play in conveying findings to policy makers. Policy makers interviewed did not see this as a primary vehicle for conveying findings whereas scientists did.

A significant observation was that six of the ways identified by ArcticNet scientists for conveying research findings were not mentioned by policy makers; these were scientific journals, magazines, sharing with local communities and governments, outreach

programs and lobbying. Several policy makers interviewed noted that there was no systematic approach for how research results are conveyed to them to help inform policy.

> "I would say they are not brought to the attention of policy makers systematically. There are very occasional discussions around climate change science, then a major report, such as an IPCC report would come out or a State of the Environment Report would come out. As policy makers, we'll get in advance a brief synopsis from the scientist of what's in it but then its often more of a discussion on how do we respond to the fact that this report is coming out rather than how should this really be affecting the climate change policy we're developing." - T. Gibson field notes, November 22, 2007

Noteworthy as well is that methods used by scientists to communicate to the general public were the same as those used to convey findings specifically to policy makers. This supports the literature that suggests scientists use the general public as a way to indirectly communicate their findings to policy makers. However, it indicates that the scientists may not target any specific methods of directly communicating results to policy makers.

Some participants indicated that government does not have the necessary mechanisms in place to obtain systematic briefings on climate science and other types of science that may be relevant to climate change (biodiversity science, toxic chemical science). It was suggested by some participants that government scientists should have the ability to summarize all research done in the arctic and give briefings to government policy makers so they have latest thinking upon which to base policy. As noted by one participant:

> " One of the things that I find kind of unfortunate and disturbing is there is no systematic briefing that is done with the policy maker about scientific reports as they come out, as journal articles get published, as the more technical papers get published. We are not adequately briefed on it. What we lack are the systems to pull the more salient messages out of those and once every two weeks or every month brief the policy makers on what new science is showing." - T. Gibson field notes, December 21, 2007

4.4 Policy Influencing Science Research

This section presents findings and an analysis on whether or not government policies that address climate change in the arctic are conveyed to scientists and how this may influence setting research agendas.

4.4.1 Conveying Policies to Scientists

Six of eight of ArcticNet scientists (75%) agreed that government policies related to climate change in the arctic should be brought to their attention, but at the same time, five of eight (63%) of them are not sure if there is a process or do not know how the process works. The most common route identified was through the ArcticNet senior scientists seeking this out for themselves by keeping abreast of the issues and requesting meetings with senior government officials (identified by four of eight or 50% ArcticNet participants). Science participants were of the opinion that ArcticNet senior scientists were probably more aware of policies and the policy process than junior scientists. This may be due to junior scientists being more focused on publishing in peer reviewed literature and not concerned with policy relevance of their work, whereas senior scientists have been drawn in to the need for policy relevance over time because of their lengthy academic experience and the possibilities of funding opportunities. A variety of other routes for conveying policies to scientists were suggested including media (identified by two of eight or 25%), meetings/briefings (identified by two of eight or 25%) and conferences/workshops (identified by two or eight or 25%). Several participants indicated that some science is fundamentally driven and discovery oriented and therefore did not believe it needed to be policy relevant. On the other hand, those

scientists involved in research dealing with human impacts of climate change in the arctic stated they recognized and understood the need for policy relevance. It was also suggested by some ArcticNet participants that the need to know the policy relevance of research was more important for government scientists than academic scientists, and that academic research can feed into policy but should not be primarily driven by it.

Within the policy community, eight out of nine participants (89%) indicated that policies need to be brought to scientists' attention, while one participant did not directly answer the question.

> "I'm not sure we do a good job of that and I think it is important for us to do it because when you are looking at policies, so much is tied to our international agreements and commitments on a federal level with other countries. I think it would be good for us to get that message to the research scientists. It might not affect their everyday work but it does put everything in context for them and they understand better why certain things are being done and how they do fit into the big picture and are having some influence. Its good for anyone to know in their job how their work is being done and used and I don't think that is always articulated to the researchers." - T. Gibson field notes, February 12, 2008

When it came to how this should occur, policy makers were quite diverse in their response with no one method emerging over the other. Two of nine (22%) participants in this group mentioned the following as possible ways they thought this occurred:

- meetings/briefings
- scientists determine policy relevance of their own research
- boundary organizations or translators
- it becomes apparent through cross cutting issues

It was the view of some policy makers that there is a disconnect between the research going on in the arctic and policy maker's needs. Figure 10 provides a summary of the

responses discussed above on how participants believed policies that address climate change in the arctic are brought to the attention of scientists.

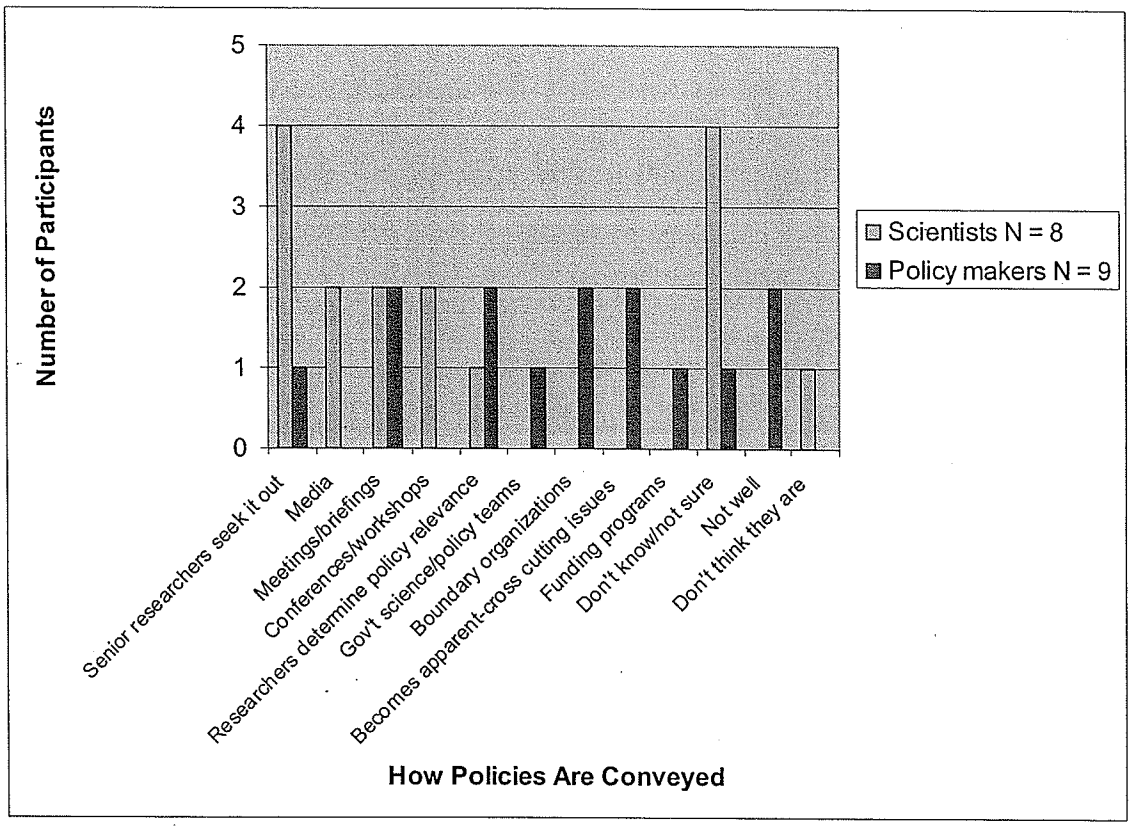


Figure 10: Participants Views of Conveying Polices to Scientists

4.4.2 Influencing Research Agendas

In consideration of whether there is a role for policy makers in determining the climate change research agenda, all nine participants (100%) from the policy maker community agreed that there was a role but they indicated this role should be based on a multidisciplinary approach and that there is a need for more dialogue between scientists and policy makers in setting research agendas. In contrast, five of eight or 63% of ArcticNet scientists supported the need for policy makers having role in setting the research agenda. Two of eight (25%) indicated they were not sure if there was a role and

one of eight (12%) did not believe there was a role. It was noted by several of the ArcticNet participants that the Network of Centres of Excellence program, of which ArcticNet is a member, is a policy relevant tool of the federal government that funds academics. These participants felt that policy makers were responding to their needs and the research dollars were being directed appropriately, i.e. to arctic research to address the government's high level policy needs for climate change research. But several scientists interviewed also indicated that it should be science that is driving the policy agenda, not the other way around. There was also a comment by two participants that not all research funding should be driven by a policy need and that fundamental science for discovery and innovation is still important.

> "The purpose for spending on science for the government is for what you call technological innovation. We fund science in order to create a better gadget for which you can build a company that will spin off out of the universities to create jobs, pay taxes, and it's all a positive feedback loop where we fund science to build us a better thing to solve cancer, save children's lives. That's all good stuff but the idea that you fund science to inform public good decision making has largely been lost in all of this." - T. Gibson field notes, January 9, 2008

> "I usually use the scientific peer review process or scientific conferences to set the agenda, and if it happens to overlap with a policy requirement of the government then that's a positive. You know, if I hear a rumour that somebody needs to understand some kind of issue in government - that doesn't direct my research programs. That's because I'm in a university. Now I think that a different thing could be said for a government researcher, they are very much structured around policy relevant research in government." - T. Gibson field notes, February 4, 2007

These results indicate there is a clear dichotomy between scientists and policy makers regarding the notion of policy related to climate change issues influencing the research agenda.

4.5 Impacts and Challenges of the Interface

Participants were asked whether in some instances policy development may not be informed by science because of a lack of an interface between scientists and policy makers. Half of the scientists interviewed (four of eight or 50%) indicated that they thought this was the case, while three of eight (38%) weren't sure but suspected so. One of eight (12%) did not know. Some of the scientists commented that they did not think scientific research was undertaken or presented in a way that fit well with the decision making process and that translation was too complicated to be used effectively in policy development. Other comments from scientists inferred problems with the interface.

> "The scientist's job is to do good science and produce papers on results, they are not asked to speak to policy makers." - T. Gibson field notes, Dec 21, 2007
>
> "Policy makers do not always hear the whole message or understand what scientists are saying." - T. Gibson field notes, January 8, 2008
>
> "Scientists struggle with making their message understandable or putting it in the bigger context of climate change." - T. Gibson field notes, January 11, 2008
>
> "There are differing time scales between science process and policy process." - T. Gibson field notes, February 12, 2008

These comments reflect those often cited in the literature regarding the challenges of the science – policy interface.

Policy makers' responses on this issue were very similar, with five of nine (56%) indicating they thought that, in some cases, policy development may not be informed by science because of a lack of an interface between scientists and policy makers. Two of nine (22%) did not answer the question and two of nine (22%) did not think the interface impeded science informing policy. Some of the policy makers were of the opinion that scientists needed to communicate with them in a way that policy makers could better

understand and that policy makers themselves needed to better understand science. Others policy makers interviewed noted that improving the interface may help to decrease the use of certain evidence that does not necessarily reflect the general consensus on an issue. It as also noted by a few that most policy makers have a background in political science with no grounding in physical sciences. One participant summed it all up very succinctly by saying:

> "Policy makers look at scientists as widget makers and scientists look at policy makers as wonks; we need to better understand the perspectives of each other." - T. Gibson field notes, January 11, 2008

Participants were asked how they would describe the interface between the arctic scientists and policy makers that address climate change in the arctic and whether they would consider them as two way dialogues. Figure 11 presents a summary of the responses.

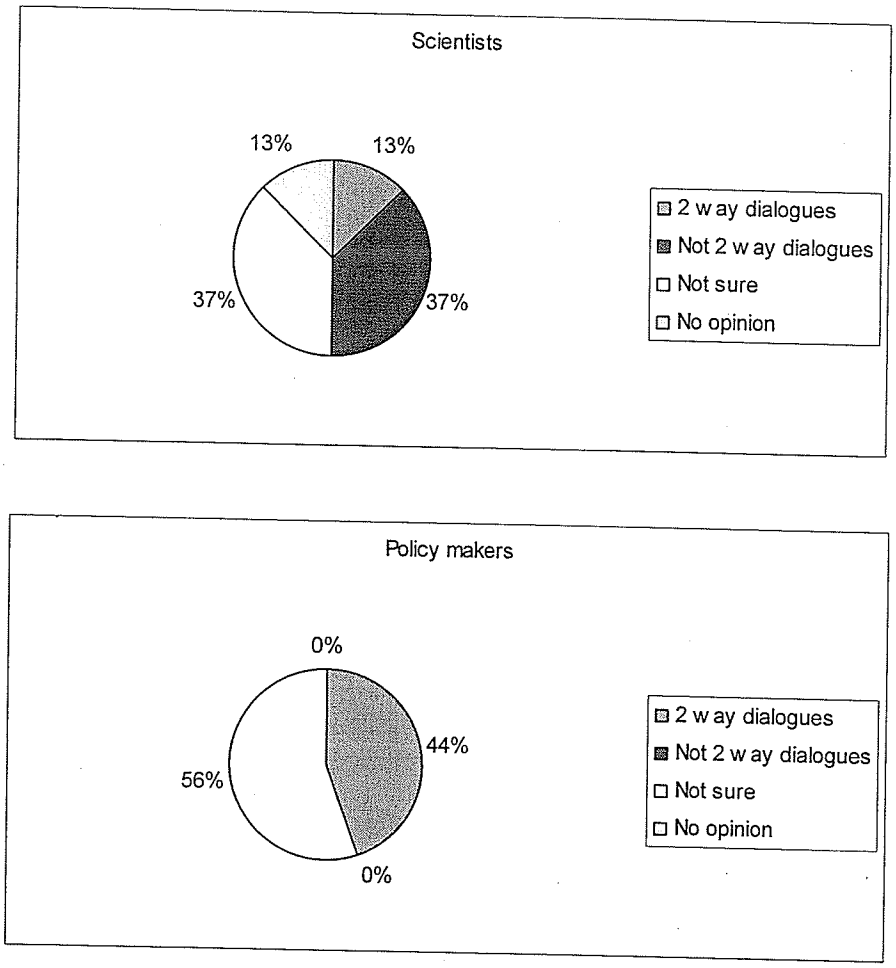


Figure 11: Participants Descriptions of the Interface Between Scientists and Policy Makers

Results from both groups are mixed. Only one of eight participants (13%) from the science community considered interactions occurring between scientists and policy makers as two way dialogues, while three of eight (37%) did not consider the interactions as two way dialogues and three of eight (37%) weren't sure. Several scientists indicated there was a disconnect between the two communities and attributed it to a decrease in interest, understanding and comprehension of science within the bureaucracy and by politicians. One participant described the relationship between scientists and policy makers this way:

> "I would say that the conventional view of the relationship is that it's one way, that is the science does its science based on what all the professors say they should look at and how they should look at it and then they present those results to the public and to policy makers on the presumption that they are going to do something about it without really any thought or idea of what sorts of policies exist or what can be done beyond things like reduce GHGs. We've had very little scientific investigation of the policy structures and processes themselves. In fact a lot of the natural scientists don't even think of that as science. So we have this, I don't know if you call it, an ignorance or arrogance or something, but if you have a research program that's supposed to contribute to policy making it would seem to me that an absolutely necessary element of that research is understanding the policy environment, the policy process, who has what authority to do things, how does it work. And furthermore, that it should influence the things that are looked at." - T. Gibson field notes, November 7, 2007

It was noted by several ArcticNet participants that the media played a strong role in facilitating interactions between the two groups. The media is used by scientists as a vehicle to convey results to the public who in turn put pressure on government for action. An example of this is the documentary shown on television in 2007 with Peter Mansbridge interviewing scientists on the Amundsen research ship and then following it up with an interview with the Prime Minister on climate change. One science participant commented:

> "I can't just phone up the Prime Minster and say you know what Prime Minister, you're not doing enough to deal with climate change, but Peter Mansbridge can. So that video was really about that, that's really a good example I think of how your can go from a science concern to a policy relevant input at the highest levels of government" T. Gibson field notes, February 4, 2008

More recently in March 2008, there was a week long series of media articles published by a Winnipeg Free Press reporter who was observing activities on the Amundsen as part of the IPY program.

The data for policy makers shows that four of nine (45%) of those interviewed considered interactions between scientists and policy makers as two way dialogues, but several participants noted that these dialogues were sometimes dysfunctional and required assistance through interpreters or translators. Five of nine (55%) of the participants weren't sure if there were two way dialogues. Several participants believed that attempts to improve the interface between the two communities were increasing but these efforts were ad hoc and unstructured, and that more needed to be done to establish a more effective network where information could more easily be shared.

Participants' views on the challenges affecting the interface were wide ranging. There was no one challenge identified that was common for both groups. A primary challenge identified by policy makers was that the "language" used by scientists is different than that used by the policy makers, especially in regard to the level of detail provided in written and oral communication, and this made it difficult for meaningful and effective use of the information by the policy maker. There was no prevalent challenge identified by the scientists, each participant provided something different. One participant provided this perspective on the challenges of the interface:

> "Sometimes there may be mechanisms in place but no one's used them for a long time in which case nothing very effective happens. There are also different time scales involved with this that I think is a key problem with this communication between policy requirements and science. Science goes on over a very long period of time and the way I like to talk about it is we deal with a crystal ball. And our science, what its role is, is to make the crystal ball clearer and clearer as we move into the future. So by understanding the processes we can make better predictions, and it's really the predictions that the policy makers are interested in, they want to know what's going to happen next week." - T. Gibson field notes, January 9, 2008

Table 3 provides a summary of the key challenges identified by the participants regarding the science - policy interface.

Table 3: Challenges Affecting the Interface

Challenge	Scientists	Policy makers
"Language" used by scientists is different than that used by policy makers, uses different levels of detail,		4
There is a lack of awareness of each others' processes		1
Scientists are more static (career scientists) compared to policy makers who move around a lot and do not develop subject matter expertise, hard to build relationships		1
Policy makers and scientists do not always agree on what it is they should be researching		1
Understanding of science by policy makers and of policy by scientists is not well developed, improvements required	1	
Science is only one driver of policy	1	
Different time scales of the two processes impacts communication, scientist time scales are very long relative to policy makers time scales which are short	1	
Science has uncertainty, policy makers want certainty and they want it now	1	
There is no-one group tasked with summarizing research information for politicians and translating it to a form they understand and can use	1	
Personality types of the two groups are different, each group is coming from different perspectives, need intermediary body to facilitate	1	

Participants provided a diversity of ideas for what they thought could be done to improve the interaction or knowledge transfer process between climate change scientists and policy makers. The predominant idea for improving the interface by both groups was the establishment of an independent national coordinating organization that would bring the players in the arctic together - government, academia, and industry - to undertake science

assessment. This proposed agency was seen as a vehicle that could communicate directly with the decision makers.

> "There should be some sort of Canadian Assembly of these kinds of activities where they sit face to face and discuss things. I'm not sure if that actually happens or not, I think it might happen on sort of an individual level on a really small scale but I think it would help to have a more national forum on that kind of thing." - T. Gibson field notes, February 11, 2008

> "We've talked about that coordinating body in Canada now for about 20 years and nothing has ever come of it because the federal government does not want to give up their responsibilities in certain areas to one agency because there's budget ramifications associated with it." - T. Gibson field notes, November 7, 2007

The second most prevalent idea for improving interactions and transfer of knowledge both ways was through the use of joint conferences and workshops.

A summary of the ideas provided by participants is presented in Table 4. A variety of ideas were presented, but many of these echo what has already been suggested in the literature.

Table 4: Ideas for Improving the Interface

Ideas	Scientists N = 8	Policy makers N = 9
Establish a national interagency coordinating organization to bring players in the arctic together (government, academia, industry); an independent agency to do science assessment; a vehicle to communicate directly with the decision makers	3	2
Government funded research should contain a summary for policy makers, it should demonstrate how the research relates to policy	2	
Media could play a role in communicating science to policy makers	1	
Joint Conferences / workshops	2	2
More interaction at higher level, ministers and senior scientists	1	
Integrate policy makers with scientist presentations	1	
More open and public dialogue by policy makers with scientists, media and general public.	1	
Earlier peer review of emerging issues		1
Translating science results into laymen's terms for policy makers to understand		1
Scientists determining their policy client and building relationships		1
Expertise inventory for policy makers		1
Government scientists to include policy implications summary for research articles they write, this then goes to database with alerting system to policy makers, marketing database to policy makers		1
Joint committees/working groups made up of both groups that meet regularly (government)	1	1
More synthesis reports on science, reader friendly, easy for policy makers to understand, but should come from science community (not environmental advocate, journalist or policy wonk) to have more credibility. Policy makers need to demand these sort of summaries through briefings from scientists		1
Use of intermediary or boundary organizations (e.g., CCME, IISD)		1
More time and listening for both communities, more direct involvement for both to get a better understanding of each others worlds and processes – joint meetings, secondments or time spent in each others camps	1	1
Training across the divide, individuals who are willing to be trained in both disciplines	1	1
Policy makers need to understand science process (uncertainty), and scientists need to understand policy making process		1
Find common ground, leaving the jargon at the door		1

The ideas presented above, although varied, are not considered by the researcher to be particularly innovative. Many of these same ideas for improving the interface have been

identified in the past, yet the gap in the interface remains. The ways in which these ideas are being implemented (or reasons why they are not) may shed some light on this problem. It appears there have been many ideas thrown out there, but no one community – science or policy – is really taking the lead on moving forward to implement these ideas. An exception is the development of "synthesis reports" which appears to be gaining popularity by both scientists and policy makers because of IPCC Summary Reports. One idea raised considered to be worth further investigation is the notion of "training across the divide". This was mentioned by both groups and has the potential to make a positive impact on the interactions between scientists and policy makers if it could be achieved.

4.6 Summary

This chapter summarized the data regarding participants' responses to questions that explore the interface between scientists conducting research in Canada's arctic and policy makers at the federal level who respond to the research. The findings highlight the importance of creating more effective mechanisms and pathways for an integrated approach to policy development for Canada's arctic. The results also point to the significant role that communication plays and the influence intermediaries or boundary organizations can exert on helping to bridge the gap in the interface.

CHAPTER FIVE: PERSPECTIVES AND REFLECTIONS ON THE SCIENCE – POLICY INTERFACE

5.1 Introduction

The data analysis in the preceding chapter revealed several key themes regarding the interface between scientists and policy makers in the context of climate change in Canada's arctic. In this chapter, further discussion is provided on these issues and how they relate to the current thinking on this topic found in the literature.

5.2 Science - Policy Community in Canada's Arctic

The issue of climate change in Canada's arctic over the past decade has resulted in an evolution of the interface between scientists and policy makers in the traditional sense (i.e., within government), to that of special networks consisting of scientists, policy makers, local governments and communities, industry and others interacting with each other. This type of network is important because it provides for a more holistic and interdisciplinary approach to increasing our understanding of climate change in the arctic and for developing national policies and strategies to address the impacts to humans and the environment in this region.

While this structure for dealing with the issue of climate change differs from the more typical science - policy structure found within government, there are both similarities and differences in regard to how the interface operates. Based on the results presented in the

preceding Chapter, an opportunity exists to improve the interface. Much could be done to help scientists better understand policy makers and their needs, the policy process, and how research can be tied into policy priorities. Much could be done to help policy makers better understand scientists, the scientific process, and to ensure they have access to and understand the science that can inform their policy.

5.3 Using Climate Change Information

The use of peer reviewed journals was one of the primary sources of information on climate change identified by ArcticNet scientists whereas this was one of the least used sources for the policy makers. This difference points to one of the long standing problems often cited in the literature – the capacity for effective communication and dialogue between the science and policy communities. Peer reviewed journal articles are most often written in a "scientific or academic language" that has too much level of detail for policy makers. The scientists use the peer review process however to provide validity and credibility to their research. The other primary source of information used by ArcticNet scientists was the use of traditional or local knowledge, which, due to the nature of arctic research, puts the scientists physically into the communities to take advantage of this source of information. This was clearly seen by scientists as a very important source of information for scientists yet was not really acknowledged by the policy makers. Policy makers interviewed used direct communication with experts and review of summary reports as their primary sources of information on climate change. Theses methods were also used by some of the scientists interviewed but to a lesser degree. It is interesting to note that direct communication with experts by the policy

makers was within the government setting and was with government scientists only. Policy makers interviewed expected or assumed that the government scientists were communicating with outside researchers and ensuring the relevant research information was bought forward into the policy process. The very basic question of where scientists and policy makers look to for information on climate change provides the first signal that there may be problems with the interface between these two groups. The gap between government and non-government science must be addressed if Network Centres of Excellence such as ArcticNet are to be able to meet their objective of translating the growing understanding of the changing arctic into national policies and adaptation strategies, as indicated in the their 2007 Annual Report.

5.4 From science to policy

All of the participants, whether a scientist or policy maker, believed it was important to rely on science for the development of policies to address climate change issues because they believed science provided the basis for stating there is a change in the climate. An important consideration here is that science is not always the only or even most critical element of policy development, economic and social factors are also important (Cimorelli and Stahl, 2005). This must be kept in mind when trying to understand and suggest improvements to the interface.

The science community interviewed was divided as to whether or not scientists should play a role in the "art" of policy development. The general policy development process

for the federal government, as presented in the literature review in Chapter 2, theoretically provides for input from experts, stakeholders and public. The model implies this input is iterative and comes during all phases of the process. The literature is not explicit in regard to what step in the policy process that scientific information is actually provided and it is usually considered to be part of the "collecting data and information for analysis" phase of the policy process.

Ideally, science influence or input into policy development should be considered at the earliest possible stage of the process. According to the model presented in Chapter 2, this is when an issue and its context are first identified. Some of the questions asked at this initial stage are: where is the policy direction coming from; who is responsible; who shares an interest in the issue; and what outcomes are being sought by government. The answers to these questions may, in part, rely on science and should trigger the need for interaction between the scientists and policy makers. For example, the priority to deal with the issue may be based on science, such as is the case with nutrient removal from Lake Winnipeg. In this example, the science community shares an interest in the issues and plays a role in determining the outcomes being sought by government. A lake stewardship board, consisting of selected scientists and policy makers plays the role of a boundary organization to facilitate the ongoing relationship between government policy makers and the science community. This example would provide a good case study for further research on the science-policy interface at the provincial level.

In the context of climate change policy, Sohngen (1998) suggests that the science and policy involve many questions that are linked. This supports the suggestion that the science should be considered early in the policy development process.

The next stage of the policy development process is assessing the risks and benefits and requires data to be collected and analyzed. Scientific input should occur here since, in many cases, it will constitute the main source of the data. Analysis of the data may have considerable influence on the next steps of the process which are to identify and analyze options and select a strategy.

Leggett (2007) suggests the uncertainties of climate change is a key factor in determining policy outcomes. Several participants reflected comments that were in support of this. The science influence on policy development will be more effective if there is an existing relationship between the scientists and policy makers, in other words, if the interface is functioning well.

While the majority (but not all) of scientists interviewed believed their findings should be conveyed to policy makers, only half of those interviewed actually indicated they conveyed their findings directly to policy makers themselves. These were science participants that had reached senior positions within the ArcticNet science community and seemed to have a better sense of the importance of conveying their findings to policy makers. But many of these scientists were frustrated with not knowing the best process to do this. The other half were unclear as to how science findings were actually conveyed

and presumed it happened indirectly through other vehicles they used to communicate their findings generally, such as through peer reviewed literature, conferences, sharing directly with community members and the media. Several participants commented on communication of research findings to arctic communities and how that may influence policy.

> "All our findings are reported back to the community every year to their decision makers and they make decisions regarding the marine protected areas in the Mackenzie pipeline locally, all my research is tied to the Department of Fisheries and Oceans. They have all my results and finding and they published all my papers, but I don't walk it over to a policy maker, I don't have any contact with the person who makes the policy decision." - T. Gibson, field notes, January 8, 2008

> "Its not as if our work leads to a very specific recommendation, that would be very presumptuous of us, rather it says, look here is something that is problematic now for people in these communities and our research shows its likely to become even more problematic in the future, and here's some of the things that might be done to address it. A lot of these can be done at the community level, and the community goes to the higher level of government where that is needed." - T. Gibson, field notes, November 22, 2007

This suggests that many ArcticNet scientists do not purposely seek out ways to directly convey their findings to federal level policy makers in a way that will get their attention. The findings imply more could be done to achieve better alignment of scientists' actions for conveying their findings with the objective of ArcticNet Project 4.7, which is to provide directly relevant information to aid policy and decision makers in the development of policies and strategies for adapting to a changing arctic environment (ArcticNet, 2008). Where there are opportunities to inform or influence policy, scientists should clearly understand the policy context in which they are conducting their research.

Policy makers interviewed seemed to be very much aware of the science - policy relationship within government and suggested that efforts were underway to improve this relationship. Government scientists follow an internal process for getting their results incorporated into federal policies, and the policy makers are familiar with that process, although it is fraught with its own systemic problems. Effective use of internal government scientists by the federal government is now being re-evaluated, as illustrated by Environment Canada's decision to create a Science and Technology Branch to bring together all researchers in one spot. A Science and Technology Branch contact is then assigned to be on a relevant policy team.

Policy makers, however, do not seem to recognize or understand the significance of the relationship that is available to them with external science networks such as ArcticNet nor the role these networks could play in influencing policy to address climate change. They appear to be less sure of how to engage with scientists outside of government (academia). Guston (1996) suggests the "principal – agent theory" as a way to explain and examine this problem. The government policy maker community is considered the principle who asks the agent, the scientific community, to undertake certain tasks (research) because the principle cannot perform them directly. The agent (scientific community) carries out the research out of self interest but with some consequential benefit for the principle (policy maker community). Guston argues this theory creates a clear dichotomy between the policy maker and science communities but does not determine a specific boundary.

Policy makers understand that their work requires scientific input but this input does not necessarily mean certainty and thus they will be required to make decisions under conditions of uncertainty. This is a difficult thing for policy makers to do. The literature indicates they want certainty and they want it in a timely manner.

5.5 From policy to science

Consistent with what the literature says on this issue, ArcticNet scientists interviewed had mixed views on whether government policies related to climate change needed to be brought to their attention. While seventy-five per cent believed they should be, close to two thirds were either not sure of or did not know how the process worked to make it happen. This finding is most likely a reflection of the fact that policy relevance for scientists has historically been far more important for government scientists. There is a tendency for natural scientists to be more discovery oriented in their research and they may not even be thinking that it could be policy relevant, much less understand how to make it so. This mind-set seems to be changing though, with networks such as ArcticNet looking to put more of a focus on the translation of scientific understanding of the changing arctic into impact assessments, national policies and adaptation strategies. ArcticNet scientists working in research themes dealing with human impacts of climate change in Canada's arctic recognized and understood the need for policy relevance better because of the "people" factor. This notion was illustrated in the model developed by Sohngen (1996) showing links between scientific inquiry and policy analysis in understanding the climate change question. Policy enters this whole system because there is feedback between the social and economic consequences and human activity.

It was the view of several of the policy makers interviewed that there is a disconnect between the policy makers' information needs and the research that is being conducted in the arctic region. This was also supported by the following statement from a science participant:

> "Policy makers need to better understand the capacity and limitations of science, but also to understand if they are willing to sit down and be more open and if they spend the time with scientists there will be benefits in terms of a more focus directed at the science that will answer the questions they want. It not useful after a big scientific assessment has been done for the policy maker to say, "Well this is the question we wished you had answered, you didn't answer this question". Largely, speaking, there hasn't been the involvement of the policy community given in advance of questions they really wanted answered." - T. Gibson field notes, February 12, 2008

While all policy makers felt they had a role in determining climate change research agendas, this idea was supported by just under two thirds of the ArcticNet scientist. The need for a multidisciplinary approach with more dialogue occurring between both groups was very much favoured by both the scientists and policy makers. The literature suggests funding programs appear to influence the research agenda to some degree, but the reality is that individual research projects and their objectives are sometimes far removed from the original policy objectives set out under the funding criteria. ArcticNet, as a Network Centre of Excellence (NCE), obtains its funding from three Canadian federal granting agencies, the Canadian Institutes of Health Research (CIRH), the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Social Sciences and Humanities Research Council of Canada (SSHRC). The networks are established by these funding agencies to address strategic research questions deemed vital to Canada's

social and economic development. It is unclear how those questions are determined and shared with the NCEs.

Recent funding for ArcticNet provided under the IPY program is more directly tied to policy priorities of the federal government related to the environment and people living in this area. Where there is an opportunity to influence research agendas, and in many cases this is done through funding mechanisms, it should be done in a manner where the scientists have had an input to the process. Given that ArcticNet is responding to a government policy priority area there is a need for the researchers in this network to be better linked into the government decision making process. This is new territory for both researchers and policy makers.

5.6 Criteria for an Effective Science Policy - Interface

The literature review noted a number of challenges affecting the interface between scientists and policy makers such as capacity for effective communication and dialogue between the science and policy communities, the nature of the science process and how it is changing, the nature of the policy process and how it incorporates science. The research findings of this thesis are consistent with the literature in regard to obstacles that are faced between scientists and policy makers. What was not found as readily in the literature was an understanding of how academic science networks, such as ArcticNet, interact with government and the nature of that relationship. ArcticNet scientists and government policy makers interviewed for this study possessed varying levels of skills and expertise in regard to their own disciplines as well as those on the other side of the

interface. Those with more experience and expertise were more attuned to the systemic problems and challenges of the science - policy interface than those with less experience or at a lower level in the network or system.

A common theme that arose from the findings was that some scientists possessed a unique skill set that made them effective "translators" of the science into lay terms which are more helpful to the policy maker. Miller (2005) referred to this in his discussion on "hybrid management" which he considers to be the people, artifacts and institutions that mix elements from science and politics. The recognition of the value that these translators can play in the science policy interface was evident by the positive responses from both groups in this regard. This supports the work of Guston (2001) who suggested that "blurring" of the boundaries between science and politics can lead to more productive policy making. Miller (2005) spoke of the "climate regime" which is a suite of social, political, scientific and economic networks and institutions that have emerged in response to climate change. ArcticNet could be considered to be part of this climate regime as it improves its efforts to interpret and manage the production of scientific knowledge on the arctic and its incorporation into policy making. The International Panel on Climate Change was identified by both scientists and policy makers as playing an important role in translating science into a form that policy makers can understand and use. IPCC would be considered a boundary organization within the "climate regime".

Based on the literature review and the findings of this research, the following model depicts what could be considered a successful science – policy interface.

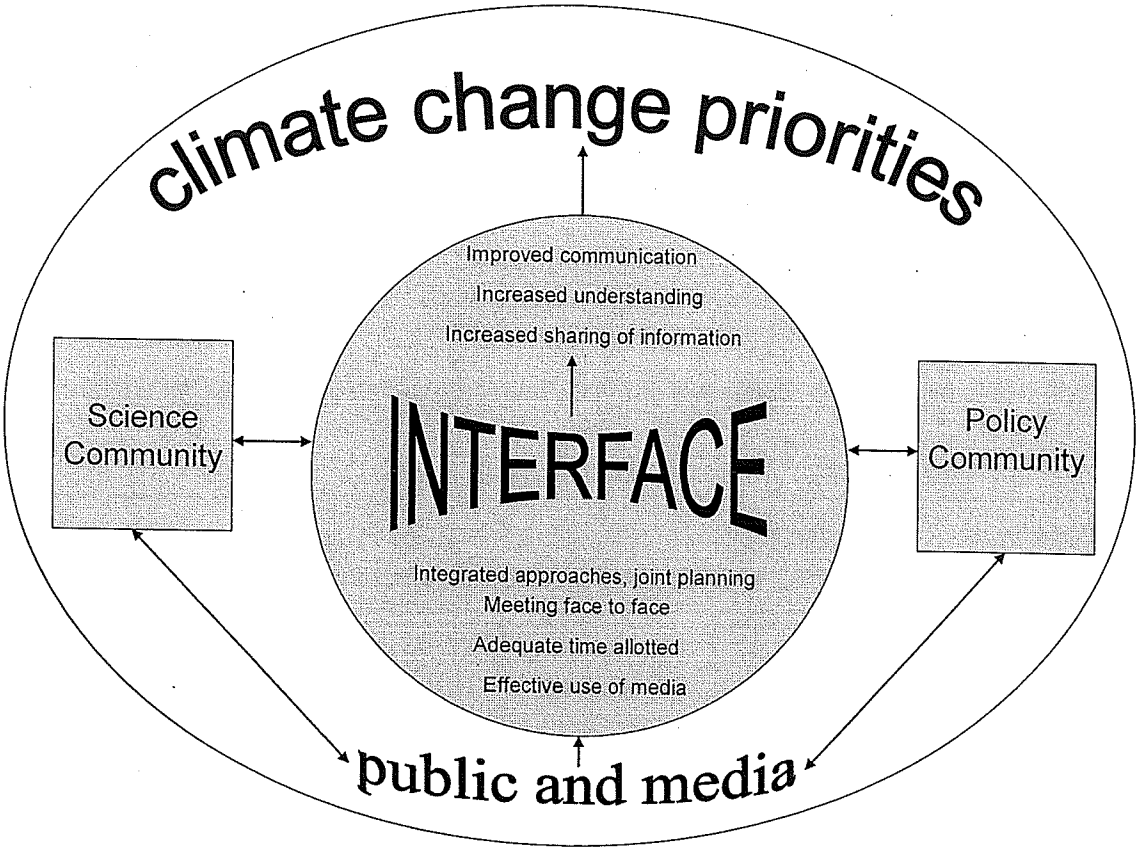


Figure 12: Model of a Successful Science – Policy Interface

The model is based on a set of criteria (listed below) that can provide guidance for a more effective interface between ArcticNet scientists and federal policy makers.

- Policy makers and scientists are meeting face to face regularly to share information on common questions related to climate change in the Arctic.
- Policy makers are part of the research teams.
- Scientists are part of the policy teams.
- Policy makers ensure adequate time is made available to hear scientists' findings.

- Policy makers understand the long term time scales of climate science while scientists understand the short to medium time scales of the policy process.
- Policy makers and scientists are jointly planning and attending national forums that are delivered in a manner that allows for meaningful communication between the two.
- Scientists and policy makers use the media collaboratively and effectively to further each others understanding of arctic climate change issues.
- Scientists develop summary reports/atlases on their research for policy makers.

In this model, climate change priorities can be effectively addressed through a well functioning interface so that the necessary research is conducted to inform the policies that are needed to deal with the impacts of climate change in Canada's arctic. The public and media play a role in influencing the interface.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a brief summary of the research (6.2), conclusions drawn from the research (6.3) and recommendations (6.4) for improving the interface between scientific scientists in Canada's arctic and federal policy makers that respond to arctic research.

6.2 Summary of the Research

Bringing scientists and policy makers together in an effective manner to influence decision making is an ongoing challenge in this era of increased knowledge and public participation in government processes. This is especially true in regard to the development of Canadian policies that address climate change issues. To influence decision making on this complex issue, an understanding of the underlying causes of environmental change and the process of decision making is necessary (Watson, 2005). While many factors contribute to the development of policies that address climate change issues, the focus of this research is on the relationship between scientists in Canada's arctic and policy makers at the federal level working on policies to address climate change in Canada's arctic. The research assumption put forward in this thesis was that the interface between science and policy is underdeveloped and functioning poorly.

The purpose of this research was to examine the interface between scientists and policy makers in the context of climate change in Canada's arctic. The objectives of the research were:

1. To explore the way in which scientists convey their research findings on climate change in Canada's arctic to federal policymakers;
2. To assess the way in which policymakers at the federal level convey their policy priorities for climate change in Canada's arctic to scientists and how this may influence research agendas;
3. To identify the challenges affecting the interface between scientists conducting research in the Canadian arctic and federal policy makers who may respond to the arctic research; and
4. To propose recommendations to improve the interface between these two groups of scientists and policy makers.

The research design consisted of qualitative approach using a case study strategy of inquiry. Qualitative data collection methods included (1) literature review, (2) primary document review, and (3) semi-structured interviews with scientists conducting research in Canada's arctic and policy makers at the federal level working on policies to address climate change in Canada's arctic. Seventeen participants were interviewed, nine from the policy community and eight from the arctic research community. The data was reviewed and analyzed using content analysis to sort through the data and identify major theme areas related to obstacles and challenges of the interface between scientists in Canada's arctic and policy makers who may respond to the arctic research.

6.3 Conclusions

There are many stakeholders who can influence the policy development process; scientists are only one of these stakeholders. This thesis focused only on the interface between the scientists and policy makers and did not attempt to assess the impact of other stakeholders on the policy development process. The research findings have led to the conclusions presented below.

6.3.1 Science - Policy Gap

There is indeed a gap in the interface between ArcticNet scientists and federal policy makers. ArcticNet participants are actively engaged with local community members, other ArcticNet scientists outside of government and other non-government partners within the network, but they were less sure of how to communicate with their government partners – policy makers - the interface was not as well developed here. For government policy makers, they interacted regularly with internal government scientists but much less so with external academic scientists. There were some limited interactions with community members by policy makers but this was also not well developed.

The issues related to communication and knowledge of processes of the two groups contributes to gap. There is a disconnect here. It signals a need for more direct communication between the two groups; and a need for increased understanding of each others "languages" and processes.

6.3.2 Science Informing Policy

The processes used by ArcticNet scientists to convey their research findings on climate change in Canada's arctic to federal policymakers are varied and ad hoc. They are not targeted specifically to Policy Makers. The scientists are unsure of whom in the policy community they should contact. This suggests ArcticNet does not systematically seek out ways to directly convey their findings to federal policy makers, but relies on the media and public pressure to bring the information to the policy maker's attention. The low level of direct communication by scientists with policy makers at the federal level further adds to the disconnect that exists between them. A factor for how well the findings may be conveyed or whether they will be conveyed at all is the researcher's level of seniority within the science community. Senior scientists are more likely to convey findings directly than are junior scientists. Where there are opportunities to inform or influence policy, scientists should clearly understand the policy context in which they are conducting their research and clearly understand the policy questions they are addressing. Conversely, the specific policies developed should be informed by the relative research. ArcticNet scientists could work towards a better understanding of the policy development process in order to influence policy and best determine where to provide input. Internal government scientists are better able to convey their finding to the policy makers because of their familiarity with the policy development process and contacts within government.

6.3.3 Policy Influencing Science Research

There does not appear to be a systematic or commonly understood approach for how policy priorities for climate change in Canada's arctic are conveyed to scientists, it is ad hoc. Policy Makers focus their interactions with internal scientists; and the role of networks, such as ArcticNet, with external scientists in policy making is not well understood by the policy makers. Thus, there is a disconnect between the research occurring and the needs of the policy makers. Federal policymakers see a strong role for government to convey policy priorities for climate change in Canada's arctic to scientists through funding programs. Funding of arctic research appears to influence the research agenda to a certain degree, but individual research projects and their objectives are sometimes far removed from the original policy objectives. There are opportunities to influence the direction of research through funding mechanisms, but it should be done in a manner where the scientists have had an input to the process. This requires a new way of thinking and a different approach for scientists who have in many cases undertaken research for discovery sake only and not specifically to address policy. Policy makers should make more time to hear scientist's findings, there is a need for this group to better understand what the science is saying. Time currently allotted by Policy Makers to hear Scientists is not adequate enough to effectively inform the policy maker in a meaningful way.

ArcticNet scientists at the senior level are more cognizant than junior scientists of the need for policy relevance in their research. Even so, it appears there could be more effort by all levels of scientists within the science community to move forward in this direction.

There are inconsistencies in the views expressed by ArcticNet scientists as to whether government policies related to climate change needed to be brought to their attention. Even though a majority thought they should be, ArcticNet scientists are not really sure how this should occur. Historically, the need for policy relevance has been with government scientists, but this is changing with the advent of climate change and the creation of networks such as ArcticNet to play a role in the policy development process for the Canadian arctic. ArcticNet scientists, especially those working in Theme 4, should consider putting more focus on the policy relevance of their research to achieve better alignment with their objective of providing directly relevant information to aid policy and decision makers in the development of policies and strategies for adapting to a changing arctic environment

6.3.4 Challenges Affecting the Interface

There are numerous challenges affecting the interface between scientists in Canada's arctic and federal policy makers working on policies that address climate change in this region. The relationship is not considered to be a two-way, open dialogue on facts, analysis, outcomes and values. One of the most critical challenges often cited is that the "language" used by scientists is different than that used by policy makers; it uses different levels of detail. This creates misunderstanding and sometimes indifference between the two groups. Another significant challenge is that a common understanding of each others processes is not well developed. Without a clear understanding of the respective processes it will be difficult to know how and where it can be influenced. This is a key factor. The results of this thesis suggest that although this gap is acknowledged,

there appears to be a reluctance or lack of interest to better understand each other's processes. The nature of scientists, who tend to have long careers as researchers where they can develop in-depth expertise in their subject areas, compared to the nature of policy makers, who tend to move from job to job and thus do not develop subject matter expertise, make it more challenging to build effective relationships. This difference may likely play a role in how these two groups communicate. The different time scales of the science and policy processes is another factor that impacts communication. Science time scales are very long relative to policy time scales which are short.

There is no one group tasked with summarizing research information for politicians and translating it to a form they understand and can use, this is a significant challenge and action to address it would have a positive impact on the science - policy interface. Personality types of scientists tend to be different from that of policy makers, each group is coming from different perspectives. The use of boundary organizations and intermediaries is a way to bring these two groups together to help them better understand each others perspectives and come to a common understanding of issues.

In this thesis, the policy community responded in a way that reflected their experiences and interactions with government scientists. They were less sure of how to engage with scientists outside of government (academia), although those at a higher level in government had a better sense of this. Policy makers need to recognize the opportunity to develop better relationships with science networks such as ArcticNet to assist in the development of policies to address climate change in Canada's arctic. Alternatively, on

the scientist side, there was a similar range of responses in which scientists were unsure of how to engage with the policy community, depending on their level of seniority within the research community. Those scientists that had some government experience or were at a high level of seniority within the research community (senior scientists) had a much better understanding of how research findings could be conveyed to policy makers but still found there were challenges in doing so.

It is apparent that some ArcticNet scientists do not have contact with any policy makers in the course of their research. They do not see a need for it or even consider there would be a need. This fact highlights the disconnect and points to the necessity for an improved understanding of the processes used by each group in their relative fields and how they relate to each other. Generally speaking, there is a certain objectivity that needs to be maintained between scientists and policy makers even though the science has the potential to influence policy. In the case of ArcticNet, their central objective is to contribute to the development and dissemination of the knowledge needed to formulate adaptation strategies and national policies to help Canadians face the impacts and opportunities of climate change and globalization in the Arctic. This objective is directly linked to informing or influencing policy, which is not usually the case for most scientists. In that regard, ArcticNet scientists could be better informed on how their work fits into the policy priorities of the federal government regarding climate change in the arctic. In many cases they do not know who to contact in regard to policy. There is need for policy makers to better understand what the science is saying. More time should be provided by policy makers to hear scientist's findings. There are few in-person

communications between the two groups, and when there is contact, it is not always in a forum that is conducive to the transfer of knowledge. The time allotted by policy makers to hear scientists is not adequate enough to effectively inform the policy maker in a meaningful way.

6.4 Recommendations - Closing the Gap

Based on the conclusions above, the following recommendations are proposed to improve the interface between scientists and policy makers in regard to climate change.

Recommendations that could be easily implemented immediately:

- More formal mechanisms, such as conferences and workshops, should be provided that bring together scientists and policy makers in a structured, facilitated format to discuss both science and policy issues of climate change in a language that both can understand, with clearly defined outcomes for the conference. These sessions could be planned and facilitated by boundary organizations such as CCME or IISD. It is essential that these workshops be developed and marketed as "science – policy interface" events that are focused specifically on improving interactions between ArcticNet scientists and federal policy makers.

- More plain language summaries of research findings using simple graphics and images should be prepared for the policy makers and community members to facilitate better understanding of the science. This type of reporting has been increasing in the science community and ArcticNet should ensure all its programs put emphasis on development of plain language summaries.

- Research theses and other types of science write-ups such as peer reviewed journal articles should be required to contain a plain language synthesis of the research and a section on the policy implications. ArcticNet could make this a criterion for future research proposals being submitted by students.

- The media should be used in a more collaborative and effective manner between ArcticNet scientists and policy makers with an aim to help bridge the interface. A communication strategy could be developed by ArcticNet, in collaboration with federal policy makers, to incorporate this notion.

Recommendations that could be implemented over the long term:

- Scientists and policy makers that have a unique skill set for effectively communicating across the interface (i.e., the "translators") should be identified within ArcticNet and used more strategically to convey information in a way that both the scientists and policy makers can relate to. These translators should also play a role in the development of plain language summary reports mentioned

above. Training, or courses to help develop theses skills, should be developed and provided through the member universities of ArcticNet as part of the academic program course requirements.

- Outreach and education on arctic science and policies needed to address climate change in this region should be developed and delivered jointly between ArcticNet scientists and federal policy makers.

- A stand alone independent science assessment body should be established and supported by the federal government to assess all science in the Canadian arctic, both government and academic, and to provide policy relevant summaries. This agency would be a repository of research undertaken in the Canadian arctic. To initiate action in this regard, a formal proposal for such an agency could be prepared jointly by ArcticNet scientists and federal senior policy makers at the bureaucratic level. The policy development model discussed in this thesis could be used as a process to develop and promote this idea up the line to the politicians, both at the federal and provincial levels, to seek support.

If these recommendations were to be implemented it is anticipated the science - policy interface would be improved and arctic research findings would be effectively informing the development of necessary policies that address the impact of climate change in Canada's arctic.

6.5 Suggestions For Future Research

The findings of this thesis suggest several potential areas for future research.

1. **A more in-depth analysis of ArcticNet in the context of the theory on "boundary organizations".** It would be beneficial to undertake an analysis, using a more statistically valid sample size, of the perceived and actual role ArcticNet plays in regard to boundary organizations and their contribution to the science policy interface. This could include a comparison of the structure and makeup of ArcticNet to other science networks working in the arctic.

2. **An assessment of the federal government's attitudes and actions towards consolidated assessment of climate change science research in Canada.** This study may help reveal barriers and challenges to such a body being established that has been proposed by the science community for many years.

3. **Further investigation into the notion of "training across the divide".** This idea was mentioned by both groups and has the potential to make a positive impact on the interactions between scientists and policy makers if it could be achieved. It could include a more in-depth look at the unique skill sets of "translators" and how their numbers can be increased throughout the interface.

4. **A study of Lake Winnipeg Stewardship Board as a boundary organization.** This would provide a good case study for further research on the science-policy interface at the provincial level.

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APPENDIX B – CONSENT FORM

Title: **An Assessment of the Interface Between Scientists and Policy Makers Regarding Climate Change in Canada's Arctic**

Researcher: **Tammy Gibson**

Sponsor: **ArcticNet Inc.**

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Dear Participant:

My name is Tammy Gibson and I am a graduate student at the Natural Resources Institute (NRI) of the University of Manitoba.

The purpose of my research is to examine the interface between scientific research in Canada's arctic and federal policy development processes that responds to the research findings, and the problem of its integration.

As a participant in my research, you will be interviewed over the telephone. The interview should take approximately one hour, and with your permission, an audio recording will be made of the interview. You can ask me at any time during the interview to pause or stop. Your responses will be held in strict confidence to ensure your anonymity. The results and raw data may be shared with my Advisor, Dr. Leslie King of Malaspina University, B.C. and the results of this study will be reported with no reference to participants' names. Your mailing address will only be requested if you wish to receive the summary of research findings.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or refrain from answering any questions you

prefer to omit, without prejudice or consequence. Your continued participation should be informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Thank you for your time and consideration.

Tammy Gibson
Masters Student, Natural Resources Institute
70 Dysart Road, University of Manitoba Winnipeg, MB R3T 2N2

This research has been approved by the University of Manitoba Ethics Review Board. If you have any concerns or complaints about the project you may contact my supervisor Dr. Leslie King, NRI or the Human Ethics Secretariat A copy of this consent form has been given to you to keep for your records and reference.

I give my consent for an interview:

Participant Signature Date

I give my consent for the interviewer to make an audio recording of the interview for research purposes:

Participant Signature Date

I give my consent for the information that I have shared in this interview to be used in the ArcticNet Inc. research project.

Participant Signature Date

Researcher Signature Date

If you wish to receive a copy of the research findings please provide your mailing address or email address.

Mailing Address:_____
Email Address:_____

APPENDIX C - INTERVIEW SCHEDULE

General Questions for both Scientists and Policy Makers

1. What is your role and experience in regard to the development of climate change policies for Canada's arctic?

2. How do you obtain the information you need regarding climate change issues? Is provided by others, if so who and how do they provide it to you, where do they get it?

3. How are climate change research results brought to the attention of or made available to policy makers? Are they, do they need to be?

4. How are policies that address climate change in the arctic brought to the attention of scientists? Are they, do they need to be?

5. Is it important to rely on science for climate change policy development? Why or why not?

6. Do you think that in some cases policy development is not informed by science because there is a lack of interface between scientists and policy makers? Please explain.

7. Do you think there is a role for policy makers in determining climate change research agendas? If so, what would that role be?

8. How would you describe the interactions between climate change scientists and policy makers? Would you consider them as two way dialogues?

9. What could be done to improve the interaction or knowledge transfer process between climate change researches and policy makers?

Questions for Policy Makers

1. Does your policy work address identified climate change priorities and information needs?

2. Do you incorporate climate change science into your policy development process? If so, how do you communicate the need to climate change scientists for this input? If not, why not?

3. What science resources are available to you to influence your thinking on climate change (i.e. media, individual experts, journals, organizations)?
4. Do you communicate directly with climate change scientists? If so, in what type of forum (meetings, one-on-one, phone)? If not, why not?

Questions for ArcticNet Scientists

1. Do your research findings address identified climate change priorities and information needs?

2. How do you share your research findings? Who do you share them with?

3. Do you see a need to communicate your research findings to government in order to influence policy that addresses climate change in the arctic? If so, how should they be communicated?

4. Do you communicate directly with climate change policy makers? If so, in what type of forum (meetings, one-on-one, phone)? If not, why not?

APPENDIX A – ETHICS APPROVAL FORM

UNIVERSITY OF MANITOBA | OFFICE OF RESEARCH SERVICES
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APPROVAL CERTIFICATE

04 April 2007

TO: **Tammy Gibson** (Advisor I. Davidson-Hunt)
Principal Investigator

FROM: **Wayne Taylor, Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2007:032**
"Examining the Interface between Science and Policy: Integrating Knowledge for Climate Change"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- **If you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to Kathryn Bartmanovich, Research Grants & Contract Services (fax 261-0325), including the Sponsor name, before your account can be opened.**

- **If you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.**

The Research Ethics Board requests a final report for your study (available at http://umanitoba.ca/research/orsc/ethics/ors_ethics_human_REB_forms_guidelines.html) in order to be in compliance with Tri-Council Guidelines.