COMMUNITY ADAPTATION TO CLIMATE CHANGE: AN EXPLORATION OF CLIMATE CHANGE ADAPTATION PLANNING IN BRITISH COLUMBIA.

by

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B. Sc. (Eng) Queen's University, 2002

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTERS OF NATURAL RESOURCES AND ENVIRONMENTAL STUDIES

THE UNIVERSITY OF NORTHERN BRITISH COLUMBIA

January 2010

Abstract

Planners in British Columbia must adapt to climate change by preparing for expected and unexpected changes in their communities. The results of survey and workshop research conducted at the Planning Institute of BC conference indicate that planners do not have a high level of knowledge of climate change adaptation. Planners feel that the impacts that will affect BC the most in 50 years will be related to forests, agriculture, river flooding, transportation and water. Different regions in the province will be affected in different ways, and adaptation strategies must be created for the specific needs and attributes of a community. Open-structured workshops are a good method to educate planners about climate change adaptation; however, they should not be expected to yield results that can be incorporated into planning documents. Global climate models are a valuable tool that decision makers can use to help determine appropriate planning actions.

Key words: climate change adaptation; climate change impacts; climate change; community planning; adaptive capacity; climate models; British Columbia; Prince George.

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Acknowledgements

At UNBC I am indebted to Orland Wilkerson for helping me to get started on my Master's. John Curry and Eric Rapaport became my supervisors and provided me with many opportunities to explore and discover. My committee members, Stephen Déry and Theresa Healy, provided excellent advice and encouragement. Thanks also to Robin Chang and William Zhang.

From the City of Prince George, Dave Dyer and Dan Milburn have been great advocates for this work. I would like to thank Arelia Werner and Trevor Murdock from the Pacific Climate Impacts Consortium, Joan Chess and Elizabeth Henry from the Fraser Basin Council, the Planning Institute of BC conference committee led by Tiina Watt, Stewart Cohen from Environment Canada, and Jenny Fraser from the BC Ministry of the Environment.

On the funding side I would like to recognize the Pacific Institute for Climate Solutions for funding this research with two graduate fellowships. The Canadian Institute of Planners also provided me with a fellowship in 2008. The City of Prince George generously contributed to this research, and many partners providing funding for the workshop including the Planning Institute of BC, the BC Ministry of the Environment, UNBC and BC Hydro.

I am fortunate to have had the opportunity to collaborate with many excellent organizations and individuals on this project. Climate change is a global issue that affects all aspects of a community and a society. I firmly believe that any success in this project is a reflection of the collaborative nature of the work, and the cooperative spirit of the parties involved.

Most importantly I would like to thank my friends and family for their love and support; especially my parents, and my partner Liz for her endless patience and kindness.

1. Introduction

The purpose of this chapter is to introduce the reader to climate change adaptation as it relates to planning in communities. A background section puts the research into context, and objectives are provided to communicate the goals of the thesis. The research approach is summarized, and an organizational overview is included.

1.1. *Background*

Climate affects people and the places where they live. Seasons, temperatures, precipitation types, precipitation amounts and extreme weather conditions all contribute to the identity of a region or municipality. Adapting to the local climate is a key factor in many aspects of community planning. If the climate of an area is expected to change, planners need to proactively consider the impacts of changes on land use and infrastructure management (Bizikova et al. 2008; King County 2007).

Proactive adaptation means planning to account for both the positive and negative effects of climate change, rather than simply reacting to changes as they occur (City of Chicago 2008). Communities must adapt to changes from a land use perspective and be prepared for major environmental consequences including (but not limited to) increased flooding, increased forest fire severity and frequency, more extreme weather events, sea level rise, diminished water supply and effects on infrastructure (BC Government 2006; Stocks 1998; Kleinen and Petschel-Held 2007; Federation of BC Naturalists 2006). Whenever possible, climate change adaptation should occur in such a way that it is complementary with mitigation actions (Ruth 2007; Cohen and Waddell 2009).

Temperature trends reveal that the north-central interior of British Columbia (BC) is warming much faster than the average global rate. Climate change models project that the interior of northern BC, as well as the rest of the province, will continue to experience rapid warming trends over the next 100 years. This temperature increase will occur even if societies drastically reduce their carbon emissions (IPCC 2007a; Füssell 2007*)*. Changes in the climate pose serious implications for municipalities across the province. Communities must plan to adapt to the impacts of warmer temperatures and precipitation changes, as well as to mitigate their contribution to climate change (Rodenhuis et al. 2009).

Many effects of these changes have already had an impact on areas in BC. For example the recent widespread infestation of the mountain pine beetle (*Dendroctonus ponderosae),* which historically has been kept in check by consistently low temperatures in the winter, can be attributed in part to climate change (Davidson et al. 2003). Without the requisite low winter temperatures to kill off the beetles they have been able to destroy swaths of pine forests. This has had an impact on the natural environment, forest industry and fire risk potential in many regions of the province (Stocks et al. 1998).

According to Walker and Sydneysmith (2008), the key impacts associated with climate change in BC are:

- increasing water shortages (which also has implications on electricity generation);
- increasing frequency and intensity of extreme weather and natural hazards impacting infrastructure and people;
- changes in forests, forest industries and forestry dependent communities;

- further stresses on fisheries; and
- both positive and negative impacts on the agricultural sector.

Communities must carefully consider the changes that they can expect to encounter and plan to adapt to them. Communities must also account for the uncertainties associated with climate change by increasing their resiliency to unexpected impacts (Halifax Regional Municipality 2006). There is currently little information available to planners in BC to help them to evaluate what the major regional climate change risks are and what can be done to plan for them. This problem can be attributed to a lack of funding and planning resources as well as a tendency to focus on climate change mitigation rather than adaptation (BC Government 2006).

This research provides information about adaptation in BC from the perspective of planners, and an example of how to begin to explore adaptation solutions using a case study community. Although climate change mitigation has been touted as a more accessible mechanism to deal with climate change, adaptation is an unavoidable reality for that must be seriously considered and planned for. Climate change is going to continue to impose a large impact on communities and natural systems for generations (IPCC 2007a; Hergel and Zweirs 2007). Therefore it is imperative that the planning profession learn how to effectively incorporate climate change adaptation into community planning.

1.2. *Objectives*

The overarching goal of this research is to gain a better understanding of planning for climate change adaptation in British Columbia. Two major research events were

undertaken to fulfill this purpose. The first event was a workshop for planners at the Planning Institute of BC (PIBC) conference. The principal objectives of the workshop were as follows:

1) To educate planners from across BC about climate change impacts, climate change adaptation and climate models.
2) To develop a workshop design that could be used by other communities and organizations as they begin to consider climate change adaptation actions.
3) To generate climate change adaptation strategies for the community of Prince George which can be incorporated into the City's Official Community Plan (OCP) and Integrated Community Sustainability Plan (ICSP).

The second event was a survey of planners in BC and Yukon which addressed their knowledge and experience relating to climate change adaptation. The primary objectives of this event were as follows:

1) To assess the knowledge of climate change adaptation amongst planners in BC.
2) To generate feedback from BC planners regarding their perspectives on climate impacts in communities and across the province.
3) To expose and educate BC planners about climate change adaptation planning.

This study aimed to use the results of both research events to develop a greater understanding of planning to adapt to climate change in BC.

1.3. *Research Approach*

This thesis encompasses an extensive literature review as well as descriptions of the two major research events outlined in the objectives section. The research is qualitative in nature. It characterizes a population of BC planners, and aims to generate new ideas about a poorly defined and understood topic; thus it can be considered both descriptive and exploratory (De Vaus 2002; Stebbins 2001). The principal research methods used were a workshop examining a case study community involving focus groups, and a purposeful and selective survey of planners. A workshop for BC planners was designed that integrated principles of open space and world cafe designs. The event utilized climate models to generate adaptation ideas for the case study community of Prince George. The case study was an ideal approach for this research due to its ability to deal with multiple data types and methods (Yin 1984).

The survey was chosen as a research tool because it is an effective and appropriate method to gather information from a large group of people in a short period of time (Patton 2002). The questionnaire was used to fulfill many purposes in this study. It was designed to characterize the level of knowledge of planners related to climate change adaptation, their experiences with adaptation, the barriers preventing them from incorporating adaptation into their work and their perceptions of climate impacts. The research design of both the workshop and the survey will be discussed in more depth in the methods sections in Chapters 3 and 4.

1.4. *Dissertation Outline*

This thesis dissertation is divided into five chapters. Chapter one has introduced the research topic, given an overview of the research approach and outlined the objectives.

Chapter two provides an overview of the general methodology employed. To put the research into context a detailed conceptual framework with the key ideas are outlined, and the terms are explained in detail.

Chapter three is dedicated to PIBC workshop exercise. This chapter provides background information about the workshop, a description of the methods and an overview of the event. The results of the workshop are discussed in detail. This includes the outputs of the different focus groups as well as a discussion about the efficacy of the workshop, its strengths and shortcomings, and the major lessons learned.

Chapter four describes the climate change adaptation questionnaire, which was administered at the PIBC conference. The chapter includes a description of the methods used and the questionnaire design. The results of the different questions are presented and discussed, and the status of climate change adaptation amongst planners in BC is analyzed.

Chapter five relates the overall conclusions and outlines further research needs and future directions.

Appendices A to D provide information to support the discussions in the main body of the thesis.

2. Literature Review and Methods

This chapter includes a literature review to provide a framework for the research, describe the relevant terminology and outline the existing related research. The literature review provides an overview of climate change, planning for climate change, mitigation, adaptation and relevant community planning mechanisms. This chapter also includes a brief summary of the main methodologies that are employed in this dissertation. Detailed methodologies for each of the two major exercises are included in Chapters three and four.

2.1. *Literature review*

Overview[1]

The evidence that *climate change* is occurring and is related to anthropogenic greenhouse gas emissions is well documented (IPCC 2007a). The *global implications of climate change* are significant and readily observable at the local scale. They pose many problems for communities, regions and governments around the world (Smith and Smith 2009; McLamb 2009). Research shows that the climate related *changes in British Columbia* vary widely throughout the province. However, BC is warming far faster than

[1] The overview of the literature review introduces the key terms and concepts that are relevant to this thesis. These key ideas are identified in italics. A detailed exploration of each of the concepts is included in the subsequent sections of the literature review.

the global average, particularly in the northern regions (Walker and Sydneysmith 2008; Rodenhuis et al. 2009).

Planning for climate change is extremely important, as climate is a key factor that influences most land use planning decisions in a community. Climate impacts communities socially, environmentally and economically in British Columbia and around the world (PCIC 2007; Parks 2007; BC Government 2006; the Federation of BC Naturalists 2006). Effectively responding to climate change involves minimizing communities' greenhouse gas emissions through mitigation, and adjusting to changing systems by *planning for adaptation* (IPCC 2007). Governments must plan to adapt to climate change as they mitigate, as anthropogenic greenhouse gas emissions already in the atmosphere will continue to affect the climate for generations (IPCC 2007; Hegel and Zwiers 2007). There are many attributes associated with adaptation that make it an effective response to climate change at a regional scale (Jacques 2006; Füssell 2007).

A community's *adaptive capacity* is described as its ability to develop and implement effective actions to adapt to changes in the climate (BC Government 2006). To effectively adapt to climate change, *climate change modelling* information is invaluable. This information needs to be clear, concise and available to stakeholders who are tasked with making these important decisions (New Zealand Ministry of the Environment 2008). The research is directed by existing *community adaptation frameworks* that are designed to help communities to develop adaptation strategies. Climate change adaptation strategies can be implemented in *Official Community Plan* and *Integrated Community Sustainability Plan* documents (Bizikova et al 2008).

Detailed overviews of the key terms introduced in the research context are included in the subsequent sections of the literature review.

Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC) (2007a), the average air temperature of earth's surface increased by 0.74 °C over the twentieth century. This temperature rise has had a strong influence on the global hydrological cycle, resulting in significant increases in precipitation in some areas of the world and extreme droughts in others. Increasing evidence shows that most of this temperature rise can be attributed to greenhouse gas emissions generated by human activities and not to natural climatic oscillations (IPCC 2007a). The activities that are primarily responsible for the increased levels of greenhouse gases are fossil fuel production and use, livestock rearing and deforestation (Davidson et al. 2003), all of which are very relevant to Prince George and British Columbia.

There are many statistics from a huge variety of credible sources that provide very strong support for the notion that the climate is changing at an unprecedented and unnatural rate, and that this is affecting more than simply the surface temperature of the earth. Examples of these statistics include:

- eleven of the twelve warmest years on earth between 1850 and 2006 (since detailed records have been kept) occurred between 1995 and 2006 (IPCC 2007a);
- the loss of area / volume, and sometimes complete disappearance, of glaciers from around the world over the twentieth century (Dyurgerov and Meier 2000);

- a substantial increase in great flooding events during the 20th century (Milly et al. 2002);
- an estimated nine-fold global increase in economic losses from natural disasters between the 1960s and the 1990s (Kovacs and Kunreuther 2001); and
- worldwide observed changes in biological functions such as the earlier timing of spring events like plant leaf unfolding, bird egg-laying and animal migrations (IPCC 2007a).

Global Implications of Climate Change

Although climate change is a global issue, its impacts are most readily observable at the local and regional scale (Smith and Smith 2009). Many of the changes that the City of Prince George and the Province of British Columbia (BC) have undergone with regards to climate change are similar to those that communities and regions around the world are experiencing. Impacts such as flooding and forest fires are affecting regions and countries across the globe, resulting in serious direct and indirect long and short-term problems (McLamb 2009).

This section outlines some major climate change impacts at the global level. These impacts are closely interrelated with each other, multifaceted, and complicated by many factors. This discussion is relevant to the City of Prince George and the Province of BC because it provides examples of problems that this region may directly encounter, or be affected by as other regions of the world encounter them. This section provides a global perspective and context within which local climate change actions can be framed.

Food Systems and Security: In 2008, the Food and Agricultural Organization (FAO) formally recognized the implications of climate change on food and agricultural production and supply. As a fundamental pillar in human survival, the threat of negative impacts on food security is applicable to everyone. Climate is described by the FAO (2008) as an integral factor in food performance that affects the quality, types and value of food that is grown. Extreme weather events such as droughts and floods can damage or destroy crops or infrastructure, and affect the transport and distribution of the food supply system (FAO 2008; United Nations 2008). Ironically, other emerging demands such as the market for bioenergy (such as sugar, maize, corn and palm oil) are also competing against the needs of food security. Bioenergy, which is being marketed as a low-carbon fuel and energy source, competes with agriculture amidst rising fuel prices that further compounds problems (United Nations 2008; Laurence 2006).

Health: Another fundamental pillar in human survival affected by climate change is health. Global climate change can affect human health through a range of mediums at multiple levels. Climate change affects regional weather through extremes in temperature and precipitation (Patz et al. 2005). Local factors that are affected by climate change, such as contamination pathways and transmission dynamics, can result in impacts such as air-pollution-related health effects and diseases (McMichael et al. 2003; Martens 1998). Indirect climate change impacts on health include increased cases of skin cancers and water-borne diseases. Direct impacts include storm related injuries or deaths. Water scarcity, which is closely linked to climate change, is also affecting human health and development (McMichael et al. 2003).

Economy: According to the International Monetary Fund (2007), the economic impacts of climate change can be divided into two major categories:

1) Market Category: includes effects on climate-sensitive sectors such as agriculture, forestry, fisheries and tourism. It also includes damage to coastal areas from sea-level rise; changes in energy expenditures (for heating or cooling); and changes in water resources.
2) Nonmarket Category: includes effects on health (such as the spread of infectious diseases and increased water shortages and pollution); leisure activities (sports, recreation, and outdoor activities); ecosystems (loss of biodiversity); and human settlements.

An additional socio-economic impact includes increasing conflicts over how fossil fuels should be managed, allotted and reduced (Newell and Paterson 1998). Also there is the "doubling" up of climate change and economic globalization vulnerabilities in certain regions of the globe. Research shows that poor people in urban and rural areas around the world are more vulnerable to shifts in markets and capital. These poorer residents also tend to live in geographical locations (such as hillsides, floodplains, or arid areas) that are susceptible to climate change impacts, which make them even more vulnerable (O'brien and Leichenko 2000).

Ecosystems: Climate change is influencing all aspects of ecosystems. This includes everything from birth, death, and growth rates of populations, to community structures and the cycling of nutrients. Climate change is directly altering water availability, which impacts the distribution and abundance of plant and animal species (Smith and Smith 2009). Research has demonstrated various changes such as shifts in biodiversity richness

toward the north, sea level rise, flooding, and salinization of lands next to estuaries (Smith and Smith 2009; Currie 2001). While it is difficult to plan for the uncertainties of climate change and its impacts on humans, it is as hard if not harder and even more important to consider the uncertainties of climate change and its impacts on the natural environment (Smith and Smith 2009). This is of particular note as humans are completely reliant on the resources the natural environment provides.

Changes in BC

The response to changes in climate between and within the bioregions of BC has varied significantly based on many different natural and anthropogenic factors (Walker and Sydneysmith 2008). Temperature records reveal that BC has experienced considerable warming trends, with an average increase of 1.2 °C over the past century (Rodenhuis et al. 2009). Northern BC showed the greatest increase with an average warming of 1.7 °C, while interior region temperatures have risen by 1.1 °C, and coastal areas have experienced less temperature increases over this time period (Rodenhuis et al. 2009). These temperatures are greater than the global average and have already been impacting communities across the province. Figure 1 illustrates the warming trends in BC between 1900 and 2004, expressed in °C per century.

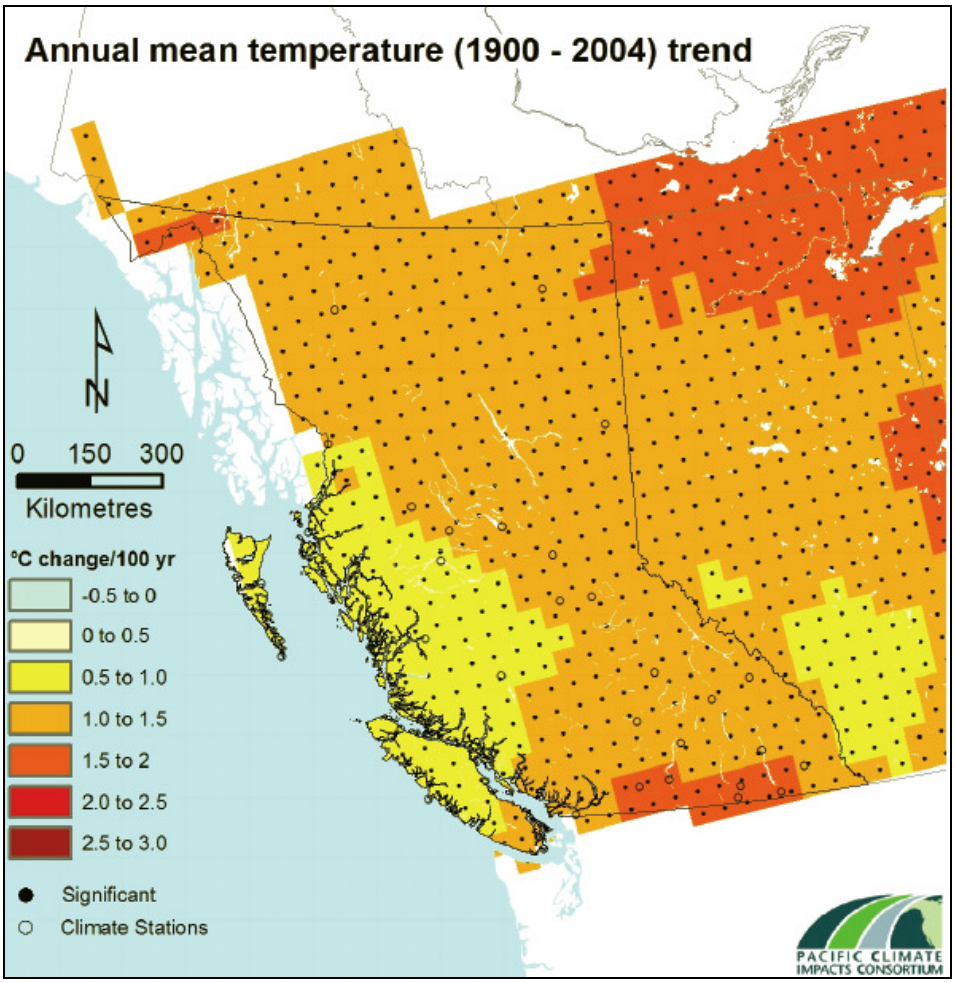

Figure 1 Observed trend in annual mean temperature from 1900-2004, expressed in °C change per century. Black circles indicate statistically significant results. Source: Rodenhuis et al. 2009: p. 18.

British Columbia has undergone considerable changes in its precipitation regime over the 20th Century. These changes are predominantly positive (e.g. more precipitation), but are far less spatially consistent than the changes that have occurred in temperature (Walker and Sydneysmith 2008; Rodenhuis et al. 2009). Figure 2 illustrates the trends in the changes of precipitation in BC from 1900 - 2004, expressed in percent per century. These changes have had major impacts, and affected snowpacks, glacier volumes and streamflow trends across the province (Rodenhuis et al. 2009). There are many

implications associated with precipitation changes and its related impacts that have and will continue to impact communities in BC.

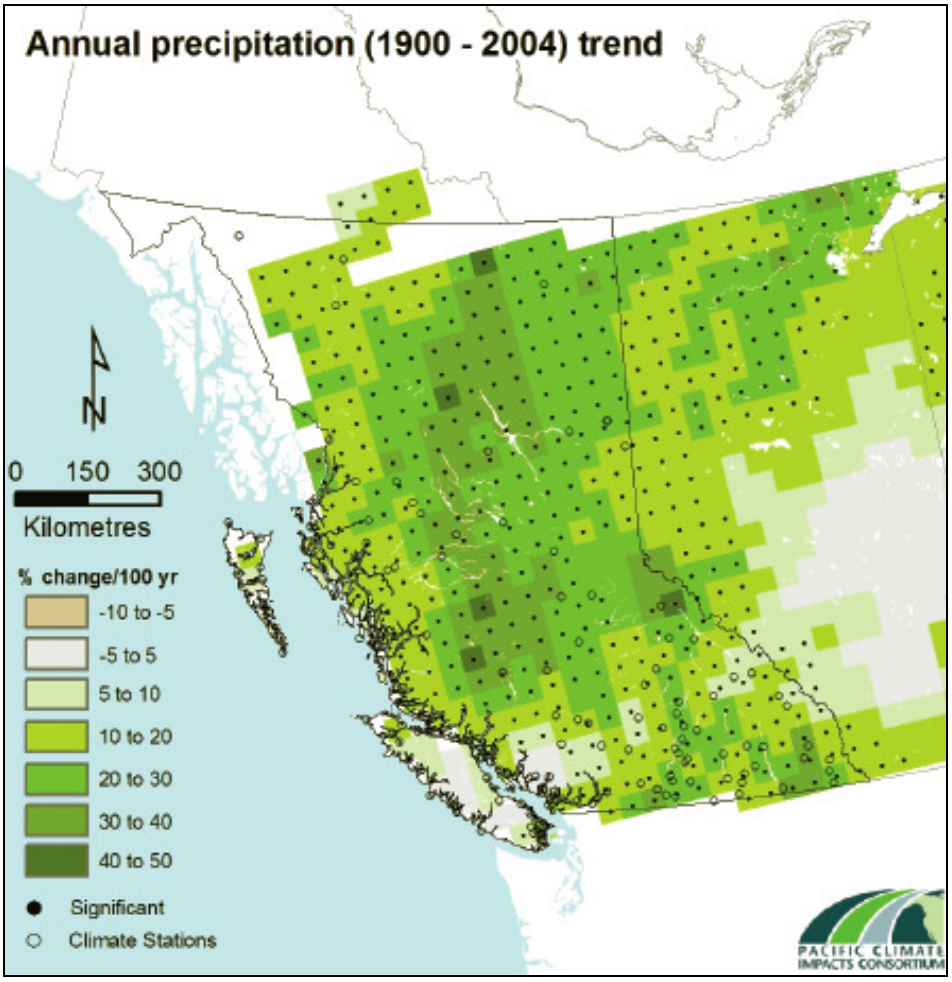

Figure 2 Observed trend in annual total precipitation, expressed in percent change per century from 1900-2004. Black circles indicate statistically significant results. Source: Rodenhuis et al. 2009: p. 18.

Planning for Climate Change

'The real need for community planning arises because people in a neighbourhood wish to improve their environment' (Hodge 2003, p. 3). Community concerns have changed over time, and the planning process has grown to include these concerns. Challenges that people who engage in community planning have and will continue to address include

globalization, safety, cultural diversity, citizen participation, and ecological issues (Hodge 2003).

Climate is a key factor in almost all components associated with community planning and operations, and affects most land use decisions. Canada will continue to experience warming trends and changes in precipitation over the next hundred years regardless of even the most severe mitigative actions (IPCC 2007a). Some of the sectors already affected by climate change in BC communities include water resources, forestry, agriculture, transportation, tourism and health (Walker and Sydneysmith 2008). Planning issues that are affected by climate change and that must be accounted for in community decisions, as outlined in Walker and Sydneysmith (2008), King County (2007), Parks (2007), BC Government (2006), Rodenhuis et al. (2007) and the Federation of BC Naturalists (2006), include:

- energy costs
- natural area preservation
- sea level rise
- severe weather events
- air quality
- inland flooding
- river flows
- stormwater management
- erosion
- river ice and ice dams
- aquifers
- surface waters
- forest fires
- wildlife
- water shortages
- transportation costs
- permafrost degradation
- food supply
- agriculture
- hunting
- tourism
- human migration

- building infrastructure
- transportation infrastructure
- emergency response
- wastewater management
- forest species conservation
- human health
- energy transmission

The IPCC (2007b, p. 6) defines adaptation as 'the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.' This means that adaptation is planning (either reactively or proactively) to account for the positive and negative effects of climate change. Mitigation is defined by the IPCC (2007c, p. 809) as human intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. This means that mitigation consists of actions that reduce the amount of greenhouse gases into the atmosphere, or increase the earth's (including oceans) abilities to absorb these gases.

Climate change adaptation is by no means new, as climate is inherently variable and societies have been adapting to changes throughout all of modern history (Adger et al. 2003). While climate change adaptation has a long social history, communities will encounter conditions and change rates that have yet to be experienced in modern human history (Füssel 2007). However, there are also changes that have occurred in humans' abilities to respond. Modern society now has the knowledge to determine the causes of climate change and to predict the extent of changes. This gives communities the opportunity to plan for and implement more effective and proactive adaptation strategies (Hay and Mimura 2006).

Planning for Adaptation

Historically, more attention has been focused on mitigation than adaptation in the climate change world (Füssell 2007). One major reason is the fact that mitigation reduces all of the long term impacts of climate change whereas there are some impacts that are difficult or impossible to adapt to (such as rising sea levels for small island nations) (Jacques 2006). Mitigation reduces the root causes of climate change problems whereas adaptation depends on the accuracy of models and impact projections. Also, measuring and reducing greenhouse gas emissions is much more straightforward than adapting to uncertain changes in the environment (Füssel 2007).

Over the last number of years the attention has shifted towards adaptation as well as mitigation in climate change research and action. Adaptation is now accepted as an unavoidable reality that communities must seriously consider and integrate into their planning processes. This acceptance comes from the fact and acceptance that climate change will continue to impose a large impact on communities and natural systems for generations, regardless of successful mitigation efforts (IPCC 2007a). Anthropogenic greenhouse gas emissions, already in earth's atmosphere, will continue to result in warming and associated changes for decades (Hegel and Zwiers, 2007).

Although climate change is a global problem with global consequences, adaptation can be an effective response to climate change at a local scale. Some reasons for this, as summarized by Jacques (2006) and Kates and Torre (1998) include:

- Small local organizations can move quickly to influence local adaptation to specific problems whereas large organizations (which are needed for large scale mitigation) move very slowly.
- Adaptation can be created for specific needs of an area which may not be apparent when looking at a larger picture.
- Small scale adaptation may occur 'from the bottom up', with the input and participation of local stakeholders.

Another advantage associated with pursuing adaptation at a community or regional scale is that it provides an opportunity for the public to be engaged in identifying and prioritizing solutions. It serves as a means to begin a conversation about climate change without immediately inferring that people will have to alter their lifestyles. Table 1, adapted from Swart and Rees (2008), provides a summary of the definitions of climate change mitigation and adaptation, and some of their key differences and similarities. For example, adaptation tends to be more focused on dealing with the effects of change, is designed to avoid local damages over shorter time frames and directly benefits the communities that implement actions. This is different than mitigation, which is focused on the primary causes of climate change, is aimed toward avoiding long term global changes and provides no direct benefits to those who implement actions. There are exceptions to these rules, particularly with strategies such as local agriculture, which address both mechanisms simultaneously. Similarities include the fact that both mechanisms are aimed at reducing risks and limited by societal abilities to change.

Table 1 Definitions, differences and similarities between mitigation and adaptation. Adapted from Swart and Raes 2008.

		Mitigation		Adaptation	
Definition		Anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases		Adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderates harm or exploits beneficial opportunities	
Differences	**Issue**	**Dominant focus**	**Examples of exceptions**	**Domin ant focus**	**Examples of exceptions**
	Cause / effect	Primarily addresses causes	Smart growth with low energy needs and low vulnerability	Primarily addresses consequences	Drought resistant bio-fuels can address both
	Spatial scale	Main objective avoiding global changes	Co-benefits for local air pollution, energy security, jobs	Main objective avoiding local damage	Forestry adaptation may have global consequences
	Sectors	Mainly energy, transport, building and industry	Mitigation options in water and land management	Mainly urban planning, water, agriculture and health	Renewable energy sources can be vulnerable
	Time scale	Long-term benefit from avoided climate change	Co-benefits for local air pollution, energy security, jobs	short-term benefit from reducing vulnerability to	Preparing for long term impacts
	Benefic -iaries	Mainly benefits others (altruistic)	Co-benefits for local air pollution, energy security, jobs	Mainly benefits those who implement it (egoistic)	Smart growth, agriculture, water use
	Incent- ives	Usually incentives needed	No-regrets policy (e.g. energy efficiency)	Often incentives not needed	Anticipatory actions without immediate benefits may need incentives
Similarities	Goal	Aiming at reduction of climate change risks			
	Benefits	Has ancillary benefits that may be as important as climate-related benefits			
	Drivers	Driven by availability/penetration of new technology & ability to change			

There are also many barriers that inhibit communities' abilities to implement community and regional scale adaptation measures. Few communities have begun to consider planning for climate change adaptation. This is an inhibiting factor because it is difficult for communities to find nearby examples and models to work from (King County 2007). Another common barrier is financial restraints due to smaller taxation opportunities at a local level. Other barriers include reduced access to technological and managerial capacity and trans-regional obstacles to cooperation (Jacques 2006).

The distinction and separation between adaptation and mitigation can be difficult. Both strategies have the same desired outcome, which is reducing the negative consequences of climate change (Swart and Raes 2008). Mitigation can be considered to be the most effective and reliable method of long term climate change adaptation (Füssel 2007). However it has become clear that climate change is more than simply an environmental problem. It cannot be addressed by only setting environmental targets and timetables, as was done with the ozone depletions problem in the early 1990s (Munasinghe and Swart 2004).

Figure 3, from Cohen and Waddell (2009), outlines the relationships between climate change mitigation and adaptation. There are often trade-offs between the two mechanisms, and one may occur at the expense of another. The figure also illustrates that adaptation and mitigation measures may happen in concert. For example, Smart Growth principles are perfectly consistent with climate change adaptation strategies such as mixed land use and limiting development on natural and sensitive areas (Ruth 2006).

Recent interest in this topic has led to the addition of a new chapter in the IPCC's Impacts, Adaptation and Vulnerability working group report entitled 'Inter-Relationships Between Adaptation and Mitigation' (IPCC 2007d).

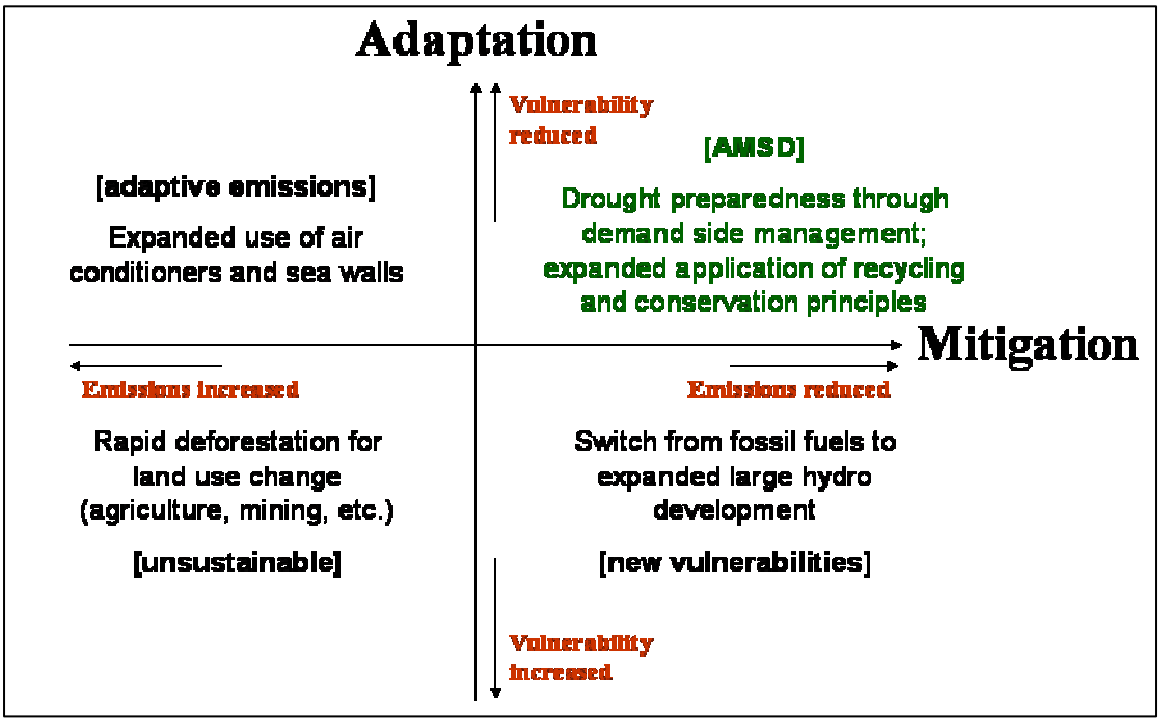

Figure 3 Interrelationships between climate change adaptation and mitigation. Source: Cohen and Waddell 2009.

As Figure 3 illustrates, it is imperative that climate change adaptation measures are consistent and complimentary with mitigation efforts. To reduce the risks of climate change societies must pursue a portfolio of both adaptation and mitigation actions. It is important to consider the inter-relationships between the two, and be aware of trade offs and synergies between adaptation and mitigation (IPCC 2007d). Due to constraints in the scope of this research the coalescence of mitigation and adaptation measures will not be discussed in detail.

Adaptive Capacity

Adaptive capacity can be described as the ability of a community to develop and implement a comprehensive strategy to address climate change (BC Government 2006). This may also be referred to as resiliency. The greater the adaptive capacity of a community, the larger the set of options available to it for implementation (Yohe and Tol 2002). A municipality's adaptive capacity is a function of many variables. Some of these, as outlined in Crabbe and Robin (2006), include:

- the range of technological options available;
- the monetary resources available;
- the structure of critical institutions;
- the human resources and leadership available;
- the ability of decision makers to manage and evaluate information;
- the credibility of the decision makers; and
- the public's perception of the risks that the community is facing.

Other variables may include leadership from within the community and the level of public acceptance about the reality of climate change. Due to its strengths regarding most of the variables listed above, BC has considerable adaptive capacity compared to most of the world (Walker and Sydneysmith 2008). The province is taking a leadership role in climate change planning (particularly with regard to mitigation) and has extensive technological, human and monetary resources available. Within the City of Prince George there are many individuals and groups that have considerable expertise on adaptation and are committed to working toward effective adaptation actions. The

citizens of north-central BC have also been exposed to the effects of climate change first hand with the recent flooding problems and pine beetle epidemic. Although these events cannot be attributed directly to anthropogenic climate change, studies have shown that there are clear linkages between changes in the climate and flooding and pest outbreak events (Milly et al. 2002; IPCC 2007a).

It is important to note that groups at an economic and social disadvantage are particularly vulnerable to climate change impacts (IPCC 2007a). This is relevant for many First Nations and remote communities in the province, and also to homeless and underserviced residents in larger centers. Therefore it is important that larger centres, such Prince George, play a leadership role in addressing this issue. Proactive adaptation plans can serve as an example that other towns and cities can follow as they begin to address climate change in their communities.

Climate Change Models:

Consulting with the people who are affected by actions is a cornerstone of government decision-making. To properly consult with people on decisions related to climate change, stakeholders must have the proper information available to them to understand climate projections, and the risks and uncertainties associated with them (New Zealand Ministry of the Environment 2008). Ensuring that stakeholders have proper information is the responsibility of local and regional governments. This includes ensuring that information is communicated and understood at a local level (New Zealand Ministry of the Environment 2008).

To effectively plan for climate change it is essential to produce detailed climate change scenarios (Mitchell et al. 1999). These assessment scenarios are undertaken to inform decision-making, when planners are faced with an uncertain future (IPCC 2007a). Atmosphere – ocean global climate models (GCMs) are widely accepted as the most reliable mechanism for modelling future climates (Mitchell et al. 1999; IPCC 2001). These models are representations of the climate based on its physical, chemical and biological properties, their interactions, and their feedback processes (IPCC 2001). Global climate models have improved over the last decade, and it is now possible to create high spatial-resolution scenarios based upon the projections from these models. Furthermore, probabilistic characterization of future socio-economic and climate impacts is now becoming available to more accurately model emissions scenarios (IPCC 2007a).

Global climate models compute global weather patterns several times per day projected over past and future time frames. These models are products from geo-spatial grids that overlay the globe and contain the data points for precipitation, temperature, and other climate relative processes. Regional Climate Models (RCMs) present information at a higher resolution and are able to better represent factors like mountains, cloud radiation and land-atmosphere interactions (Kunkel and Liang 2004). Large advances have recently been made in GCM and RCM technologies, and higher-resolution scenarios have become available that allow impact studies to be performed at a community scale (IPCC 2007a).

Community Adaptation Frameworks:

There is a growing body of research aimed at helping communities to develop strategies to adapt to climate change. Some of this is closely related to strategic planning, which

typically implements the concepts of strengths, weaknesses, opportunities and threats to identify and prioritize strategic actions (Bryson 1995). Threats and opportunities are external to the community or organization, and strengths and weaknesses are internal or within the organization. Strategic planning is typically easy to use, and it is applied often to planning scenarios. There are many different versions of strategic planning. To apply it to adaptation in communities one must focus on the ability of the municipality to deal with or respond to the issues (Bryson 1995).

The Adaptation and Impacts Research Division of Environment Canada, in collaboration with the University of British Columbia, have produced a guidebook entitled "Canadian Communities' Guidebook for Adaptation to Climate Change" (Bizikova et al. 2008). This guidebook is designed to assist municipalities as they incorporate climate change adaptation and mitigation into their short and long term plans and operations. It has been referenced extensively when developing the framework for this research. The objectives of the guidebook, outlined by Bizikova et al. (2008), are:

- to assist local decision makers in applying current scientific knowledge on climate change to facilitate actions at the local scale;
- to help communities to promote their sustainable development priorities in a way that accounts for climate change adaptation and mitigation needs;
- to identify the capacity needed to carry out successful adaptation and mitigation actions; and
- to create a network of local cases to facilitate integrated responses to climate change and foster information exchanges.

Other important documents on the subject of community adaptation frameworks were considered in this exercise. A guidebook by Parks (2005) provides an overview of impacts that will affect Canadian communities (with a focus on the eastern provinces) and tools that planners can use to implement adaptation actions. This document overviews the importance of climate change modelling, discusses tools for implementing adaptation measures and provides recommendations to include climate change impacts in land use planning.

There are guidebooks written for local governments by the Australian Government (2007) and the New Zealand Ministry of the Environment (2008) that provide an overview of actions that municipalities can take, and a summary of the risks they are facing in their countries. From Washington State, a climate plan by King County (2007) discusses adaptation in detail, and outlines a decision making framework for using climate information and minimizing climate change impacts in community planning. The City of Chicago (2007) has produced a comprehensive guidebook that includes mechanisms for evaluating climate change impacts, and that identifies priorities for adaptation within the City. The Halifax regional municipality (2006) created a community guide to climate change that includes a general step by step framework for how municipalities can identify and implement adaptation actions.

Official Community Plans and Integrated Community Sustainability Plans

Official Community Plans (OCPs) are also referred to as master plans, general plans, municipal plans and community plans. The OCP is the fundamental component of

community planning. It is a legal document that provides a long range vision for a municipality and manages its social, economic and physical future (Christy 2008).

An OCP provides the criteria for evaluating all of the public and private development in the community, and for making regulations with regard to land use. Zoning by-laws and capital budgets are often referred to as tools of implementation for the community plan (Hodge 2003). City council and staff use the OCP to make decisions about zoning, development and service provisioning. The community residents use it to determine the future of neighbourhoods, and businesses use it to guide their development and growth (Christy 2008).

The purpose and content of an OCP is formally outlined in the Local Government Act of British Columbia, Chapter 323 (BC Government 1996). Section 876(1) of the Local Government Act defines a community plan as,

> *"a general statement of the broad objectives and policies of the local government respecting the form and character of existing and proposed land use and servicing requirements in the area covered by the plan."*

Once an OCP is adopted as a bylaw, all future land use decisions made by Council must be consistent with the objectives and policies outlined in it (Hodge 2003). The policies and land use maps in an OCP are not intended to function as a zoning map, as the Plan emphasizes long-term direction. As a rule, an OCP is reviewed at least once every five years. Once the OCP is adopted, any future rezoning that Council considers must conform to this Plan (BC Government 2006). (There is no requirement for plan to be updated at a regular interval by law. An extreme example was the case of Saint John, New Brunswick, which in 2009 had an OCP that was 30 years old.)

An OCP that is developed with climate change adaptation will provide an umbrella for identifying actions to respond to climate change and help to build a resilient community (Bizikova et al. 2008). The Develop With Care document, created by the BC Ministry of the Environment (2006), provides environmental guidelines for planning, implementing and reviewing developments. The community planning chapter includes a section on adapting to climate change (Section 2.7.3). This chapter advises communities to incorporate adaptation by assessing their vulnerability and considering future changes.

The requirement for OCPs to identify and consider landscape hazards and the encouragement of smart growth principles are examples of how climate change adaptation is beginning to be considered in OCPs (Bizikova et al. 2008). Saanich is a BC community that has incorporated adaptation into its OCP at a cursory level. It has a climate change section that outlines the importance of mitigation and adaptation, and the first policy in the public infrastructure section indicates that the impacts of climate change be considered in long term infrastructure projects (District of Saanich 2008). The District of Elkford and the City of Richmond are both in the final stages of developing OCPs that will include significant adaptation components (M. Daykin pers. comm. 2009; K. Gosal pers. comm. 2009). The presence of adaptation in these documents indicates that it is beginning to be considered in OCPs in BC.

The Integrated Community Sustainability Plan (ICSP) is an initiative in BC that started from the Union of British Columbia Municipalities Gas Tax Agreement (GTA), which began in 2005. This initiative and was designed to tie in with provincial interests to encourage the development of healthier and more sustainable communities and to address climate change. The ICSP initiative was designed to go beyond GTA support and to

encourage partnerships to support community sustainability planning in the province (BC Ministry of Community Services 2007).

An ICSP is a document that builds upon existing planning tools to encourage communities to self-analyze and become more sustainable. The plan is intended to guide the development of all municipal planning, decision making and policies into one decision making framework (Baxter and Purcell 2007). It is designed to embrace certain tenets of sustainability. Some of these, as outlined by the BC Ministry of Community Services (2007), are:

- long term thinking for sustainability and resilience;
- consideration of the environmental, social, cultural and economic needs of a community;
- integration of many different plans to encourage a coordinated approach with the input of various stakeholders (such as First Nations, neighbouring communities, NGOs, the private sector and different levels of government);
- extensive public engagement in the planning process, and public education; and
- a focus on implementation, with monitoring and evaluation to rate progress and continually improve plans.

Figure 4 from the City of Prince George (2009) outlines the range of topics that the ICSP incorporates, and the different strategies, bylaws, reports and systems that fall within its scope. A climate change adaptation strategy is identified in the figure under the environmental stewardship bubble. As noted above, adaptation should also be a component of OCPs (which are included in the land use plan bubble in Figure 4). Transportation, civic utilities and infrastructure, water supply and consumption,

wastewater and forestry are incorporated into this plan. These were all identified as priority adaptation impact topic areas that were discussed during the PIBC workshop (see Chapter 3). Furthermore, a comprehensive climate change adaptation strategy should influence many aspects of social development, such as health and public safety.

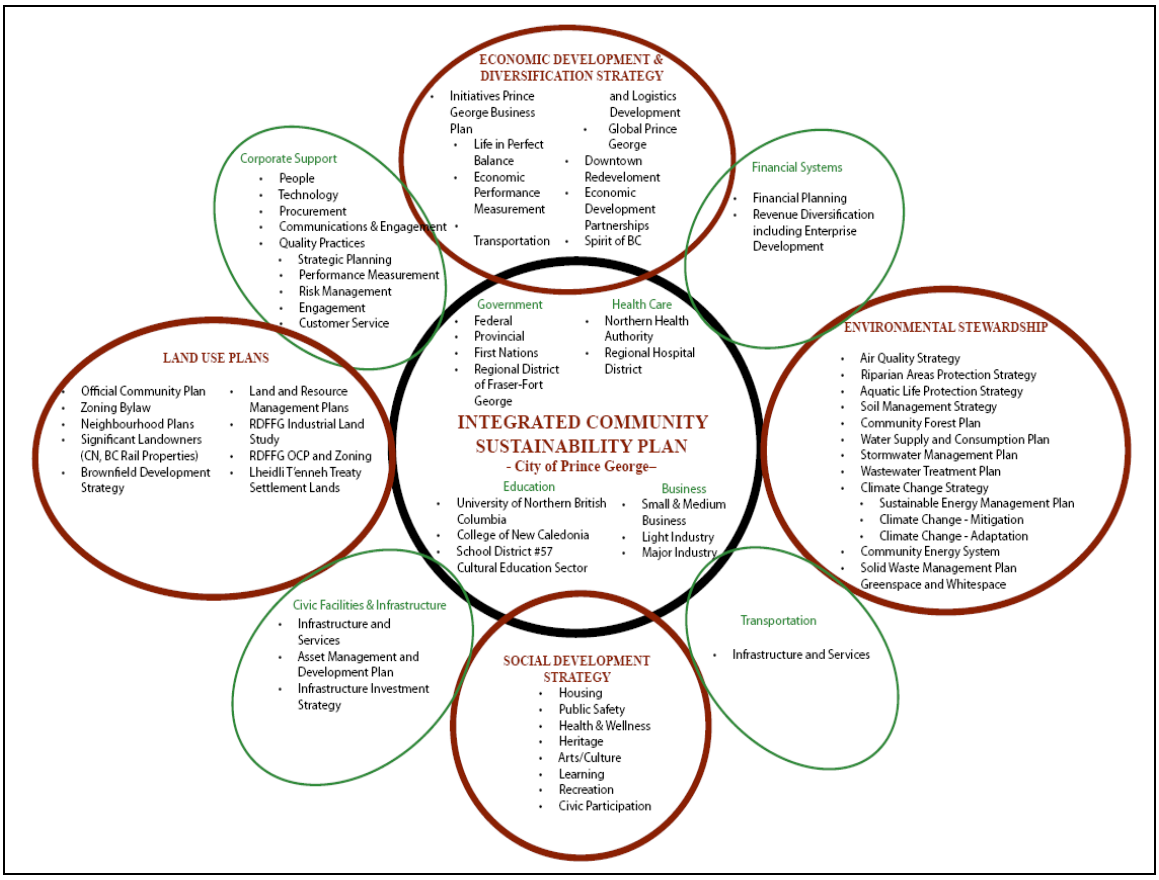

Figure 4 Schematic of the Prince George ICSP. Source: City of Prince George 2009.

Integrated community sustainability plans are ideally suited to climate change adaptation, as effectively planning for and responding to climate change impacts requires coordination and teamwork between many sectors. Whistler BC's ICSP is entitled 'Whistler 2020: Moving Toward a Sustainable Future'. There are some items in this document referring to climate change adaptation, including several statements relating that Whistler needs to adapt to global impacts and take advantage of related opportunities

(Resort Municipality of Whistler 2007). Many of the adaptation actions suggested in the document are related to tourism and climate change.

2.2. ***Methods:***

Different research methods have different strengths. Therefore it is reasonable to conclude that combining multiple methods will produce more comprehensive information than each individual method would in isolation (Morgan 2006; Denzin and Lincoln 2005). It is valuable to incorporate the results of multiple sources of evidence to add validity to the research, given the inevitable strengths and shortcomings associated with single method studies (Jick 1979). Thus, to strengthen the outcomes of this study, two different research designs - a workshop with focus groups and a comprehensive survey - were used to collect data. As different approaches were used for each of the two research events, the methods for each of the research information sources are discussed in the appropriate sections of the following two chapters.

3. Research Project One: Planning Institute of BC Workshop

This chapter provides a comprehensive overview of the Planning Institute of BC (PIBC) workshop exercise. Background information about the event is summarized, and a detailed description of the methods used is included. Results of the workshop are outlined and a discussion about the effectiveness of the event follows. This discussion includes an analysis of the major strengths and shortcomings of the exercise, observations about the participants' levels of interest and engagement, and key lessons learned for future events focused on climate change adaptation. Final conclusions from the exercise are discussed in Chapter 5.

3.1. *Background*

In June 2008, PIBC held its annual conference in Prince George. The conference was entitled 'Planning for Change; Acknowledging the past, preparing for the future', and focused on the role that planners have in addressing and responding to climate change. All four days of the conference were focused on climate change under three sub-themes: 1) form and function; 2) in transition; and 3) First Nations planning.

The University of Northern BC participated in the conference by partnering with the City of Prince George and other groups to organize a workshop focusing on adapting to climate change. The conference participants could elect to attend the full day workshop

on the Thursday of the conference. It was entitled 'Adapting to Climate Change', and had two major objectives:

1) To educate planners about climate change adaptation.
2) To generate discussion about climate change adaptation and innovative ideas for climate change adaptation strategies, using Prince George as a case study.

The workshop began with an overview of climate change adaptation, background information about the case study community of Prince George, and a description of past climate information and future projections for the north-central BC region. The workshop then split into five separate focus groups which discussed different impacts related to climate change adaptation. The five separate focus groups joined into three integrated sessions in the afternoon, and came together to present their conclusions to the entire PIBC conference at the end of the day. The organization of the workshop is discussed in more detail later in this chapter.

Participants were encouraged to arrive with an open mind and prepare for creative problem solving and learning opportunities. They were instructed to focus on the case study community of Prince George, but also encouraged to discuss how ideas can be applied to other communities in BC and Yukon. The workshop was organized by Ian Picketts (workshop organizer), with guidance from UNBC planning professors Eric Rapaport and John Curry and the PIBC conference organizing committee.

Case Study community: Prince George, BC

Prince George is a city in north-central BC with a population of approximately 77 000 (city of Prince George 2008). The main industries in Prince George, in the order of the

number of people employed, are health care and social assistance, retail trade, and manufacturing (BC Government 2009). The average income is approximately four percent above the provincial average, and most individuals and families in the City own their own homes rather than rent (BC Government 2007). Over the past 25 years, Prince George's population has become increasingly stable largely due to the investment in the forest industry. In addition, the urban infrastructure and services have improved within the city limits. Prince George continues to have a number of planning issues, particularly with its downtown and the location of heavy industry in the heart of the city (Llewellyn 1999).

The City of Prince George lies in the Fraser-Fort George Regional District and encompasses a total land area of 316 square kilometres, or 33 000 hectares (BC Government 2009). It is situated just east of the geographical centre of British Columbia: 786 km north of Vancouver BC and 739 km west of Edmonton Alberta (BC Government 2007). The city is situated at 53°53" North Latitude, 122°40" West Longitude, and is at an elevation of 575 metres above sea level in the city centre. The population density is 229 persons per square kilometre (City of Prince George 2008). The average summer temperature is maximum 20.1 °C and minimum 6.8 °C, and the average winter temperature is maximum -3.4 °C and minimum -11.8 °C (City of Prince George 2008).

Prince George is located within the Sub-Boreal Spruce biogeoclimatic zone, which has a climate with extremes in hot and cold weather (B.C. Ministry of Forests 1996). The area experiences snow cover from roughly November to April and thunderstorms are frequent through the summer months, contributing to the considerable fire hazard within the zone. Lodgepole pine (*Pinus contorta*) and trembling aspen (*Populus tremuloides*) are common

pioneer species, with hybrid white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*) as the more common late-successional species (Timberline Forest Inventory Consultants 2006; BC Ministry of Forests 2004).

3.2. *Methods*

Case Study Approach

This research utilizes the case study approach, which is justified on both practical and methodological grounds. Research is considered a case study is if it examines a bounded system or a specific phenomenon (Smith 1978). Case studies are considered the most appropriate method for asking how or why questions about complex social phenomena, and for understanding the role of process and context in affecting change (Yin 1984). A case study design is applicable to certain types of research problems. Some of the factors outlined by Merriam (1998) that are directly relevant to this research are:

- it is difficult to manipulate or control the variables that are in question;
- the research problem requires multiple sources of information to analyze;
- the desired end product of the research is a holistic description and interpretation of a phenomenon, not a quantification of the extent and nature of certain variables;
- the case study analysis can be readily generalized to other situations; and
- the research involves the analysis of multiple factors that are interrelated.

There are many drawbacks to a case study approach: the research provides very little basis for scientific generalization; and it is not easily transferable to other situations and settings (Yin 1989). However, due to the large number of variables that affect climate

change adaptation decisions, the multiple sources of information used, the multitude and complexity of variables and the objective to gain a better understanding of community climate change adaptation, the case study approach is deemed to be the most appropriate method.

Prince George is an ideal community to partner with on climate change adaptation for a number of reasons. The major criteria that make the City an excellent candidate as a case study community for this research are as follows:

- **Commitment to climate change adaptation**: The City has shown a strong commitment to climate change action, and is already a provincial leader in some areas related to climate change adaptation (such as forest fire management).
- **Upcoming OCP and ICSP revisions:** Prince George is reviewing and updating its OCP and is in the process of creating an ICSP in 2009-2010. The City intends to incorporate climate change adaptation directly into both of these documents.
- **Site and Scale**: Prince George is a medium sized city that is situated near the geographical centre of BC. The City is located in the Northern region of BC, which has not been the focus of much climate change adaptation work in the province to date.
- **Vulnerability to climate change:** Prince George already is encountering major natural phenomena that can at least partially be attributed to climate change (such as the mountain pine beetle infestation and increased flooding). The City will be affected by many different impacts, and the senior staff is well aware of the need to start thinking about these impacts and incorporating adaptation strategies into municipal plans.

- **Collaboration with UNBC and convenience:** Prince George and UNBC have a long history of collaboration, particularly with respect to planning activities. Prince George was also the site of the 2008 PIBC conference, and is therefore a convenient case community to be discussed at the workshop.

Workshop Structure

The design of the workshop incorporated elements of world cafe and open space technology. World cafe is a methodology for hosting conversations that link and build on each other as people move between groups. People are able to cross pollinate ideas, and discover new and important insights. World cafe is designed to evoke the collective intelligence of the group, and to increase the ability of the participants to take the information and apply it in effective actions (Brown et al. 2005). Due to the large amount of information about climate change adaptation that the workshop had to cover, the principles of world cafe were not strictly adhered to. People were encouraged to communicate freely and creatively, and participated in a focus group as well as an integrated session. However the participants were not encouraged to move between all of the topic groups, as the workshop agenda was more rigid. Some of the drawbacks of world cafe, as it was applied to this exercise, include that the physical space was not as intimate as is intended and that it was being applied to a group that was not familiar with each other. World cafe design is often more effective amongst groups and organizations where the individuals know one another well (Brown et al. 2005).

Open space technology is an approach to organizing meetings that is based primarily on the idea of peace. Participants are not presented with an agenda, committee or timeline. The onus of planning, facilitation and guidance is placed on the participants (Owen

1997). Because of the specific intended outcomes of the exercises and the intent to incorporate findings of the workshop into further adaptation work with the City of Prince George, the organizers were not be able to incorporate all of the principles of open space. They were not able to allow the style and timeline of workshop be completely open ended, and were compelled to place participants into to specific focus groups. The organizers did, however, strive to create a sense of creativity and peace, and allow for participants to influence the focus of discussion in the different groups (Owen 1995). The facilitators were granted significant leeway in running their groups so that they could allow the focus of the discussion to change in response to the requests of the participants.

Focus Groups

Focus groups were utilized at the PIBC workshop to generate solutions related to specific impact priorities. Focus groups are a method of data collection that capitalize on communication between research participants to generate data. This is a very useful tool to analyze what people think about a subject, as well as how people think and why they think that way (Kitzinger 1994). The focus group method allows people to work together to explore and clarify their views and opinions in greater depth than they could in an interview setting. When there are good dynamics within a focus group, they have the potential to take the research in new directions (Kitzinger 1995). Interactions between the participants can enhance the data, the consistency of views can be quickly assessed and the group nature of the exercise tends to be enjoyable. The process can also be educational for the participants and facilitators (Patton 2002), and support the emergence of a collective intelligence. Furthermore, focus groups are appropriate if the research is in

an exploratory stage. These groups provide an effective tool early in the research process to refine frameworks (Hoggart et al. 2002).

Focus groups were the best method for the workshop because they are a quick and convenient way to collect data for a number of different people at once. With the time restraints of the conference it was not possible to conduct individual interviews from a large amount of people about many different issues. There is the possibility that not all of the people in groups were able to appropriately discuss their views, and there is the chance that groups did not coalesce to produce quality data (Patton 2002).

Workshop Facilitation

Careful planning and proper facilitation is crucial to allow groups to effectively share their ideas and perceptions, and to encourage conversations to flow among the participants (Krueger and King 1997). It is important that the facilitators are well suited to their groups and possess adequate knowledge on the topic to help guide discussion (Stewart et al. 2007). The facilitators of the focus groups were selected carefully to ensure that each group had within it the capacity to facilitate the group, and expert knowledge of the subject being discussed. Two facilitators were put in charge of each group, except for the implementation group which had three leaders. Each group was led by an expert on the impact topic to be discussed, as well as by a representative from the City who possessed local knowledge about the impact and was aware of planning and operations for Prince George. The workshop organizer met individually with all of the facilitators to make them aware of the organization and intended outcomes of the workshop. The facilitators of each group were put in touch with each other and encouraged to meet to discuss the workshop and gain rapport.

It is best that group leaders use a guide to ensure that there is time for the appropriate topics to be covered (Greenbaum 2000). All of the facilitators were provided with a timeline to follow and a detailed list of instructions. These described the tools that were provided including the visions, climate change modelling information and posters. The instruction also included a description of how the integrated sessions were designed to build on the focus groups. Facilitators were given background information to draw upon and prompt questions to ask to encourage conversation if necessary.

Because of the newness of the topic of discussion, the fact that the group leaders were experts in their fields and the desire to maintain the tenets of open space and world cafe workshop design, facilitators were granted considerable latitude in how they chose to conduct their group. They were permitted to use the tools and materials in the way they felt was most appropriate to facilitate good conversations and outcomes. The facilitators were encouraged but not required to fill out the posters and utilize the visions. An overview of the facilitators of each group and their relevant experience is included in the focus group section. A potential drawback of facilitation is that leaders may bias results knowingly or unknowingly by providing cues about appropriate responses and group conclusions (Stewart et al. 2007).

Climate Change Modelling Information

As summarized in the conceptual framework, detailed climate scenarios are essential for effectively planning for climate change. The City of Prince George and UNBC agreed that climate change projections at an appropriate scale for the City would be an important component of the PIBC workshop, and that this information would be valuable for future projects. For this reason the City partnered with Pacific Climate Impacts Consortium

(PCIC) to provide state of the art climate projections for north-central BC. This organization is based at the University of Victoria, and is a global leader in the production and communication of past and future climate information (PCIC 2009).

The Pacific Climate Impacts Consortium was created to assist people in the pacific north-western region of North America to effectively adapt to climate change. According to the vision of PCIC, they are "dedicated to stimulating collaboration to produce practical climate information for education, policy, and decision-making in the Pacific Northwest. The Consortium informs adaptation in both operational activities and long term planning to reduce vulnerability to climate variability, climate change, and extreme weather events" (PCIC 2009).

This partnership led to the creation of a backgrounder booklet that summarized past climate information and future climate projections for the Prince George region. This document was provided to all of the PIBC workshop participants and is included as Appendix A of this thesis. Arelia Werner, a hydroclimatologist with PCIC, presented climate information during the workshop introduction and conclusion, and was on hand throughout the day to answer questions and provide further information.

3.3. *Process*

Participant Selection

Participation in the workshop was limited to PIBC members who elected to sign up for the event, to ensure that the participants were knowledgeable professionals with an interest in climate change adaptation. It was not appropriate to invite specific planners, or create a list of experts to invite by snowballing or another mechanism. This is because

only inviting experts to participate would hinder the educational component of the workshop. It would also be unacceptable to have a workshop that all PIBC members were not invited to be a part of as a component of the annual conference.

A maximum of one hundred participants were permitted to sign up for the workshop out of the approximately two hundred conference attendees. Members of PIBC were provided with a description of the workshop in the conference information package, and could elect to sign up for it in their conference registration form. Response was excellent, and 77 attendees of the conference enlisted in the workshop. Some workshop enlistees did not end up attending due to the busy PIBC conference, which had many meetings and presentations scheduled that conflicted with the workshop. Attendance was still good, and the workshop involved over 50 participants; including planners from across BC and Yukon, adaptation experts, and representatives from the City of Prince George.

Placement of Participants into Focus Groups

Participants were contacted approximately three weeks before the workshop and provided with information about the focus groups and integrated sessions. Based on this information, they were asked to rank the top three focus groups that they would like to attend for the first session (out of flooding & stormwater, water quality and quantity, infrastructure, forests, communication and implementation). If the participants ranked 'implementation' or 'communication' as their first or second focus group choice, they were asked to rank their first three choices of the four other technical groups so that they could join their desired integrated session in the afternoon.

Two reminder emails were sent to participants who did not respond with their rankings. The plan was for most or all participants to be placed into their top focus group choice. Out of the 77 scheduled attendees, 45 responded and indicated their focus group and integrated session preferences. Only one individual ranked the forest impacts focus group as their first choice, therefore this group was cancelled prior to the workshop.

Because not all people who signed up for the workshop attended, and many of the people who attended the workshop did not respond to the requests to rank their group priorities, predetermining the groups was not possible. To rectify this, the groups were explained in the workshop introduction and participants simply attended the session of their choice. (Because at least five of the 45 people who had responded to the ranking request picked each group except forestry, the organizers were confident that a sufficient number of participants would select each group to have a good discussion.). This was different than the initial plan of having approximately eight to 10 people in each group, which is an ideal size for this type of research (Patton 2002). However, this remained consistent with the ideals of open space technology (Owen 1997). The smallest group (Flooding and stormwater) had four participants plus a transcriber and facilitators, and the largest group (Implementation) had 18 participants.

Information Provided to Participants

Information was disseminated to all participants prior to and during the workshop event to set context and to provide educational background materials. This was done in an effort to ensure that the participants had a basic understanding of climate change adaptation, and to provide relevant information so that the groups could discuss adaptation strategies. All participants were provided with the following information:

- **Workshop Overview Document:** Each participant was emailed an overview of the workshop approximately three weeks before the event. This document included a description of the workshop components and background information on each of the focus groups. Participants were to use this information to rank which focus groups and integrated sessions they would like to attend.
- **Introductory Presentation:** The workshop organizer began the day with a thirty minute presentation introducing climate change adaptation and the City of Prince George. Arelia Werner from PCIC gave a brief presentation on past climate changes and future projections, and was available throughout the day for discussion. A summary of the information presented is included in the literature review and the workshop schedule sections.
- **Climate Change Modelling Document:** Participants were provided with the 'Climate Trends and Future Projections for the North-Central British Columbia Region' document, that was prepared by Ms. Werner. Refer to appendix A for this document.
- **Impact Visions:** Each participant was given two visions for the City of Prince George specific to their focus group. These visions were designed to illustrate different scenarios for Prince George in 2050; one in which the City proactively planned and adapted to changes; and a 'business as usual' scenario where the City did not plan effectively, encountered problems, and was forced to reactively adapt and suffer the consequences of changes. Refer to appendix B for the vision documents for the focus groups.

- **Impact Posters:** Posters were created for each focus group to guide and organize the findings of the discussions. Large posters were displayed in each focus group room, and each participant was provided with a small copy of the poster to use as a reference and to write notes on. The facilitators were instructed to use the posters as a guideline for discussion, but were not required to fill them out if the session headed in a different direction. Each poster had background information, strategy types and spaces for groups to list top priorities. Refer to Section 3.4 for an overview of the information provided on the posters and appendix C for copies of them.

Workshop Schedule

The workshop consisted of four sessions, which are outlined in Table 2, illustrated in Figure 5, and described afterward.

Table 2 Planning Institute of BC workshop agenda.

Time	Topic	Facilitators
9:00am - 10:00 am	**Workshop Opening Session:** *Welcome, overview of workshop, background on climate change adaptation and definitions of terms. Overview of past changes and future projections of temperature and precipitation in the PG region.*	Ian Picketts (UNBC) and Arelia Werner (PCIC)
10:00am - 12:00pm	**Focus Group Sessions:** *Flooding & stormwater; Water quality and quantity; Infrastructure; Communication; and Implementation focus group sessions.*	City of PG reps and topic experts
LUNCH		
1:15pm – 2:30pm	**Integrated Sessions:** *Flooding & stormwater; Water quality and quantity; and Infrastructure integrated sessions.*	City of PG reps and topic experts
2:45pm - 4:00pm	**Workshop Plenary Session:** *Welcome to entire conference. Review of key terms, climate information and workshop structure. Presentations from workshop focus groups and conclusions.*	Ian Picketts (UNBC), group reps & Stewart Cohen (Environment Canada)

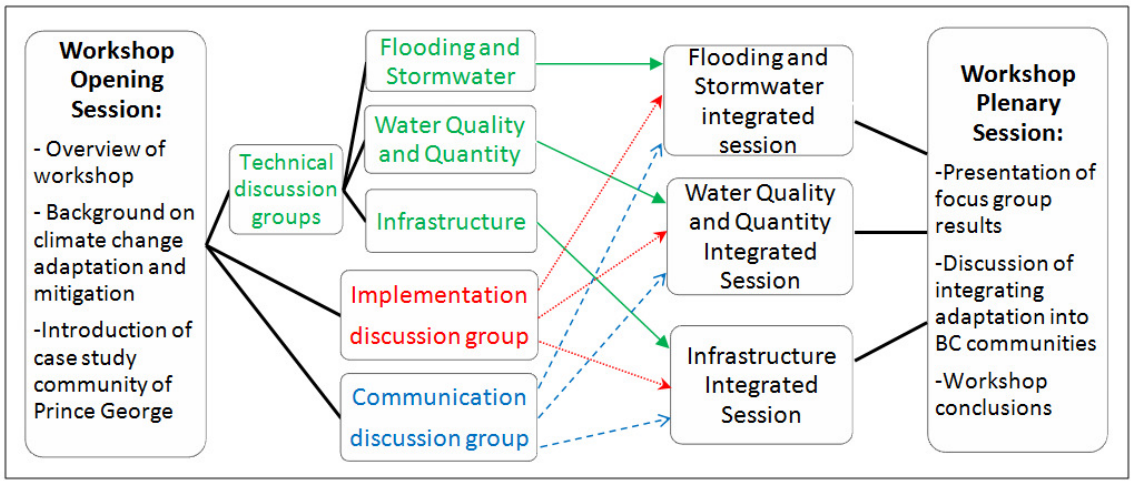

Figure 5 Flowchart describing the four workshop sessions (opening session; focus groups; integrated sessions; and plenary session).

1. Opening Session

The workshop began with an opening session that provided an overview of the day's activities and presented key background information. The objectives of this presentation were to welcome the participants and to provide an outline of the workshop's purpose. The organizer presented an overview of climate change, and the clear definition of and differentiation between climate change adaptation and mitigation. The focus of the days' activities on adaptation was emphasized, although maximizing mitigation co-benefits was encouraged. The workshop objectives were explained and a brief overview of the partnerships between UNBC, PCIC, and the City of Prince George was provided to put the workshop into context for the participants. Definitions of other key terms and facts about the case study community of Prince George were also presented.

The representative from PCIC presented an overview of past climate information and future projections for the region (see Appendix A). This presentation served as an opportunity to communicate the concepts of climate variability, climate change, global and regional climate models, historic climate trends and future climate projections. It also

helped attendees to begin to grasp what the major trends in the region are and what types of changes to the climate are expected.

In the concluding comments of the introduction, the participants were urged to discuss ideas and concepts openly, and encouraged to 'think outside the box' and be creative. This is because communities will experience impacts that they have not seen before with climate change over the next decades. Therefore, new and innovative solutions will be necessary to adapt to these changes. It was expressed that the participants were the experts; as they are the professionals who are witnessing and planning for changes in their communities. Therefore they possess the knowledge to identify and prioritize the different adaptation solutions for communities in BC and Yukon.

2. Focus Groups Sessions

During the second phase of the workshop, the participants broke off into five separate focus groups. These groups were flooding and stormwater, water quality and quantity, infrastructure, implementation and communication. Each session began with introductions by the facilitators, who gave an overview of the topic and shared their personal experiences related to it. This was followed with participant introductions where people stated their names, communities, roles with their community or affiliated institution, and anything about the topic that they were interested in focusing on. This permitted participants and facilitators to gain an understanding of the range of interests and experiences that had come together for each focus group of the workshop.
The local expert facilitator described the present situation in Prince George related to each focus group, and provided an overview of the vision documents. The climate change

projection information provided by PCIC was referenced in the visions to illustrate that the scenarios are plausible under the projected changes. The groups discussed the visions, if they saw their own communities headed down similar paths (that were outlined in either the positive or negative vision), and what was similar and different about their own communities.

During the second half of the focus group session the technical groups explored the specific impacts using Prince George as the case study. They began to consider different mechanisms to address the impacts, and evaluate which strategies would be most appropriate for Prince George. The implementation and communication groups looked at the broader issues and explored the challenges of gaining support for adaptation actions and putting them into practice. The facilitators and participants were encouraged to organize the outcomes of their discussions into the categories on the posters.

3. Integrated Sessions

Following the advice of Dr. Stewart Cohen from the Adaptation and Impacts Research Division of Environment Canada, the format of the workshop was modified so that participants in the non-technical implementation and communication groups could join the technical focus groups in the integrated sessions during the afternoon. This was enabled by adjourning the non-technical focus groups at lunch, and having some members of these two groups join each integrated session. (Refer to Figure 5 for a schematic of the workshop organization.) Participants and facilitators in the technical focus groups remained in the same sessions to continue the discussion. The integrated sessions were:

1) Flooding and Stormwater Integrated Session
2) Water Quality and Quantity Integrated Session
3) Infrastructure Integrated Session

The larger integrated sessions were intended to provide an opportunity for the groups to share their ideas and search for more holistic solutions. These groups continued to build on the morning focus group discussions, but were instructed to reorient their conversations to talk about the issues at a broader scale. Participants were encouraged to examine how the strategies that were identified in the morning can be applied to communities, and how they can be effectively communicated to the public and implemented.

Each session started with a brief overview of the outcomes from the morning by a facilitator of the technical group, as well as summaries from representatives from the communication and implementation groups that had joined the integrated session. The sessions then continued to discuss the impacts, and worked toward identifying strategies to address them. The implementation and communication strategy sections on the posters were supposed to be filled in, if the group had come to any conclusions regarding these strategies. The final 15 minutes of each session was dedicated to determining what information would be presented to the entire workshop in the final plenary session.

4. Final plenary session

The entire PIBC conference attended the final plenary session. The workshop organizer gave an overview of the days' activities for the plenary, and a brief description of community adaptation to climate change. Information about past climate trends and

future projections for north-central BC was summarized. A representative from each group provided the plenary with a synopsis of the key climate change adaptation ideas and strategies that were discussed in the integrated sessions, and in the communication and implementation focus groups.

Dr. Stewart Cohen from Environment Canada gave the concluding statements for the workshop. Dr. Cohen articulated the importance of planning for climate change, and how professionals can no longer rely on the past as a proxy for the future. This means that communities will have to become more resilient to an uncertain future, and planners must take the lead in advocating for this resiliency. He concluded his talk by stressing that the planning community already has the capacity and creativity to deal with this issue, but that action must be taken quickly to address this unprecedented challenge.

Data Collection from Workshop

Each focus group had a graduate or senior undergraduate planning student from UNBC transcribe the session. The workshop organizer met with the transcribers prior the workshop to brief them on data collection, and explain to them the format and objectives of the workshop. The transcribers were asked to help the facilitators to organize the results of their discussions into categories on posters. These categories were developed before to the workshop with input from the focus group facilitators (see Section 3.4). Each focus group was also required to give a short presentation to the entire workshop at the end of the day that summarized their major findings. At the conclusion of the conference, participants were invited to provide feedback from the workshop on the evaluation forms. These forms included seven questions pertaining to the workshop.

Finally, at least one facilitator from each group was interviewed after the workshop to gather more information about out how the individual sessions.

3.4. *Results*

This section provides an overview of the final focus group topics that were selected for the workshop and a brief summary of the key background literature of each group. The solution categories to organize the results of each group - that were included in the posters – are also outlined. A brief summary of the results of the groups is included, and an analysis of the lessons learned from this exercise follows.

Focus Groups Used in Workshop

Initially 12 workshop discussion groups were envisioned by UNBC researchers and the City of Prince George staff members during the conceptualization stages. These were selected from a list of planning issues generated from an extensive review of literature (refer to Section 2.1). The list was reviewed by UNBC researchers, City staff, adaptation experts, and other Prince George stakeholders. A list of impacts and other relevant discussion topics was created which stakeholders felt were most closely related to climate change adaptation in the region. The topics selected were:

- Increased flooding
- Forest issues
- Diminished water supply/quality
- Land stability
- Land use capabilities (such as agriculture)
- Severe weather events

- Building infrastructure
- Transportation infrastructure
- Storm-water management
- Communication of issues
- Health issues
- Climate change modelling

Other important climate change adaptation planning issues in Canada that are not directly applicable to the north-central interior of BC include sea level rise, coastal flooding, permafrost degradation and other severe weather events (such as tornadoes) (Parks 2007).

It soon became apparent that having 12 discussion groups was not reasonable for a single day workshop with one principal organizer. Based on conversations with city staff, academics, and climate change adaptation specialists, the list was narrowed to four technical focus groups that were most relevant to the issues Prince George is currently facing and likely to encounter in the near future. These final focus groups were:

- Flooding and stormwater
- Water quality and quantity
- Infrastructure
- Forest issues (this group was later cancelled due to lack of interest)

Two non-technical groups were included to cover focal issues outside of the scope of specific impacts. These groups were:

- Implementation

- Communication

A brief description of each of these groups and their facilitators (and literature review information about the technical groups) is as follows*:*

A. Technical: Flooding and Stormwater

Group Description: River flooding events are expected to become more frequent with climate change, and existing flood protection works may no longer be adequate to accommodate for more severe and frequent flooding events. This group focused on coming up with creative ideas to deliver planning solutions to the effects that increased flooding will have on communities, and also on managing stormwater better to account for changes brought upon by climate change. The group discussed what information is needed to inform these solutions (i.e. precipitation projections, spring snowmelt projections, river flow rates).

Facilitators:

Stephen Déry, PhD**:** Assistant professor at UNBC and the Canada Research Chair in northern hydrometeorology.

Dave Dyer, P.Eng**:** Chief Engineer of infrastructure with the City of Prince George, and principal City contact during the 2008 ice jam flooding event response and subsequent flood risk assessment study.

Literature Review Summary: The frequency of great floods increased dramatically during the 20th century, and models suggest that this trend will continue (Milly et al. 2002). By examining the great floods from rivers around the world through a pooled study, the IPCC (2007a) concluded that there has been a strong increase in 100-year

flooding events in the last 15 years, and an intermittent increase over the last 35 years. Prince George is potentially affected by flooding from two major rivers: the Fraser and the Nechako. Frequent flooding of the Nechako River over the past two years has had a major impact on the City of Prince George. The Fraser River is at a high risk of open flow flooding, and the Nechako River is more susceptible to experiencing ice jam flooding (Dyer 2006). The scale of the risk of extreme weather events for any city is greatly influenced by the quality of housing and infrastructure in that city and the preparedness of emergency services and the general population (Huq et al. 2007).

Communities must adjust their stormwater management practices to proactively adapt to changes such as higher peak flows during periods of heavy rain, different spring freshets and an increased percentage of precipitation falling as rain rather than snow (Federation of British Columbia Naturalists 2006). Urban areas are at a higher risk of flooding because building and roads infrastructure, and other paved areas, produce more runoff by preventing rainfall from infiltrating into the soil (Holman-Dodds et al. 2003). Fortunately, this increased risk can be mitigated by the provision of adequate storm and surface drainage systems and other measures – such as using parks and undeveloped areas to safely accommodate excess water from serious storms – to protect from flooding (Huq et al. 2007). These strategies can also have important costs savings co-benefits (Watt et al. 2003).

B. Technical: Water Quality and Quantity

Group Description: Climate change will alter the hydrological cycle, and is expected to increase strains on water supplies. Communities must manage their water resources carefully to ensure that they have a sustainable supply of clean water for the future. This

group focused on coming up with strategies to deliver planning solutions for the impacts of climate change on both water quality and quantity. The group discussed what information is needed to inform these solutions (i.e. precipitation, temperature and streamflow projections).

Facilitators:

Stewart Cohen PhD: Researcher with Environment Canada Impacts and Adaptations Research Division with extensive experience working in the Okanagan on water management issues.

Marco Fornari: Manager of the Utilities Division of the City of Prince George and a local expert on water issues.

Literature Review Summary: The IPCC (2007b) projects that water resources in North America will be constrained by climate change. Demand from economic development, agricultural activities and population growth will further limit surface and groundwater availability in many areas within the province. Many regions in the interior of BC have already felt the effects of water scarcity and have been forced to take action in response to the issue (Cohen and Neale 2006). Water shortages are frequently cited as the number one impact associated with climate change that Canadians are concerned about (Swain 2007; Federation of BC Naturalists 2007).

Although precipitation in Canada is projected to increase, studies reveal that a widespread increase in extreme precipitation events will occur. This means that there will also be an increase in drought (Christensen et al. 2007). Groundwater will also be influenced severely with climate change; reflecting changes in the demand and

availability in other sources, recharge rates and surface water interactions (Rivera et al. 2004).

The city of Prince George relies on groundwater for the majority of its water supply. Over 80% of the City's water wells tap into aquifers that are charged by the Nechako River. The maximum future pumping rate from these wells is projected to be approximately 1% of the low water flow of the Nechako River (Golder Associates 2003). This means that Prince George is not facing immediate water shortages. However, this abundant supply is vulnerable to contamination as it does not have a protective layer of low permeability on top of it to prevent pollutants from entering it. Reduction in water demand will slow the movement of contaminants into and through the aquifer, and thus make easier to avoid potential contamination (City of Prince George 2005).

C. Technical: Infrastructure

Group Description: Climate change affects the way transportation and building infrastructure is planned, constructed and maintained. This group focused on exploring creative ideas related to planning building and transportation infrastructure in a way that appropriately considers and accounts for climate change. The group discussed what information is needed to inform these planning solutions (i.e. winter and summer precipitation projections, temperature projections, freezing degree days, freeze-thaw cycle projections).

Facilitators:

Eric Rapaport PhD, MCIP: Acting chair of the School of Environmental Planning at UNBC (at the time of the workshop) and expert on transportation and infrastructure planning.

Glenn Stanker P.Eng: Transportation Manager for the City of Prince George.

Literature Review Summary: Climate change will have a serious impact on the way that buildings are located, designed, constructed, and maintained. A great number of factors that should be considered in the design of a building which are affected by climate change, as outlined by Riley (2000), include:

- effects of wind increases;
- higher temperatures impacting building materials and structural stability;
- heavier rainfall impacting building materials and structural stability;
- increased precipitation loading rooftops;
- indoor air quality issues (particularly in summer) due to hotter, drier temperatures;
- changes to water tables affecting building foundations;
- capacity of buildings to cope with increased instances of flooding;
- increasing risk of fungal attack on timber structures; and
- impacts of increased thermal structure movements.

Climate change will have an impact on transportation infrastructure in Prince George, particularly roads. There are 630 km of roadways and 155 km of sidewalks in the City to maintain (Amec 2006). Some of the potential effects of climate change on roads, as outlined by Dyer (2006), include:

- more frequent freezing and thawing will result in more ice on roads and cause safety issues:
- more frequent freezing and thawing will result in more rapid road surface and road structure deterioration;
- temperature changes will result in an increase in maintenance costs to deal with roads (more salt, pre-wetting, anti-icing etc.);
- greater amounts of salt will increase the toxicity in runoff; and
- more snow disposal sites may potentially be required if snowfall increases.

The effects of climate change impacts on infrastructure will be compounded by aging infrastructure, maladapted urban form and building stock, urban heat islands, air pollution, population growth and an aging population (Mirza and Haider 2008). Proactive adaptation in developed areas is extremely important for avoiding costly retrofits in the future (IPCC 2007a). Riley (2000) proposes that a 'climatic impact assessment' be carried out as part of the planning process for any new infrastructure development.

D. Forest Issues

Group Description: This group was cancelled due to lack of participant interest.

Literature Review Summary: Forest fire risks are expected to continue to increase as a result of warmer temperatures, infestations and summer droughts. The IPCC (2007a) concludes that disturbances such as wildfire and insect outbreaks are increasing and are likely to intensify in a warmer future with drier soils and longer growing seasons. Warmer summer temperatures are expected to continue to extend the window of high fire

ignition risk in Canada, and substantially increase the area that will be affected by forest fires in Canada over the next century (IPCC 2007a).

In 2003 large fires swept through the southern interior of B.C and severely affected many communities. This was the worst summer in recent years for B.C. forest fires, with over 2500 fire starts and an all-time record number of wildland/urban interface fires. The large increase in fuel load in the forests from the recent mountain pine beetle (*Dendroctonus ponderosae*) outbreak has greatly increased the potential for forest fires to cause great damage in the province. This is in addition to the significant social, environmental and economic impacts associated with the outbreak (Filman 2004).

E. Implementation

Group Description: This group focused on discussing the challenges of getting adaptation measures incorporated into the appropriate community plans. These plans include OCPs, ICSPs, corporate plans, management structures and functional plans. People in this group discussed strategies for and potential challenges to implementation. The group then split up to join different integrated sessions during the next part of the workshop.

Facilitators:

Elizabeth Henry**:** Program Coordinator with the Fraser Basin Council specializing in sustainable transportation and climate change adaptation.

Gerard LeBlanc MCIP**:** Planner with Landworks Consultants with more than 15 years of experience working with different groups focusing on project implementation.

Grant Bain MCIP**:** Former Manager of Long Range Planning with the City of Prince George and the current Director of Development Services.

F. Communication

Group Description: This group focused on raising awareness about climate change at all levels including government, industry and the public. The objective was to foster support for adaptation plans. To gain this support stakeholders must understand this incredibly complex and uncertain issue. Adaptation needs to become a much higher priority for officials of all levels of government, local staff, elected officials and the public. People in this group spent the focus group session discussing communication strategies. The group then split up to join different integrated sessions during the next part of the workshop.

Facilitators:

Joan Chess MA, MCIP**:** Sustainability Facilitator for the Fraser Basin Council with extensive experience facilitating, communicating and organizing projects with and for planners.

Brian Frenkel**:** Councillor with the Town of Vanderhoof, and a key contributor to the Climate Vulnerability Assessment for Forest Based Communities project with the district.

Information Included on Posters

The facilitators were asked to work with the participants to organize the outcomes of their discussions into categories on the provided posters. These posters included a summary of the climate change visions, relevant climate information for the group provided by PCIC,

and solution categories to organize the outcomes into (see Appendix C). The solution categories on the different focus group posters are explained below.

The **flooding and stormwater group** organized their information onto separate flooding and stormwater posters. On the flooding poster the strategy categories were: improve flood response; large scale flood protection methods; flood proof infrastructure; zoning; and other. On the stormwater poster the strategy types were: onsite stormwater retention; increase capacity of stormwater; maximize permeability in the city; and other. Toward the end of the session the group was requested to explore the top three short term (~five years) and long term (10+ years) strategies, as well as modelling and information priorities for each category if there was time.

The **water quality and quantity group** organized their information onto separate water use mitigation and conservation of water quantity posters. On the mitigation poster the categories were: reduce agricultural water usage; reduce industrial water usage; reduce residential and municipal indoor water usage; reduce residential and municipal outdoor water usage; and other. On the conservation of water quality poster the strategy types were: encourage development close to existing supplies; minimize potential for groundwater contamination; and other. Towards the end of the session the group was requested to explore the top three short term (~five years) and long term (10+ years) strategies, and well as modelling and information priorities for each category if there was time.

The **infrastructure group** organized their information onto separate building and transportation posters. On the building poster the strategy categories were: flood-proof

buildings; locate buildings more appropriately; design buildings for changing conditions; and other. On the transportation poster the strategy categories were: design roads for more freeze thaw cycles; locate roads more appropriately; maintain roads better; and other. Towards the end of the session the group was requested to start to consider the top three short term (~five years) and long term (10+ years) strategies, as well as modelling and information priorities for each category if there was time.

The **communication** group organized information under: *who* needs to be communicated to; *how* to communicate to them; and *what* needs to be communicated. Toward the end of the session the group was asked to indicate the top communication strategies for Prince George, key ideas to communicate to the integrated session, and key strategies to communicate climate change projections. This group was adjourned at lunch.

The **implementation** group organized information under: vision statements; policy documents; and regulatory enforcements. Toward the end of the session the group was asked to indicate the top ideas for successful implementation, key barriers to implementing actions, strategies to overcome the barriers and key strategies to use climate change projections. This group was adjourned at lunch.

Copies of the posters are included in Appendix C.

Outcomes

Research data were collected at the event in five formats:

1) Focus group posters – Each focus group had posters on which the facilitator was requested to write key results from the group. The posters also served as a mechanism to structure the group and categorize and rank the outcomes.
2) Transcripts from focus groups and integrated sessions – Each group had a note-taker who was familiar with the subject matter to document the discussion.
3) Presentations from focus group and integrated sessions to the final plenary.
4) Feedback from facilitators – at least one of the facilitators from the focus groups was contacted after the workshop for feedback on how their session went, key outcomes of the sessions, and their impressions on the workshop in general.
5) Conference evaluation forms.

Results from Posters

Only the communication group filled in their entire poster. The three technical groups each filled in approximately 60% of their posters, but only the infrastructure group completed the section listing the top strategies and modelling requirements. The implementation group elected to leave their poster entirely blank to allow for the discussion to flow more freely, and recorded notes and outcomes on a separate flip chart. When asked about the posters, most facilitators indicated that it was difficult to direct the conversation toward top priorities in the time frame provided, and that they ran out of time before they could accomplish this. Information on the posters was used to validate the information from the transcripts to form a summary of the results for the focus groups, which is included in Section 3.5.

Results from focus group session transcripts

The transcripts from the focus group sessions were analyzed by basic coding for connection and themes (Berkowitz 1997). When necessary the transcribers were contacted to provide clarification on their notes. The information from the analysis formed the basis of the summary of workshop outputs, which is included in Section 3.5. The analysis showed that there was frequent deviation from adaptation to mitigation, which illustrates that many planners do not have an accurate understanding of climate change adaptation. There was a concern amongst participants about a lack of resources to assist in planning for adaptation. There was a wide range of comments ranging from optimism about communities' abilities to adapt to changes and emphasis on possible positive impacts, to marked pessimism about the future for communities in BC and around the world.

Presentations from focus group and integrated sessions to plenary

The information presented by each of the groups to the plenary was transcribed and reviewed. The presentations reiterated the information that was found in the session transcripts. No major new ideas were presented, and the presentations were generally quite brief.

Feedback from facilitators

At least one facilitator from each group was contacted after the event and asked for their comments on the workshop and their specific focus group in an informal interview. Each leader indicated that their groups had an educational and productive discussion about climate change adaptation related to their topic. Facilitators from three of the groups

noted that it was difficult to keep the participants on track, and that often the group members had a hard time focusing solely on climate change adaptation. This is likely attributable to the newness of the topic and the desire of some participants to discuss mitigation. There was also a general consensus amongst the facilitators that there was not adequate time to discuss adaptation strategies in depth, and to produce refined adaptation ideas and prioritized lists. For this reason most of the posters were only partially filled in.

Feedback from PIBC conference evaluation forms

At the conclusion of the PIBC conference the participants were asked to fill out evaluation forms to comment on their experience. A section on the workshop was included in the form for those who participated in the event. This evaluation was handed out on the final (Saturday) morning of the conference, when many people had already left or were leaving. Therefore not many people filled out the evaluations. Thirteen people filled out the section on the workshop, out of 33 people who returned the conference evaluation form. This is a very small number from a data collection standpoint, but the feedback is valid and warrants discussion.

Participants were asked to rank seven questions from a scale of 1 to 5 about the workshop: with the numbers representing 5 - definitely agree; 4 - agree; 3 - somewhat agree; 2 - neither agree nor disagree; and 1 - disagree. The questions were as follows:

1) Did you find the workshop relevant?
2) Did you find the workshop interesting?
3) Were the workshop objectives generally met?
4) Was there time for questions or comments?

5) Was the length of the workshop appropriate?

6) Was the information gathered summarized in adequate depth?

7) How would you rate the relevance of the topics discussed relative to your occupation?

The data were analyzed through a simple quantification of the responses. Response to the questions was good, and the mean value of the response to all questions was 3.7 out of 5. At the end of the evaluation the participants were asked to list the event or session that most interested them. Three people indicated that the climate change workshop was very interesting to them. The only parts of the conference that received more votes were the Stephen Lewis presentation, a presentation about renewable energy in BC, and a talk about climate change and transportation. This indicates that some people highly valued their experience in the workshop.

3.5. *Outputs*

The data used to provide an overview of the workshop outputs were summarized primarily from the transcriptions. Information that facilitators placed on the posters was considered, but could not be exclusively used because most posters were only partially filled in. A summary of the key impact related results from the integrated sessions was created by reviewing the transcripts from the event and cross-referencing it with the feedback included on the posters. This information was summarized into brief half to full page reports, and then distributed back to the facilitators for review. With the input of the facilitators, the outcomes of the integrated sessions were summarized into a single

paragraph so that they could be reported back to the planning community. The final information reported is as follows.

Flooding and Stormwater: this group concluded that a detailed flood risk assessment needs to be conducted as soon as Prince George is not in an emergency situation. In the short term, the floodplain bylaw must be amended to reflect recent happenings. All levels of government need to communicate more clearly to address flooding issues. All natural stormwater retention areas (such as wetlands and ravines) should be utilized to the greatest extent possible. Increased streamflow and precipitation data (particularly seasonal data) and projections are crucial to inform adaptation plans.

Water Quality and Quantity: this group concluded that all (municipal, residential, agricultural and industrial) water use should be metered and charged at an increasing block rate (e.g. higher rates for excessive use). Surface water, stormwater, and grey-water should be utilized wherever possible to reduce strains on freshwater sources. Prince George should encourage development near existing wells to protect aquifers and reduce costs. To conserve water quality, development should occur in a manner that is sensitive to important groundwater recharge zones. Streamflow and precipitation projections are required to adequately plan for this. The public must be educated to overcome the misconception that there is an infinite supply of clean water in Prince George.

Infrastructure: this group concluded that reducing the overall footprint of the City of Prince George will reduce the amount of infrastructure needed (particularly roads). Costs savings associated with this can be reallocated to building structures that can better withstand more extreme events and freeze-thaw cycles. This strategy also has important

climate change mitigation co-benefits. To inform infrastructure adaptation, a detailed analysis must be performed on future freeze-thaw scenarios and building and paving materials in the north. Provincial building codes must account for long term climate change. The public must develop a greater awareness about the costs of city infrastructure and the benefits of compact cities.

3.6. *Analysis*

Many participants indicated to the workshop organizer and the facilitators that they had a more solid understanding of adaptation as a response to climate change after the workshop. These sentiments were echoed in the focus group transcripts and the conference evaluation forms. The transcriptions and feedback from the facilitators both indicate that it proved to be an effective method to encourage dialogue about this new facet of planning. The final plenary provided an excellent forum to share information about climate change adaptation with approximately 200 planners attending the PIBC conference.

From the workshop evaluations the two questions (out of the seven) that were the most favourably responded to were questions one and seven. These questions were:

- How would you rate the relevance of the topics discussed relative to your occupation?
- Did you find the workshop relevant?

These responses indicate that the participants found the information being discussed relevant to their jobs and the communities with whom they are affiliated. This supports

the conclusion that the workshop was an effective mechanism to raise awareness of climate change adaptation amongst the planning community. It also illustrates that planners in BC are concerned about climate change.

A drawback to group discussions is that all participants may not be able to contribute their opinions, and that discussions are easily sidetracked (Patton 2002). Although these potential pitfalls were minimized by having experienced facilitators with a good understanding of climate change adaptation lead each group, as outlined in Hay (2005), it was clear from the workshop transcriptions and interviews with the facilitators that many groups went off topic repeatedly. The conversation often turned away from an adaptation focus toward mitigation, and focus group participants repeatedly suggested planning solutions that were geared toward mitigation. This is evidence that many planners in BC do not have a comprehensive understanding of climate change adaptation. The workshop also covered a large amount of material and concepts that were closely related to the idea of the 'precautionary principle'. It would be worthwhile to explain this principle and how to apply it in planning to participants in future related exercises, given the uncertain nature of climate change predictions and impacts.

The level of completion of the posters clearly indicates that many groups did not have the opportunity to discuss and explore the full breadth of issues planned for the focus groups and integrated sessions. This is supported in the focus group transcripts, and in the presentations to the plenary which were often narrow in scope. As an example, the water group focused almost entirely on water use mitigation strategies and did not have time to hone in on protection of water supplies in detail. Because the posters were not filled in

consistently, and facilitators indicated that they were not a focal part of the discussions, the information on them was not analyzed in detail to produce adaptation priorities for the City.

From the workshop evaluations, the two questions (out of the seven) that were the least favourably responded to were questions five and six. These questions were:

- Was the length of the workshop appropriate?
- Was the information gathered summarized in adequate depth?

These responses indicate that the participants felt that there was a lot of information to discuss in a short time period, and that there was not time to cover the topics in sufficient detail and depth. This correlates with the feedback received from the facilitators as well as the transcripts and the presentations.

The fact that groups were not able to discuss the full breadth of issues is also closely related to the frequent deviation from the topic of adaptation. Future workshops designed to raise awareness of climate change adaptation should not include directed outcomes (such as adaptation priorities for a community). If these outcomes are desired then a more formal and focused workshop design is necessary. This workshop should involve directing the conversations toward identifying and prioritizing problems and solutions.

In future workshops, participants could focus on adaptation solutions for a specific region more easily if the event was organized specifically for a smaller participant group that was familiar with the community being focused on. This would save a significant amount of time that would be otherwise dedicated to familiarizing participants with the case

study community. Participants would be more invested in the communities in which they live and work, and would be more inclined to work toward creating strategies. These people would also possess better knowledge about the local natural area, and the planning and operations of the community. Local stakeholders are able to offer relevant and insightful suggestions to inform adaptation strategies (New Zealand Ministry of the Environment 2008; King County 2007).

For a workshop taking place outside of a conference setting it would be preferable to have more than a day to complete the exercises. This may include an introductory session on climate change adaptation and a separate priority setting session intended to gather community specific results. Some participants and facilitators expressed disappointment that they were only able to participate in one of the focus groups. This could be ameliorated in other settings by having different impact discussion sessions at different times, allowing for stakeholders to be involved in multiple groups. Many local contributors will have relevant expertise to offer regarding multiple impacts.

One method to begin to interact with a community about climate change would be to start out with a briefing workshop. This type of workshop, conceptualized by Wates (2000), is a short session that is designed to map out future related actions. Stakeholders have a chance to meet and establish the key issues, and people become more interested and engaged in the process. The outcomes of this type of event may include the identification of next steps and the formulation of an agenda for an upcoming event (Wates 2000). It is affirming that an analysis of the results of the workshop yielded a recommendation that was very similar to the briefing workshop, as outlined by Wates (2000). Wates' work was

not studied prior to the exercise. This shows that the results of this research align closely with prominent literature on community planning and public participation.

The exercise was successful in gathering general solutions to different impacts associated with climate change. Although the workshop generated outputs regarding different impacts associated with climate change adaptation, these solutions were not directly applicable to an adaptation strategy for Prince George as they were too broad and general. This is attributable to most participants' lack of familiarity with the City and the region, and the limited time frame of the workshop. The case study aspect of the workshop helped people to focus on specific solutions to address the impacts that they were discussing. However, it also was time consuming to familiarize participants with the case study community of Prince George. Therefore the case study focus may have been detrimental to the educational component of the workshop.

A key positive outcome of the workshop was the educational value it provided for the workshop organizer, the academic experts, and to the facilitators who took part in the process. The exercise also served an important relationship building function among northern practitioners. Without exception, the workshop facilitators that were interviewed spoke highly of their co-facilitators, and expressed an appreciation for being included in the process. The facilitators from the City of Prince George have continued to be advocates for adaptation actions in the community. Each of the local representatives participated in the second City adaptation workshop, and they have all contributed their expertise toward future adaptation planning in Prince George. The workshop organizer and some of the academics continue to be engaged in adaptation research with the City as

well. Hopefully this type of research will lead to more interaction between local government staff that plan for and respond to climate related issues on a daily basis, and academics who study global and community change.

The feedback from the workshop indicates that the climate change modelling information was generally understood and well received. Some of the participants were familiar with the projection information data that PCIC provides and were generally aware of the expected changes to their region over the next half-century. One of the facilitators indicated that the visions were an effective mechanism to put the projections into context. The use of models was educational, and raised planners' awareness of this important adaptation tool. However the time restraints of the workshop led to some of the groups spending minimal time discussing climate models.

4. Research Project Two: Planner Survey

This chapter describes and discusses the results of the climate change adaptation questionnaire that was administered to planners at the PIBC conference. It begins with relevant background information and a description of the methods used and the questionnaire design. The results of individual questions are presented and discussed briefly, and an in-depth analysis of some of the key results follows. Final conclusions from the exercise are discussed in Chapter 5.

4.1. *Background*

The second major component of this research consisted of a self administered climate change adaptation questionnaire of planners in BC. This survey was included as part of the 2008 PIBC conference, which was entitled 'Planning for Change' and focused on climate change (see Section 3.1 for more information about the conference). The conference presented an ideal opportunity to query a large group of planners from across BC and Yukon about their knowledge of and experiences related to climate change adaptation, as well as their opinions on the impacts that will affect their communities and the province. The research helped planners to gain a greater awareness of climate change adaptation by getting them to evaluate impacts and barriers.

4.2. *Methods*

Questionnaire Approach

"There is almost a limitless body of desirable and useful information that can be gathered only by asking people questions" (Fowler 1995, p. 1). A survey was used to ascertain

information from BC planners about climate change adaptation knowledge and strategies. Communicating directly with planners is an effective way of gathering current information about a new issue. This is because many communities' climate change adaptation measures are in the early stages of development and have not yet been incorporated into OCPs and other documents.

According to Gray and Guppy (1999) information from surveys can be used to determine values for a number of questions and to describe complex variables. It can also be used to attempt to describe the relationship between these variables. Analysis of the variables and their relationships provides insight into planning for adaptation in BC, and may assist governments and other institutions as they seek to influence and encourage these types of actions.

Questionnaire design

To get good answers that can be analyzed, good questions have to be asked. Questions must be clear, well worded and carefully thought through if they are to provide adequate data (Payne 1951). Fowler (1995) outlines the five basic characteristics of questions and answers that are fundamental to a good measurement process:

1) The question must be consistently understood.
2) The question must be consistently administered to the respondents.
3) What constitutes an acceptable answer must be communicated consistently to all respondents.
4) All respondents should have access to the information needed to answer the question rapidly.
5) Respondents must be willing to respond to the questions being asked.

These characteristics were all carefully considered in the questionnaire design and administration. How each was considered is described below:

1. The question must be consistently understood.

The survey was reviewed by many external parties to ensure that it was consistently and easily understood, straightforward, clear, and concise (so that respondents could complete it in a timely fashion). The individuals who reviewed the survey, the organizations that they represent, and the insight that they provided, is as follows:

- University of Northern BC professors reviewed the document from an academic perspective. Planning professors Eric Rapaport, John curry, Theresa Healy and Orland Wilkerson ensured that appropriate information was being asked about planners' roles, and that the questions were properly worded so that they would provide rich data. Stephen Déry also reviewed the document and offered input from a climatologist's perspective.

- Fraser Basin Council staff member Joan Chess was able to offer considerable feedback from a planner's perspective. She also drew upon her experience from working on the Council's 'State of the Basin' reports (that provide an overview of sustainability related statistics about the Fraser River basin) to offer feedback regarding which questions would provide the best descriptive information. Elizabeth Henry provided feedback from the perspective of a respondent working for a not-for-profit institution.

- Environment Canada researcher Stewart Cohen used his adaptation expertise to ensure that the terminology used in the survey was consistent throughout the

document and with the current literature. He also assisted in finalizing the impact categories for the survey.

- British Columbia Ministry of Community Services employee Cathy LeBlanc provided feedback from the perspective of a respondent working for the Provincial or Federal government. Ms. LeBlanc also provided feedback on correct terminology for planners and municipalities.

- Pacific Climate Impacts Consortium staff members Trevor Murdock and Arelia Werner were able to draw upon their experience communicating climate information to offer suggestions to improve the wording and format so that it was more easily understandable. They also provided feedback on which impact categories should be included.

- University of Northern BC student Robin Chang provided feedback about the questionnaire from the perspective of a respondent who is a university student.

- The PIBC organizing committee agreed to serve as a 'test group' of respondents for the questionnaire. Planners Tiina Watt, Dan Milburn, Kerry Pateman, Kenna Latimer, Pam Hext, Mandy Stanker and Finlay Sinclair filled out the survey and provided final feedback. Based on the test group's feedback some final changes were made to provide clarity and two questions were removed from the survey.

2. The question must be consistently administered to the respondents.

The questionnaire was administered to the PIBC conference attendees on the first morning of the event. It was printed on bright green paper and folded into a booklet so that the survey could be easily recognized and identified. A copy of the survey and a

pencil was placed on every place setting in the room where breakfast was held on Wednesday June 11, 2008. Conference organizer Tiina Watt held up a copy of the questionnaire and reminded people to fill it out in her introductory speech, and noted that Ian Picketts was on hand to answer any questions.

Generally the conference attendees appeared to be interested in the exercise and eager to be a part of the research. However, they were also sitting down to breakfast on the first day of a large conference and meeting up with friends and colleagues. Several people asked if they could take the survey with them and fill it out on the bus rides during the field trips on the first day of the conference. Although this was not ideal (as some groups would be talking about climate change on the conference field trips) respondents were permitted to take the surveys with them and return them that evening or the next morning.

At the conference dinner on Wednesday June 11, Ms. Watt made an announcement reminding people to return their questionnaires. At this point Ian Picketts provided surveys to a couple of conference delegates who had arrived late, and asked them to return them to the registration area by breakfast the next morning. No questionnaires were handed out after breakfast on Thursday June 12, or accepted if they were returned after this time. This is because on Thursday there was the climate change adaptation workshop and presentations that focused on adaptation. These events were directly relevant to the questionnaire and may have influenced responses.

3. What constitutes an acceptable answer must be communicated consistently to all respondents.

The questions were clearly and concisely stated, reviewed extensively by planning and adaptation experts, and critiqued by representatives from the different response groups. This process helped to ensure that the questionnaire would be consistently understood by the respondents. There were clear instructions for each question asking the survey participants to provide information, circle appropriate answers, or rank issues by circling an appropriate number. Many questions had a space for respondents to indicate other impacts or variables, and to comment on or rank these as well.

4. All respondents should have access to the information needed to answer the questions rapidly.

All of the necessary information was available so that the respondents could answer each question to the best of their abilities. The survey included an introductory paragraph at the top of the first page instructing participants to focus to on climate change adaptation and not mitigation in the survey. The definition of climate change adaptation from the IPCC was provided for planners who were not familiar with the topic. The definition was also clarified in simpler terms and related to community planning. This information ensured that respondents knew the basic concept of climate change adaptation. Because the survey was designed to gain a better understanding of planners' opinions and levels of knowledge associated with climate change adaptation, no further information was provided to them. Participants were also requested to return the surveys promptly (before being exposed to adaptation related events and presentations at the conference that may

influence their responses to the questions) and without discussing answers with their colleagues.

5. Respondents must be willing to respond to the questions being asked.

All survey participants were informed about the purpose of the research, and that participation was voluntary. Participant confidentiality was also assured; no individual results would be shared and the responses would be securely stored until they were destroyed. No individual was forced or coerced into taking the survey.

Sampling Method

The sampling method can be described as purposeful and/or selective. A survey is selective if the researcher is able to choose to involve only a certain group of people to be involved in it (Gray and Guppy 1999). Schatzman and Strauss (1973) state that selective sampling is a practical necessity that is shaped by the time available to the researcher, by his/her framework, by his/her interests (both starting and developing) and any restrictions placed upon his/her observations by his/her hosts. The PIBC annual conference was an ideal opportunity to survey a large contingent of planners at one time, and distributing a survey to people directly yielded a much higher response rate then if it was mailed out (Yu and Cooper 1983). This method is also considerably faster, more efficient and cheaper then distributing surveys by mail or by other means.

Any type of sampling that is directed toward a purpose is considered purposeful (Chambers Dictionary 1983). Patton (2002) describes purposeful sampling in such a way that all types of qualitative sampling fall within its definition. He describes fifteen strategies for purposeful sampling that may be used in different circumstances. The

number of different strategies listed illustrates how complex qualitative sampling is. The underlying principle that is common to all purposeful strategies that is that one must select information rich cases purposefully that fit the study (Coyne 1997). Four of the sampling strategies listed by Patton (2002) that were employed in this research were intensity sampling (e.g. sampling a large group of people in one event), homogeneous sampling (e.g. sampling a group of similar people), opportunistic sampling (e.g. taking advantage of a chance to sample a group of people) and convenience sampling (e.g. using a response group that one has easy access to).

To receive good qualitative data one must survey good informants. These people should be articulate, knowledgeable and willing to share information with the studier. (Morse 1991). In qualitative research, the sample selection has a profound effect on the ultimate quality of the research (Coyne 1997). Surveying the planners attending the PIBC conference ensured that the vast majority of the participants had planning experience. This is because only professional planners and planning students who are members of PIBC or have expertise regarding climate change were invited to attend the conference. The first questions of the survey were designed to ascertain more information about the respondents in order to ensure that they were involved in community planning.

Purposeful/selective sampling by means of a questionnaire was the most appropriate method of data collection for this study. The questionnaire method has many downsides associated with it. There is the possibility that participants did not interpret the questions consistently, and the data from informants are not as rich as information collected during a private interview. Many of the workshop participants likely filled out the questionnaire

as well, so the results from the two exercises can not be viewed as entirely independent. However, due to the many restrictions that the conference placed on the availability of the participants, a questionnaire was the best mechanism to survey the greatest number of planners.

The results from this survey do not meet the criteria of a random sample, and this research cannot be used to produce quantitative results that can generalize with confidence to opinions the general population (Patton 2002). It would be impossible to meet the requirements of a random sample by selecting from the participants of the PIBC conference. This is not important, however, because the research is exploratory and directed toward a specific group of professionals. This method provides rich data from a large contingent of BC and Yukon planners.

Sample characteristics

A total of seventy eight people returned the questionnaire and filled out the majority of the questions. The individual questions were answered by 68 – 78 people. The response rate was lower for the latter questions of the survey. This is most likely because some respondents ran out of time while filling out the questionnaire because they arrived at breakfast late or were distracted while meeting up with colleagues.

4.3. *Results*

The survey questions were designed to gather as much information about climate change adaptation from planners as possible in a short, digestible manner. This section provides an overview of the key questions that were asked, the responses and a brief discussion if appropriate. Further discussion and analyses are provided in the subsequent sections of

this chapter and in Chapter 5. The full questionnaire is included as Appendix D of this document.

The first questions of the survey were created in conjunction with planning professors at UNBC to ascertain information about the planners' roles and responsibilities. Respondents were asked to provide their complete job titles. Out of the 77 people who provided a job title, 55 explicitly indicated that they were some type of planner and eight specified that they were students. Next the participants were asked to:

Please circle the order(s) of government(s) / client groups that you most frequently work with:

Seventy-seven people answered this question, and the results are illustrated in Figure 6. No 'other' groups were selected by more than one person. Note that respondents could select more than one organization, so the responses add up to more than 100%.

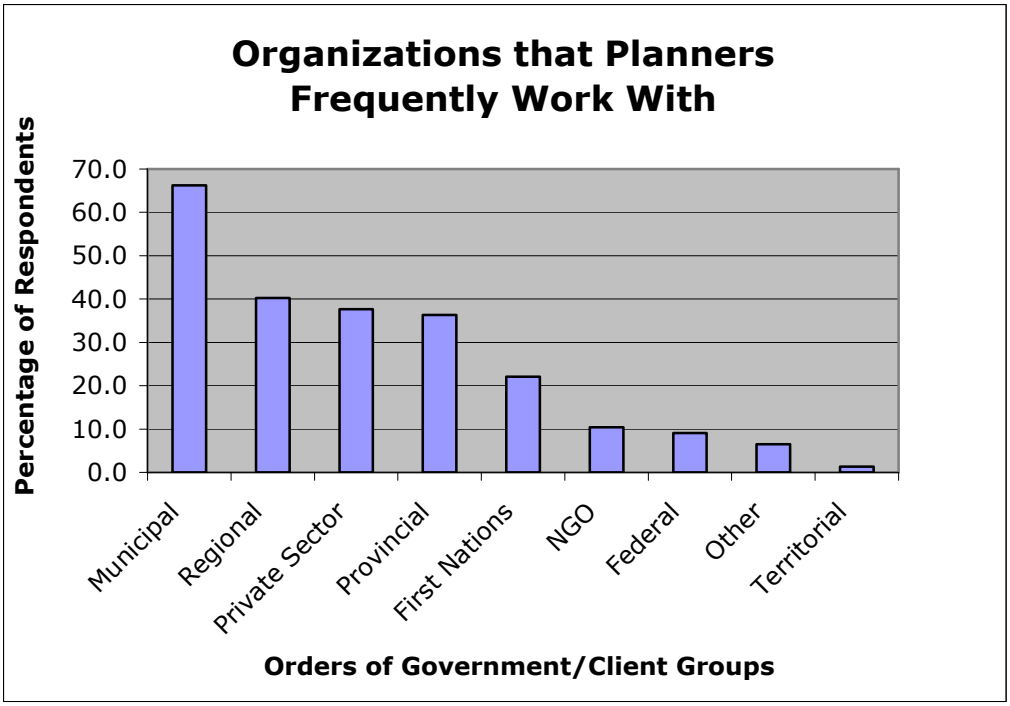

Figure 6 Orders of government that respondents work with.

Next, participants were asked to:

Please circle the type(s) of activities that you most frequently engage in for your job:

This question was answered by 78 people, and the results are illustrated in Figure 7. The categories were created using the material in the Canadian Institute of Planners Professional Practice Manual, authored by Witty (2002), as a guideline. Twenty-one percent of people listed specific 'other' activities that they frequently engaged in. The only 'other' activity that was identified by more than one respondent was build capacity, which was expressed by two people (or three percent of respondents).

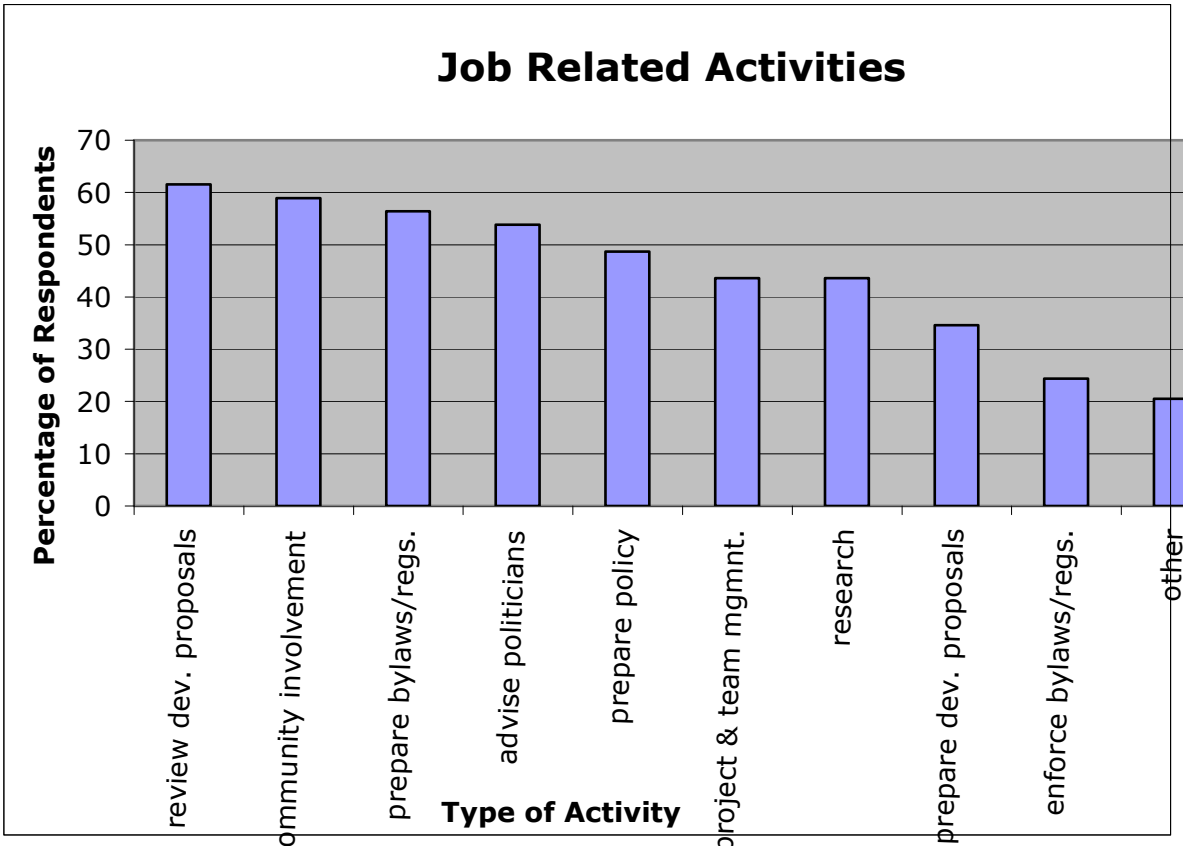

Figure 7 Job related activities that respondents engage In.

The participants were then asked to self assess their level of knowledge of climate change adaptation by responding to the request:

Please circle the number from 1 to 5 that you feel best represents your knowledge of climate change adaptation.

Planners were given the following scale to select from:

1) No knowledge
2) Minimal knowledge
3) Some knowledge
4) Extensive knowledge
5) Expert knowledge

Seventy-eight people responded to this question by circling a number. The responses are illustrated in Figure 8.

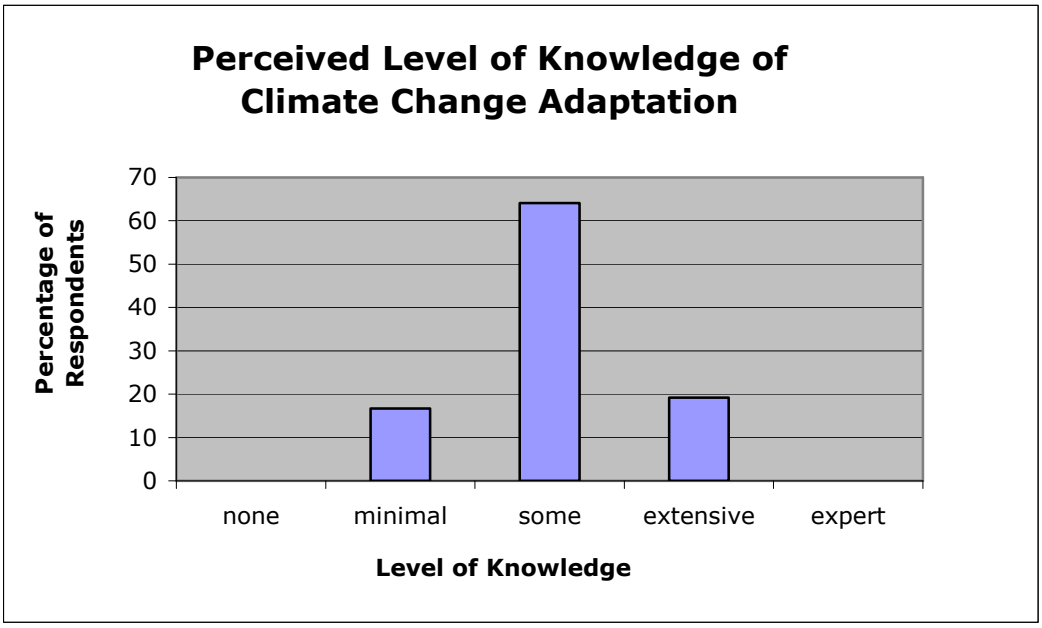

Figure 8 Respondents' perceived level of knowledge of climate change adaptation.

The final question of the first part of the survey asked planners:

Have you been involved in climate change adaptation planning before?

Seventy-seven people responded to this question by indicating either yes or no, and the responses are illustrated in Figure 9.

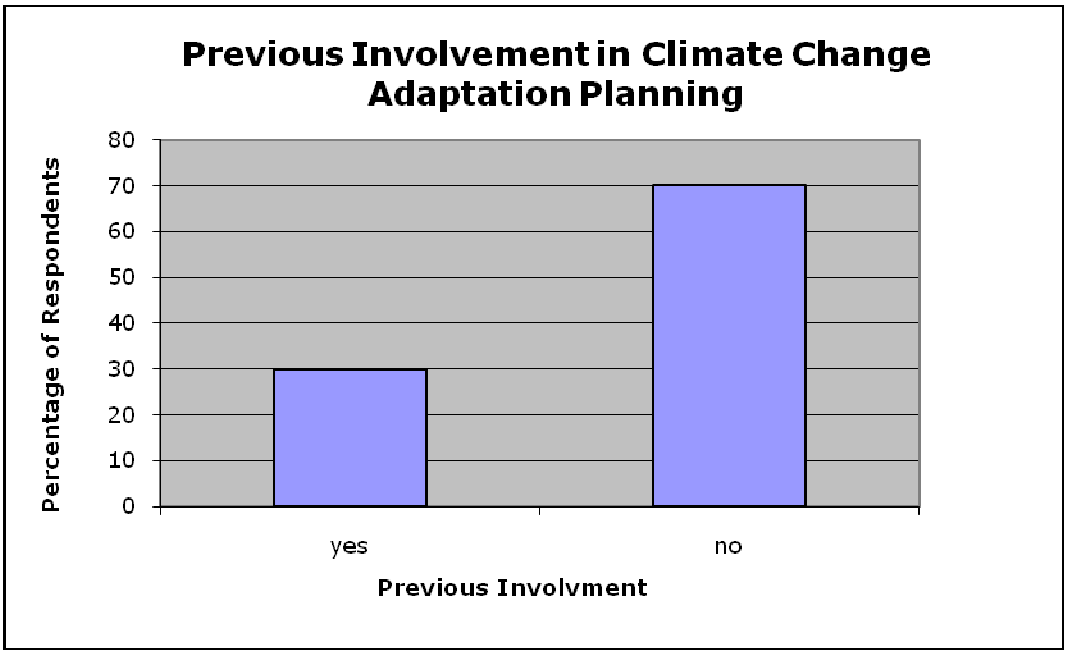

Figure 9 Respondents who have been involved in climate change adaptation planning.

The second section of the survey asked questions about climate change in the respondents' communities. They were asked to indicate their community by responding to the following question:

Which community or region do you most closely work with? (Please indicate the community or region who's planning policies that you are most familiar with. This may be the community that live in, work in, or are otherwise most closely affiliated with from a planning perspective.)

Seventy-one people identified communities that could be located as a city, town or settlement in BC (There were two respondents from Yukon, one from Alberta and one individual simply indicated 'aboriginal community'). The responses to this question are grouped into five distinct regions in BC for analysis, using regions identified by the BC Government (ND) as a guide. The five regions selected represent geographically distinct

areas that had a minimum number of respondents within them. The names of the regions selected for this analysis, the number of participants from them and the area that each encompasses is as follows:

- **Kootenays** – four respondents were from the Kootenay region in southeast BC.
- **Okanagan** – six respondents were from the Thompson / Okanagan region in south-central BC.
- **Islands** – 14 respondents were from the southern islands and coast region of BC including participants from Vancouver island (10 people), the gulf islands (three people) and the sunshine coast (one person).
- **North** – 19 respondents were from northern BC including participants from the Cariboo (seven people), Northeast (five people), North Coast (four people) and Nechako (three people) regions.
- **Vancouver** – 28 respondents were from the City of Vancouver and surrounding areas.

The proceeding segment of the questionnaire included a detailed chart where participants rated different impacts related to climate change. Respondents were asked to evaluate impacts based on how they felt they are currently affecting their community, will affect their community in 50 years, and will affect the Province of BC in 50 years. Participants ranked the impacts using the following scale: 0. don't know; 1. no effect; 2. little effect - no or minimal planning is required; 3. moderate affect that should be planned for; 4. Large effect that should be strongly considered; and 5. Severe effect that needs to be planned for. The impacts that respondents were asked to rank were as follows:

- Forest impacts (fires, composition, disease)
- Increased river flooding
- Sea level rise
- Increase in severe weather events
- Health issues
- Slope stability / landslips
- Water shortages
- Water quality degradation
- Effects to building infrastructure
- Effects to transportation infrastructure
- Effects to storm water infrastructure
- Agricultural affects/changes
- Degradation of permafrost

The impact list was created based on the review of pertinent literature, including Walker and Sydneysmith (2008), King County (2007), Parks (2007), BC Government (2006), Rodenhuis et al. (2007) and the Federation of BC Naturalists (2006). The list was reviewed by UNBC researchers and outside experts from Environment Canada and PCIC before it was finalized. There were also three spaces available in which participants could indicate and rank other impacts.

Seventy-eight people ranked the effects of the different impacts in their communities and in the province by filling out the matrix. A summary of the results of this exercise, including the average (mean) response of all participants who ranked the impact with a number from one to five and the number of people who indicated '0' (or don't know), is shown in Table 3. These results include participants from Alberta and Yukon, and the respondents who did not indicate a community. A superscript 1, 2 and 3 in Table 3 indicates the top three ranked impacts for each column. All of the impacts were predicted to have larger effects in 50 years than they are presently having. Permafrost was ranked as the least important impact in all three columns. The highest ranked current impact on

communities was slope stability. Agricultural changes and severe weather events were ranked to be the highest impact on communities in 50 years, and the biggest predicted impact on the province in 50 years was forests. All but four impacts had a mean ranking of above four (large effect that should be strongly considered) for the effect that it will have on BC in 50 years. The numbers of zero rankings indicate that sea level rise, health issues and permafrost are the least understood climate impacts of the list.

Table 3 Impacts affecting communities and BC.

Climate Change Impact	Effect impact is currently having on respondents community		Effect impact will have on respondent s community in 50 years		Effect impact will have on BC in 50 years	
	Mean Ranking	# of 0 rankings	Mean Ranking	# of 0 rankings	Mean Ranking	# of 0 rankings
Forests (composition, fires, disease)	2.87	6	3.60	6	4.42[1]	1
Increased river flooding	2.87	3	3.62	4	4.19[3]	2
Sea level rise	2.24	18	3.39	14	4.03	3
Increase in severe weather events	2.80	2	3.76[1]	3	4.02	2
Health issues	2.56	11	3.41	9	3.73	8
Slope stability / landslips	2.93[1]	5	3.51	4	3.83	2
Water shortages	2.87	5	3.63	3	4.00	3
Water quality degradation	2.88[3]	6	3.64	4	4.12	3
Effects on building infrastructure	2.4	8	3.13	6	3.59	4
Effects on transportation infrastructure	2.77	6	3.58	3	4.13	3
Effects on stormwater infrastructure	2.85	5	3.69[3]	4	4.05	3
Agricultural affects/changes	2.93[1]	4	3.76[1]	4	4.25[2]	2
Degradation of permafrost	1.75	4	2.15	28	3.15	14

[1] *Top ranked impact*
[2] *Second highest ranked impact*
[3] *Third highest ranked impact*

Following the matrix there were three final questions regarding community responses to climate change. Participants were asked:

Has your community taken proactive measures to begin to consider climate change adaptation?

The results of the 69 respondents who answered this question are illustrated in Figure 10.

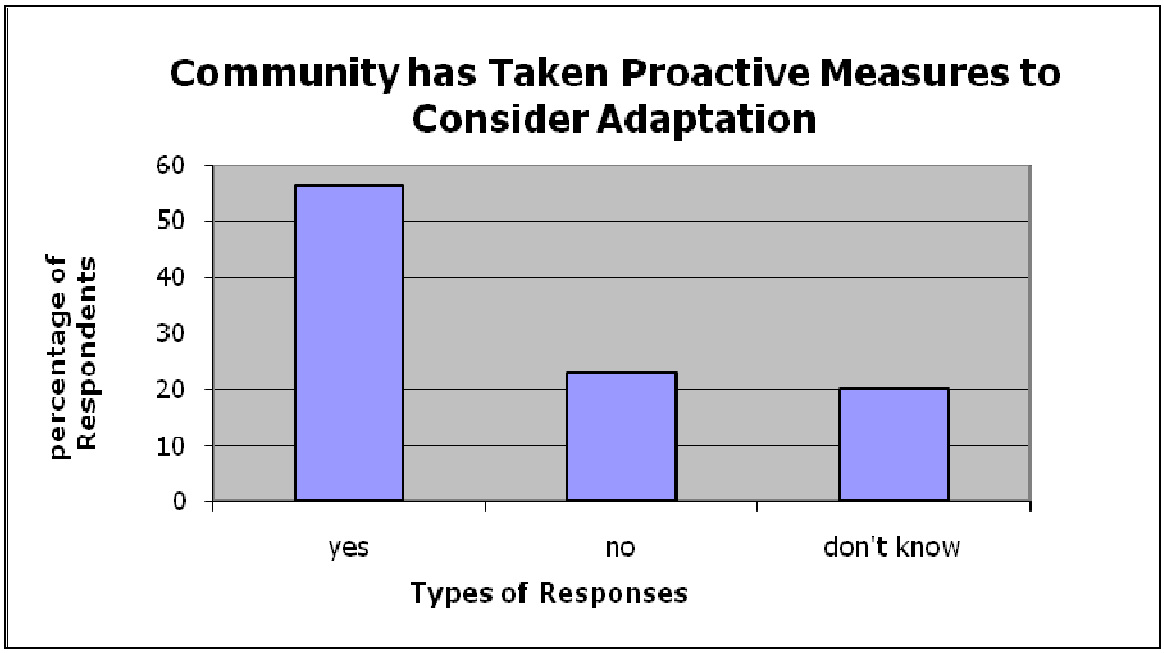

Figure 10 Planners who have been involved in climate change adaptation planning.

Respondents were then asked to rank the barriers that they felt limited their communities from incorporating adaptation in their plans. Participants were presented with a number of potential barriers and were requested to:

Please rank the 3 top barriers that limit your community from incorporating climate change adaptation into its plans by placing the numbers 1, 2 and 3 (1=biggest barrier, 2=2nd biggest barrier, etc) beside the corresponding barrier

Sixty-eight people responded to this question. The number of people who indicated that each of the options was one of their communities' top three barriers is shown in Figure 11. No 'other' categories were indicated by more than one respondent, therefore they are not included in the analysis.

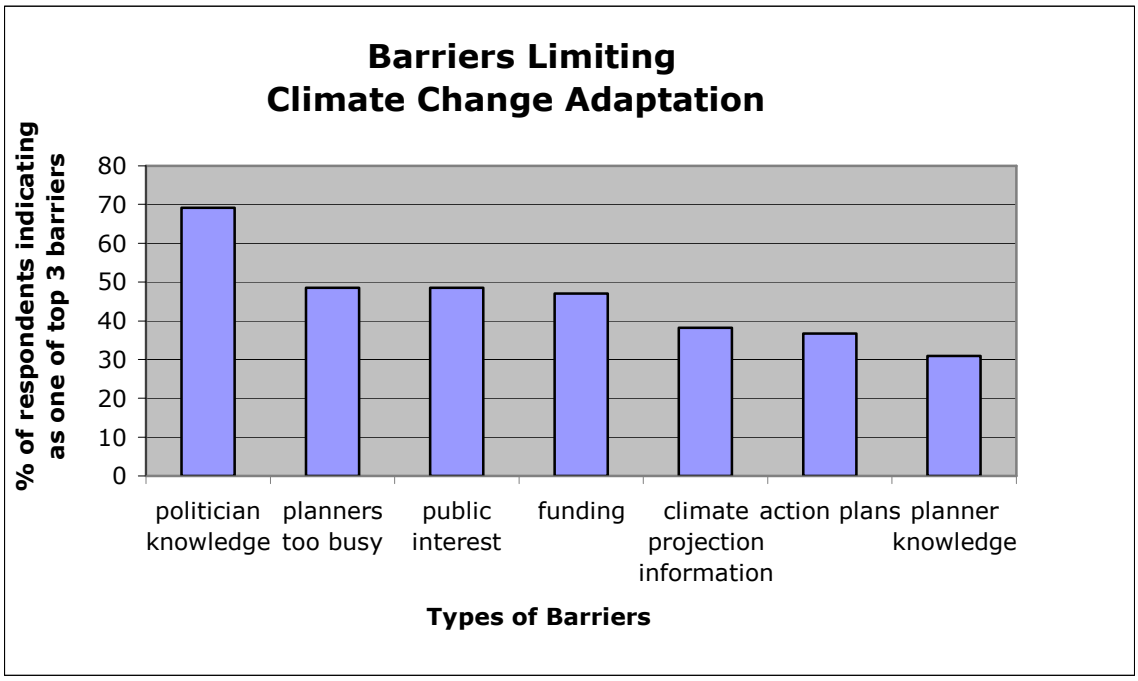

Figure 11 Top barriers that limit climate change adaptation actions.

Finally, participants were asked to indicate where policy actions for community adaptation to climate change should be outlined. Seventy-three people responded to this question, although some individuals did not provide feedback (by indicating yes or no) for all of the documents listed. The number of respondents who indicated that adaptation should and should not be included in each of the listed documents is shown in Figure 12.

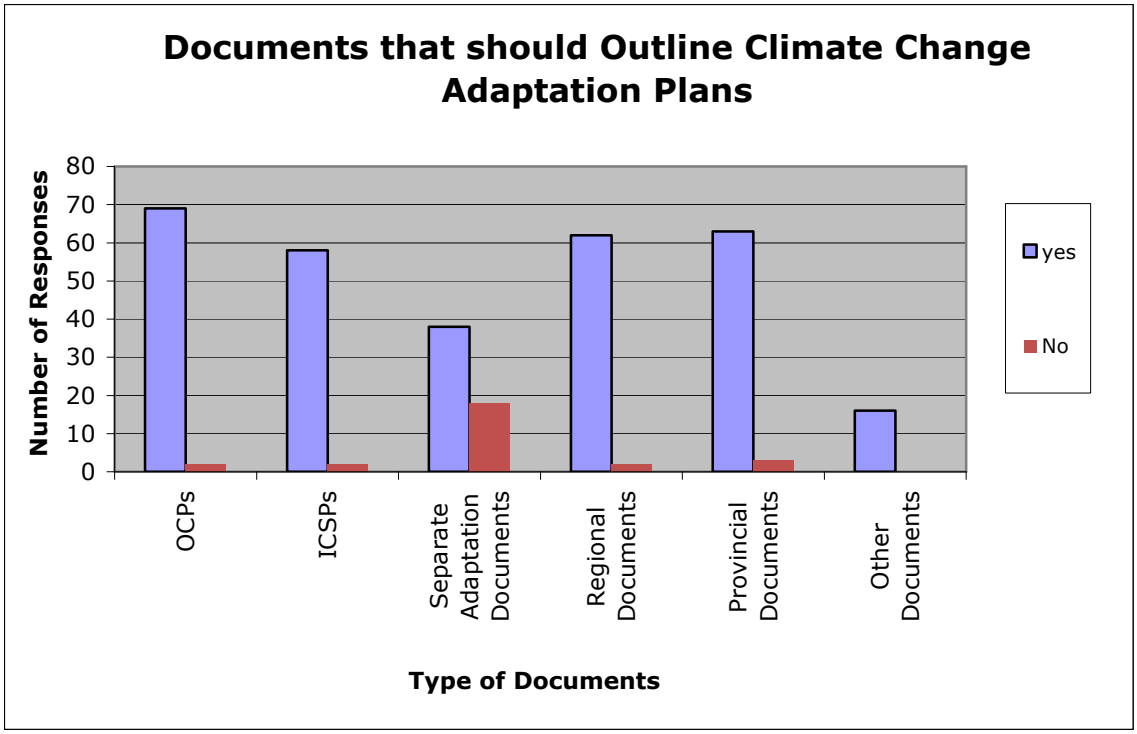

Figure 12 Documents that should and should not outline climate change adaptation actions.

There were 17 'other' suggestions of documents where adaptation actions should be incorporated. These suggestions (and the number of people who identified them) are: neighbourhood plans (two identifiers); First Nations documents (two identifiers); National documents (two identifiers); International documents (two identifiers); energy plans (two identifiers); bylaws (two identifiers); comprehensive community plans (one identifier); street design standards (one identifier); local area plans (one identifier); environmental charters (one identifier); and provincial agency business plans (one identifier).

4.4. *Analysis*

Potential sources of bias of the survey results are that some of the questions were not applicable to certain respondents, that respondents did not properly understand the

questions, and that respondents did not have adequate time to consider the questions fully and complete the entire survey. People who are motivated to attend a conference focused on planning for climate change are apt to have a personal and professional interest in the subject, and more likely to be supportive of, and participate in, a study aimed at increasing adaptation knowledge. Planners who attend this conference are likely to have a higher degree of concern about climate change impacts, and a greater level of knowledge on the topic.

Fifty-five (or 71% of) respondents explicitly indicated that they were some of type planner when asked to provide their job titles. Eight participants self-identified as students, who were all very likely studying planning (many of whom were involved in the conference organization). The other common responses to this question were 'manager', 'principal' and 'professor'. Of the 14 respondents who did not explicitly state that they were planners or students, 11 indicated that they were involved in the local planning processes in their community. This illustrates that the overwhelming majority of the respondents to the questionnaire were practicing planners or planning students. From an information richness perspective, this shows that the results of this survey are representative of a contingent of professional and student planners. The three respondents who did not identify themselves as planners or indicate that they were involved in local planning processes were not omitted from the survey results, because they are likely practising professional planners as well.

The most common orders of government that respondents indicated that they worked with were municipal (66%) and regional (40%). (Note that respondents could indicate more than one order of government, so the results add up to more than 100 %.) Eighty

percent of participants indicated that they worked with at least one of these two orders of government. These results illustrate that most of the respondents are involved in planning at the local and regional level. This makes the information collected very relevant to the issue of community planning for climate change.

The results from question five are very compelling. Out of the 78 participants who ranked their knowledge of climate change adaptation, not a single respondent indicated that they had no knowledge of adaptation (a '1' in a scale of 1 to 5) or that they had expert knowledge (a '5' in a scale of 1 to 5). Nearly two thirds of those surveyed indicated that they had 'some knowledge' (a '3' in a scale of 1 to 5) and roughly equal numbers of people rated themselves as having 'minimal knowledge (a '2' in a scale of 1 to 5) and extensive knowledge (a '4' in a scale of 1 to 5).

The literature on self assessments indicates that people tend to accurately self evaluate if they are competent and experienced. In a synthesized study of 17 articles by Davis et al. (2006), it was shown that the worst accuracy in self assessments among physicians was from the least skilled practitioners. This is consistent in studies of other professions; Kruger and Dunning (1999) found that participants from a range of disciplines who tested in the bottom 12th percentile in several different types of tests estimated themselves to be in the 62nd. A study of university students showed that upper level students in advanced classes had a better ability to evaluate themselves than those in introductory courses (Falchikov and Boud 1989).

The literature indicates that the least competent professionals also have the lowest level of self awareness of their knowledge and abilities. This shows that people with less

competence tend to make poorer decisions, and also do not have the ability to recognize their own shortcomings. The results from this question show that planners were very modest in their self assessments. Many of the people who identified themselves as having 'extensive knowledge' were likely people with considerable expertise on climate change, some of whom would be presenting at the conference on a related topic.

These results indicate that planners in BC were very conservative in their assessment of their own level of knowledge about climate change adaptation. This implies that as a group they are competent professionals who are aware of their lack of knowledge regarding climate change adaptation, and are likely to recognize their own inexperience when engaging in this type of work. Therefore they may be hesitant to initiate adaptation actions in their communities, and be more inclined to seek outside expert assistance.

To explore the levels of knowledge of climate change across BC, the regions that respondents identified where cross referenced with the level of knowledge that they identified. The results of this analysis are illustrated in Figure 13. This comparison showed that there is little variation in respondents' perceived levels of knowledge across different regions of BC. The lowest knowledge levels were recorded from participants from the Kootenays (mean response 2.75) and the highest knowledge levels were from the Islands (mean response 3.36).

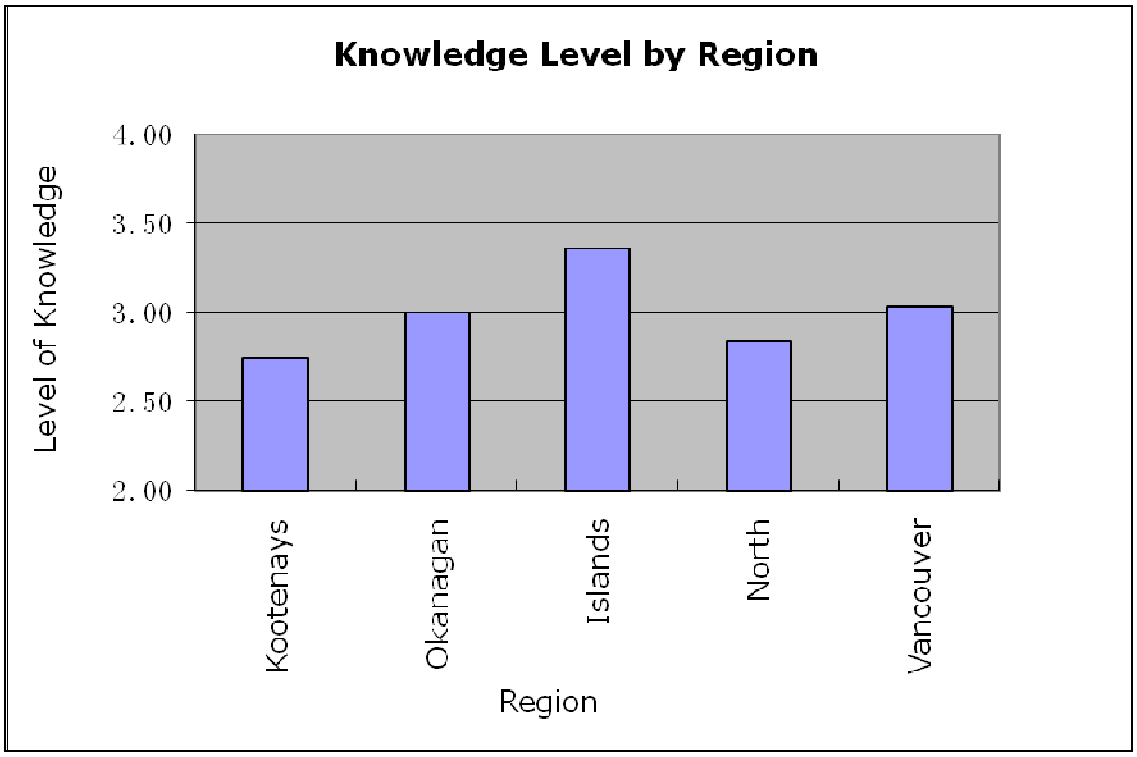

Figure 13 Respondents' level of knowledge cross referenced with their regions.

To determine if participants with different perceived levels of knowledge had dissimilar opinions regarding the impacts of climate change on BC, the results from these two questions were cross-referenced. Table 4 illustrates results of the mean impact effects on BC in 50 years by participants who assessed their knowledge of climate change as minimal, some, and extensive. Responses of '0' or don't know were not included in the mean calculation. The results indicate that participants with a greater knowledge of climate change are predicting that future impacts will be more severe on average. The participants' mean rankings of the impacts that they evaluated for BC in 50 years were compared to their knowledge perception. Only the 69 respondents who ranked at least 10 of the 13 impacts in the matrix were included in this analysis. A chi square test was

performed and the correlation between level of knowledge and ranking was not found to be significant (p = 0.95).

Table 4 Impacts of climate change cross referenced with planners' level of knowledge.

Climate Change Impact	Effect impact will have on BC in 50 years		
	Respondents with minimal knowledge	Respondents with some knowledge	Respondents with extensive knowledge
Forest impacts (fires, composition, disease)	4.18	4.48	4.73
Increased river flooding	4.27	4.30	4.07
Sea level rise	3.75	4.09	4.27
Increase in severe weather events	4.13	3.95	4.40
Health issues	4.11	3.65	4.00
Slope stability / landslips	4.00	3.81	4.07
Water shortages	3.80	4.02	4.42
Water quality degradation	4.30	4.07	4.43
Effects on building infrastructure	4.00	3.43	4.07
Effects on transport - ation infrastructure	4.38	4.15	4.21
Effects on storm - water infrastructure	4.00	4.09	4.21
Agricultural affects/changes	4.00	4.35	4.43
Degradation of permafrost	3.22	3.03	3.38

The results showing the different impact effects on communities by region are included in Table 5. The values in the table are the mean scores from the 71 respondents who indicated that they were from a community that could be located within one of the

regions of BC. Zero (or ‘don’t know’) responses were not included in the mean value calculation. The results of this analysis conform to general expectations about the climate related impacts in different areas of BC. A superscript 1, 2 and 3 in Table 5 beside the appropriate value indicate the top three ranked impacts for each column. These results clearly reflect the location specific nature of climate change adaptation (Bizikova et al. 2008).

Table 5 Effect impacts are having in different regions of BC.

Climate Change Impact	Effect impact is currently having on respondents community					Effect impact will have on respondent s community in 50 years				
	Kootenays	Okanagan	Islands	North	Vancouver	Kootenays	Okanagan	Islands	North	Vancouver
Forests (composition, fires, disease)	3.25	3.50[2]	2.57	3.39[2]	2.32	4.00[3]	4.17	3.67	3.76[1]	3.29
Increased river flooding	2.50	2.83	2.46	3.18[3]	2.80[2]	4.33	3.83	3.08	3.60	4.00[1]
Sea level rise	1.00	1.00	2.64	2.00	2.43	1.00	1.67	4.08[1]	2.00	4.00[1]
Increase in severe weather events	3.00	2.67	2.86	3.00	2.72	4.00[3]	3.50	3.85	3.69[3]	3.92
Health issues	2.67	2.50	2.91	2.59	2.48	3.33	3.20	3.73	3.07	3.65
Slope stability / landslips	3.33[3]	3.33	2.79	3.00	3.00[1]	3.67	4.00	3.54	3.27	3.76
Water shortages	3.50[2]	3.67[1]	3.14[2]	2.39	2.71	4.33[1]	4.33[2]	3.92[3]	3.12	3.67
Water quality degradation	3.33[3]	3.50[2]	3.21[1]	2.63	2.68	4.00[3]	4.33[2]	4.00[2]	3.31	3.59
Effects to building infrastructure	2.67	2.80	2.57	2.60	2.14	3.67	2.50	3.31	3.07	3.35
Effects to transport - ation infrastructure	2.33	2.50	2.75	3.06	2.75[3]	3.33	2.67	3.42	3.53	4.00[1]
Effects to storm - water infrastructure	2.67	3.17	3.00[3]	2.88	2.72	3.00	3.83	3.92[3]	3.40	3.88
Agricultural affects/changes	4.67[1]	3.33	2.93	3.12	2.71	4.00[3]	4.50[1]	3.62	3.75[2]	3.73
Degradation of permafrost	2.50	1.25	1.60	3.50[1]	1.27	2.00	1.50	1.90	3.18	1.71

[1] *Top ranked impact*
[2] *Second highest ranked impact*
[3] *Third highest ranked impact*

The results of the question asking if community members had taken proactive measures to begin to consider climate change adaptation in their communities are very provocative. Fifty seven percent of participants indicated that their communities had taken proactive measures to consider climate change adaptation. This was much higher than anticipated. These responses were cross referenced with the self assessment of planners' knowledge, and the results were as follows:

- Average level of knowledge of respondents who indicated that their community had considered adaptation: 3.1.
- Average level of knowledge of respondents who indicated that their community had not considered adaptation: 2.8.
- Average level of knowledge of respondents who did not know if their community had considered adaptation: 3.0.

These results indicate that there is low degree of correlation between level of knowledge and the response to this question. A chi square test was performed comparing the respondents who indicated yes, no and don't know, and another test was performed only including the respondent who indicated yes and no. As expected, the correlation between level of knowledge and ranking was not found to be significant for either test ($p = 0.95$).

The responses to this question were also compared to the specific communities that people identified in question seven of the survey (not the region). Although it is difficult to make strong inferences based on this comparison due to the small number of individuals representing the individual communities, the results show that there are inconsistencies in the responses amongst planners from the same communities. In the greater Vancouver area two people indicated that their community had not taken

proactive measures, 15 that their community had taken proactive measures, and four did not know. Three people from Prince George thought that the City had taken proactive measures, one that it had not and one did not know. From Nanaimo three representatives indicated that they had taken proactive measures and two that they had not. From both Smithers and Victoria one person answered yes and one did not know. In Williams Lake one respondent indicated yes and one respondent said no. There were also some towns that were consistent in their answers. From the Fraser Valley both respondents indicated yes, from Kitimat both respondents indicated no and from Whitehorse (in Yukon) both respondents did not know.

After scrutinizing the question it is apparent that it was not well formulated. There is a great deal of ambiguity in the statement 'proactive measures to begin to consider climate change adaptation'. Many different actions may or may not qualify as proactive adaptation measures depending on the evaluator. This ambiguity was likely a key factor in the wide range of responses. However, these responses also indicate that there is not a high level of awareness of climate change adaptation in the planning community.

Politician knowledge was by far the top barrier that planners indicated limited their communities from taking adaptation action. Sixty-nine percent of respondents indicated this as one of their top three barriers, and 35% chose it as the top barrier. Interestingly, fewer respondents indicated planner knowledge as a barrier than any other barriers listed. This is surprising considering the modest self assessments of the respondents' knowledge of climate change (as illustrated in Figure 7).

The results from the final question indicate that most planners think that adaptation strategies should be outlined in OCPs, with 69 out of 71 (or 97% of) participants indicating yes to this question. Significant numbers of respondents also selected Provincial documents, Regional documents, and ICSPs. Although a smaller number of people identified yes in response to these documents than the OCP question, at least 95% of people who responded to each selected yes (e.g. fewer participants responded to these questions). The only document that a significant number of respondents indicated that adaptation actions should not be included in was separate adaptation documents.

5. Conclusion

The final chapter of this thesis provides an overview of the key outcomes from the two research initiatives. Based on the results, conclusions are made and future research needs and key information gaps are discussed.

Climate change is happening, and is changing how communities must be planned (IPCC 2007a). Planners in BC must proactively consider the impacts of a changing climate on the cities, towns and settlements in the province. Using climate information from the past alone is no longer an appropriate baseline from which to plan the future, and communities must be prepared for climates that they have not experienced before (Bizikova et al. 2008). The purpose of this study was to explore climate change adaptation planning in BC. This was accomplished by reviewing the literature, executing a climate change adaptation workshop and surveying professional planners.

There are many valuable lessons to be learned from the PIBC workshop that can be applied to similar future exercises. An open-structured style of workshop is an excellent method to educate participants on the subject of climate change adaptation and to stimulate conversation on the topic. Incorporating world cafe and open space concepts allowed for the participants to explore the key concepts related to adaptation and general ideas for strategies. An event such as this is an ideal way to introduce the subject of climate change adaptation to a group of planners and to begin to identify priorities for addressing the impacts. Focus groups are an effective method to facilitate conversations about the impacts of climate change in communities. It is helpful to have facilitators that

have topical expertise and local knowledge on the subject lead the groups. The plenary session provided an educational opportunity about adaptation for the conference participants who were not involved in the workshop. This type of event can serve as a template for communities, planning organizations, and other groups to begin identifying and prioritizing solutions to climate change impacts in their regions.

Educational events about climate change for planners should incorporate future climate scenarios (most likely generated by global climate models), as they are an integral tool to direct and inform adaptation solutions (Mitchell et al. 1999). If possible, a person with expert knowledge regarding future climate projections should be present at the event to explain the data and to answer questions. This will assist planners and other professionals in when they are tasked with utilizing projection information in planning, and communicating this information to the public in an understandable manner. The public needs to understand future climate information to properly engage in climate change adaptation actions (Government of New Zealand 2008).

The priority physical impacts for Prince George selected to be discussed in the focus groups during the workshop were:

1) Flooding and stormwater
2) Water quality and quantity
3) Infrastructure
4) Forest issues

This list of impacts groups was created by extensively reviewing the literature (see Chapter 2). The priority impacts for Prince George were selected from the literature with input from academics, City staff and other local stakeholders. Lack of participant interest resulted in the forest issues group being cancelled prior to the event.

One of the major limitations of this exercise was that groups were not able to discuss the issues in sufficient depth so that they could start to envision adaptation solutions. It is clear that a more directed workshop approach should be employed if the goal is to outline workable adaptation strategies. This is because long range planning issues and climate predictions are uncertain and complicated. Therefore, the discussion requires a highly organized process to inform complex community adaptation strategies and solutions. An adaptation strategy must allow for revalidation and flexibility. These plans must also be revisited frequently to make sure that they are effective, and modified to respond to actual (not projected) changes in the climate (Australian Government 2007).

If the participants do not have a solid understanding of climate change adaptation prior to a workshop event, then the objectives of an initial meeting probably should not include strategy idea development. Organizers could host a separate event such as the briefing workshop outlined by Wates (2000) before the main workshop to build internal capacity and establish goals; however it would be difficult and time consuming to gather together decision makers and local experts for two separate workshops. A highly organized single event could both build internal capacity and result in meaningful outputs that can feed into an adaptation strategy. For such an event it would be preferable to interact with stakeholders from a single community, region or organization in order to ensure that the

participants are knowledgeable about the case study community. Based on the feedback from the PIBC workshop, a second workshop was planned for Prince George staff. These ongoing activities are briefly explained in the future research section.

Participants felt that the workshop was relevant to their jobs, and showed concern about climate change impacts in communities. The participants in the workshop, the organizers and the facilitators all indicated that they developed a greater understanding of climate change adaptation from the workshop experience. A key outcome of the event was the creation of valuable partnerships. Many of the people who came together for the workshop are still involved in adaptation research with the City of Prince George.

Although the participants did not have time to discuss the full breadth of the issues related to their topics, they produced many creative ideas for the case study community of Prince George that the City can use to begin to plan for climate change. A summary of the key outcomes is as follows:

1) The City needs to conduct a detailed flood risk assessment. All natural stormwater retention areas should be utilized to the greatest extent possible in order to mitigate river flooding and accommodate more severe precipitation events.
2) Prince George should meter and charge all water use, and work to educate residents about the importance of conserving water supplies and protecting vital aquifers from contamination.
3) Constructing fewer roads and buildings can save the City money which can be reallocated to creating infrastructure that is more resilient to changes in the

climate. This strategy will also result in important climate change mitigation co-benefits.

4) Detailed projections and modelling information is necessary to inform all of these strategies.

The workshop and the questionnaire exercises both indicated that planners do not currently have a high level of knowledge regarding climate change adaptation. This was most evident from the self assessment of planners' knowledge in the survey. Nearly two thirds of respondents indicated that they had 'some knowledge' of climate change adaptation, and not a single respondent indicated that they had 'expert knowledge'. It is worth noting that this prudent self assessment indicates that planners in BC (as a group) are likely competent professionals who are aware of and apt to acknowledge their own strengths and weaknesses. Perceived knowledge level did not vary considerably by region in BC. Participants who indicated that their communities had conducted adaptation planning before did not indicate that they had a significantly higher level of knowledge on the subject.

Other outcomes from the research reveal that many planners in BC do not fully understand what community adaptation means. Participants in the survey did not consistently specify whether or not their communities had begun to consider climate change adaptation measures. Although this inconsistency can be partly attributed to a poorly framed survey question, the responses indicate that planners do not have a strong grasp of adaptation. A lack of understanding about the subject was apparent in the workshop exercise as well. In this exercise many focus group participants frequently

deviated from the topic of adaptation, and repeatedly discussed climate change mitigation strategies. This shows that many planners in BC are not currently aware of what climate change adaptation is, and how it differs from mitigation.

Jick (1979) and Denzin and Lincoln (2005) indicate that multiple methodologies which yield similar results strengthen research. Therefore the fact that the two separate research events both indicated that that planners in BC do not have a high level of knowledge of climate change adaptation reinforces this conclusion. Some planners participated in both research events, therefore the results from the two exercises should not be viewed as entirely separate. However, it is not uncommon to perform two independent studies on a similar population within one study in order to yield stronger results (Denzin and Lincoln 2005).

Planners indicated that politician knowledge is the greatest barrier limiting climate change adaptation action in British Columbia, and did not feel strongly that planner knowledge was a top barrier to adaptation. Workshop participants felt that effectively communicating and creating awareness about climate change adaptation amongst the public was going to be a major challenge. Ninety-seven percent of survey respondents indicated that adaptation actions should be incorporated into official community plans. Over 95% of planners also indicated that actions should also be included in provincial documents, regional documents and integrated community sustainability plans. Many respondents felt that strategies should not be outlined in separate adaptation documents. This indicates that many planners would prefer to see adaptation strategies incorporated into existing plans, rather than to work with and create separate adaptation plans.

According to the survey respondents the top five impacts that will affect BC in 50 years are:

1) Forests
2) Agricultural changes
3) Increased river flooding
4) Effects to transportation infrastructure
5) Water quality degradation

Along with the top five impacts, planners also indicated that effects on stormwater infrastructure, sea level rise, increases in severe weather events and water shortages will have a large effect in BC in 50 years, and that they should be strongly considered. (Planners selected these impacts out of a list that was generated from the same literature review that was used for the impacts discussed in the workshop.)

The responses to the survey question asking participants to rank the impacts that will affect their communities showed considerable variation based on the respondents' regions. Kootenay region respondents showed the highest levels of concern for river flooding and water shortages in the future. Representatives from the Okanagan region ranked forest impacts, water quality degradation and agricultural changes to be the greatest impacts in 50 years. Planners from Vancouver Island, the Gulf Islands and the Sunshine Coast selected sea level rise and water shortages to be the greatest impacts on their region in the future. Northern respondents concerns were greatest regarding agriculture, forests and severe weather. Vancouver area representatives ranked river

flooding, sea level rise and transportation infrastructure as the greatest local future impacts.

These different responses illustrate that climate change adaptation strategies must be responsive to the unique characteristic of individual communities. Effective adaptation strategies should be tailored to and provide benefit for specific regions (Swart and Raes 2008; Jacques 2006). The responses also reveal that planners are aware of what the key sources of vulnerability are in their communities. Adaptation strategies must be designed specifically for individual towns and cities with input from knowledgeable local stakeholders and decision-makers (Bizikova 2008). The concerns that planners have regarding their own communities in the present also vary considerably throughout the different regions of BC (as is illustrated in Table 5). Planners felt that all impacts would have a greater effect on their communities in 50 years than they are currently having.

The top impacts identified for BC in 50 years by the survey respondents are very similar to the impacts that local experts and academics in Prince George decided should be discussed in the workshop focus groups. This is also very similar to the top five impacts planners from the north indicated would affect their communities in 50 years. (Northern planners selected forests, agriculture, severe weather, river flooding and stormwater.) The similarity of the results of these different prioritization exercises reinforces the impact conclusions (Jick 1979; Denzin and Lincoln 2005).

The climate change impacts that planners were least concerned about for the province in 50 years were degradation to permafrost, effects on building infrastructure and health

issues. The numbers of 'don't know' rankings indicated that sea level rise, health issues and permafrost were the least understood climate impacts.

This research was successful in exploring adaptation; a topic that is not currently well understood in BC. It also has effectively characterized the knowledge of BC planners on the subject, and their opinions on the climate related impacts that the province will face in the future. More research needs to occur regarding adaptation, which until recently has received much less attention than mitigation in the climate change world (Füssell 2004). This needs to happen so that communities can proactively and effectively adapt to future expected and unexpected changes.

British Columbia and Canada should assist developing countries around the world as they endeavour to adapt to climate change. As a major contributor to global greenhouse gas emissions Canada has an ethical responsibility to help developing nations prepare to adapt to the impacts of climate change. To properly assist less developed nations, BC must first increase its own capacity to deal with climate change. If this does not happen, the province will use its resources reactively adapting to climate change internally rather than assisting other regions in the future.

Future research

There is a considerable amount of additional research that needs to occur regarding this topic. An in-depth analysis should be conducted exploring what measures different communities in BC are taking to proactively plan to adapt to climate change. This research will assist planners as they begin to consider climate change in their own communities by providing them with relevant BC examples.

Community case study projects should be initiated so that there are examples of cities and towns proactively adapting to climate change across BC. These pilot projects should include different sized communities from all of the regions within the province. The communities should be selected based on different levels of internal monetary resources, as this will impact the response options available to them (Crabbe and Robin 2006). These should include communities with large numbers of assets and large revenue bases (such as Whistler) and communities with fewer resources and access to funds (such as Hazelton). The province should assist towns with a lower adaptive capacity as they begin to consider climate change (such as remote and First Nations settlements), particularly those that are deemed to be highly vulnerable to climate impacts.

Educating planners in BC about climate change adaptation should be a high priority. First Nations, local, regional and provincial governments, as well as planning institutes and academics, should continue to endeavour to help planners learn more about this important issue. This education can occur in many forms including conferences, workshops, guidebooks and internet resources.

There is a significant research opportunity exploring how to communicate complicated climate modelling information to planners and to a lay audience. Resources should be developed to help planners utilise these models and explore how they can be communicated to the public in a simple, understandable manner while maintaining scientific rigor. Also, incorporating climate change adaptation measures along with mitigative actions was not explored in this research. More actions should be taken to build on the considerable research already taking place by groups such as the IPCC

(2007d) to explore how communities can address mitigation and adaptation issues concurrently.

Finally, collaborative research with Prince George is needed which envisions and implements effective long term strategies to adapt to climate change. Many of the researchers and City staff involved in the project have continued to work toward this goal. A key research outcome has been the envisioning of an additional adaptation workshop building on the lessons learned and helping Prince George create a climate change adaptation strategy. This workshop focused on identifying and prioritizing climate change impacts in the City.

The event built upon the PIBC workshop and many of the same techniques, topics and formats were used. The event was introduced in a similar manner, used climate modelling information from PCIC and employed focus group techniques. There were also some notable differences in the second workshop. The structure was very rigid, and facilitators were required to work with their groups to produce defined outcomes. Education remained an objective of the second workshop; however there was less time for open discussion and idea sharing.

The results from the second workshop will build upon the outcomes of the PIBC workshop to inform an adaptation strategy for Prince George in future research. With continued collaboration between UNBC, PCIC, departments within the City of Prince George and other organizations, Prince George can become a provincial, national and international leader in effective climate change adaptation action.

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Appendix A Backgrounder for PIBC Workshop: Climate Trends and Future Projections for the North-Central British Columbia Region

Prepared by Arelia Werner.

The purpose of this backgrounder is to provide data that has been gathered thus far for Prince George and the greater North Central region of BC.

The baseline climatology and trends from an observational station at Prince George (A 1096450) is provided in addition to the baseline climatology over the region, as depicted by the PRISM dataset. Projections for the 2041-2070 (2050s) period are shown for temperature, precipitation and snow water equivalent from the Canadian Regional Climate Model. Lastly, Global Climate Model projections from 15 models, driven by two emission scenarios (A2 & B1) over the region are summarized via boxplots.

A description of the data source is provided with each image. Analysis and interpretation of these findings will be completed in the next phase of this work.

Baseline Climatology (in °C).

Prince George A 1096450

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Temperature	-5.8	-0.7	4.6	10.8	16.0	19.7	22.1	21.5	16.0	9.8	0.6	-4.5
Mean Temperature	-10.0	-5.5	-0.7	4.7	9.4	13.1	15.3	14.6	9.8	4.8	-3.2	-8.5
Minimum Temperature	-14.1	-10.3	-6.0	-1.4	2.8	6.5	8.4	7.7	3.6	-0.1	-6.8	-12.5
Precipitation	65.1	40.8	38.9	31.8	56.9	70.0	65.1	66.2	64.5	64.3	60.6	63.0
Rain	6.5	9.6	13.8	22.5	54.1	69.9	65.0	66.2	63.6	56.1	18.8	10.1
Snow	58.6	31.2	25.1	9.3	2.8	0.1	0.0	0.0	0.9	8.2	41.8	52.9

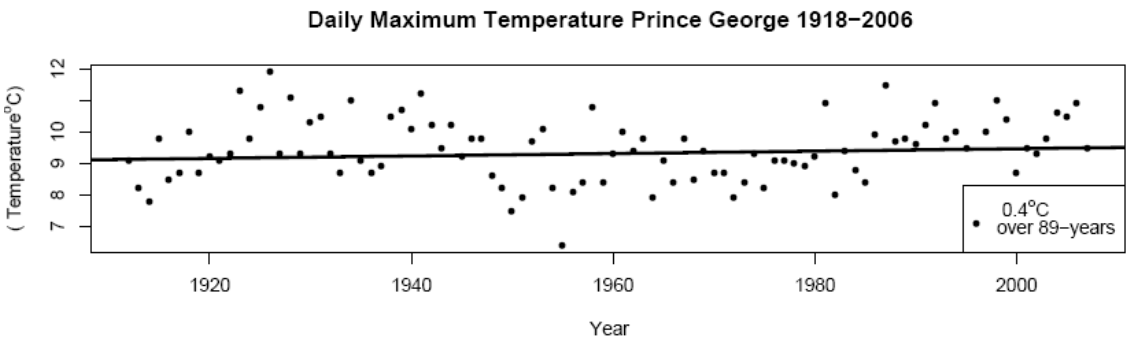
Prince George A 1096450 (in °C).

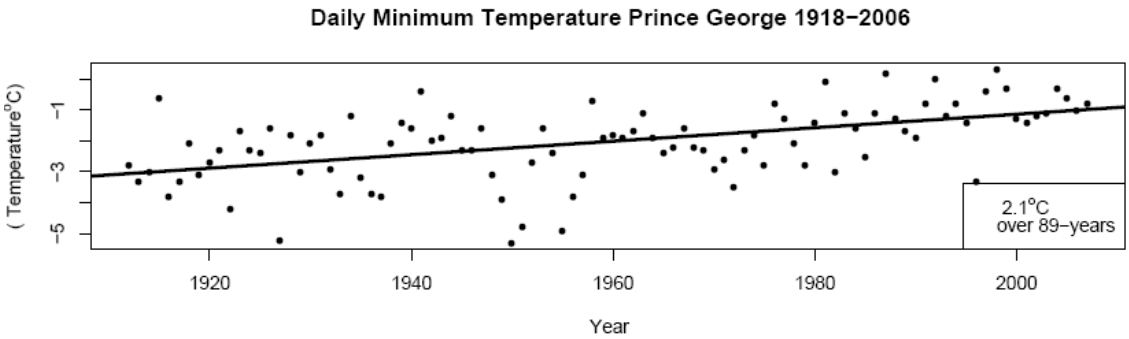
	Annual	Winter	Spring	Summer	Autumn
Maximum Temperature	9.2	-3.6	10.5	21.1	8.8
Mean Temperature	3.7	-8.0	4.5	14.3	3.8
Minimum Temperature	-1.9	-12.3	-1.5	7.5	-1.1
Precipitation	687.2	166.6	127.6	201.3	189.3
Rain	456.2	26.8	90.4	201.1	138.5
Snow	230.9	139.9	37.2	0.2	50.9

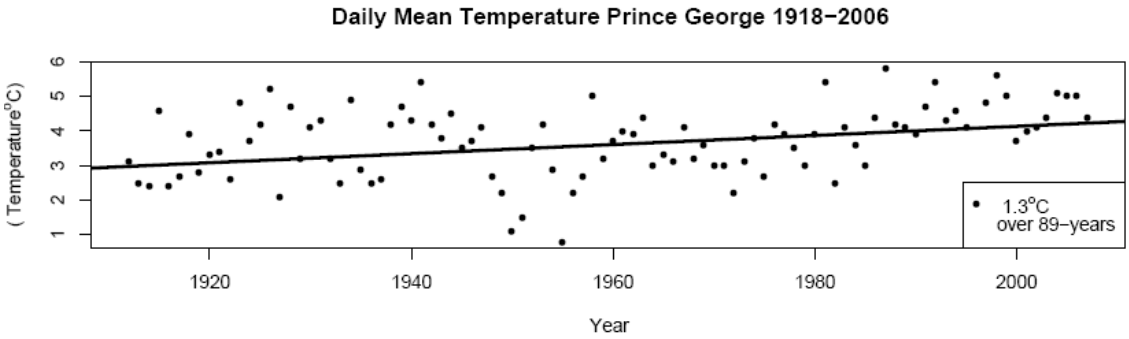
Historical Trends (Graphs)

Adjusted Historical Canadian Climate Data (AHCCD) was analyzed for trend. This was completed using an iterative approach to pre-whitening and testing for trend (Zhang, 2001). The magnitude of the trend was computed with the Theil-Sen method and significance was assessed with the Mann-Kendall test.

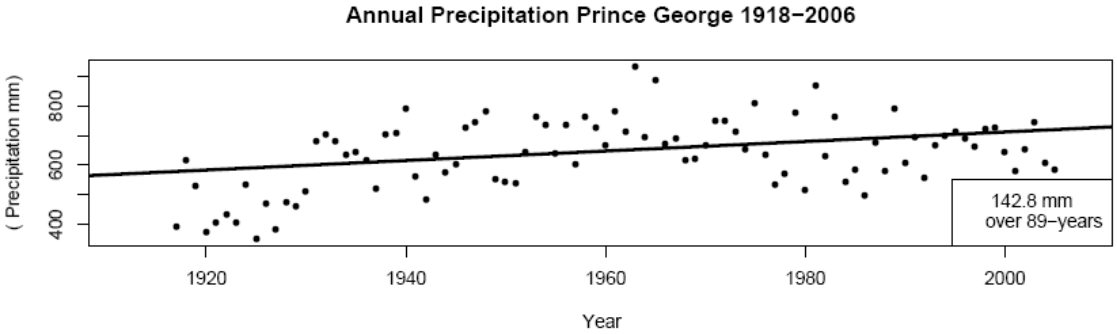
Temperature Trends:

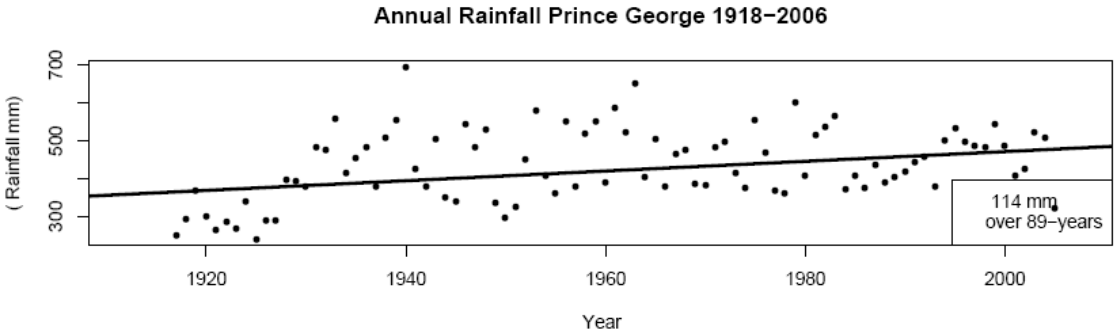


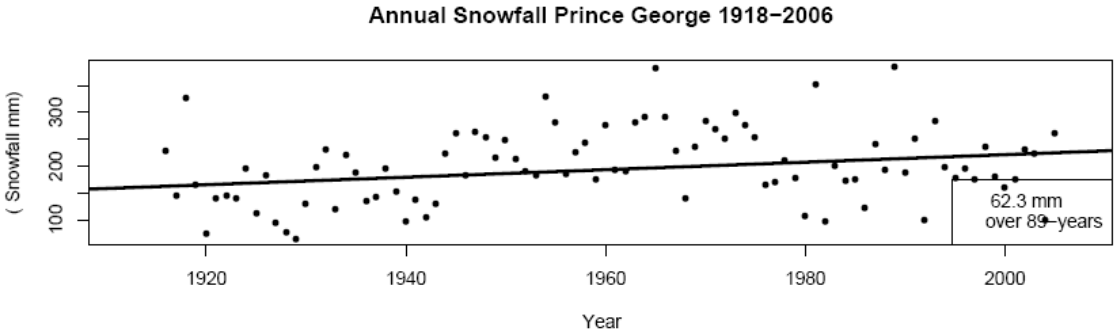




Precipitation Trends:

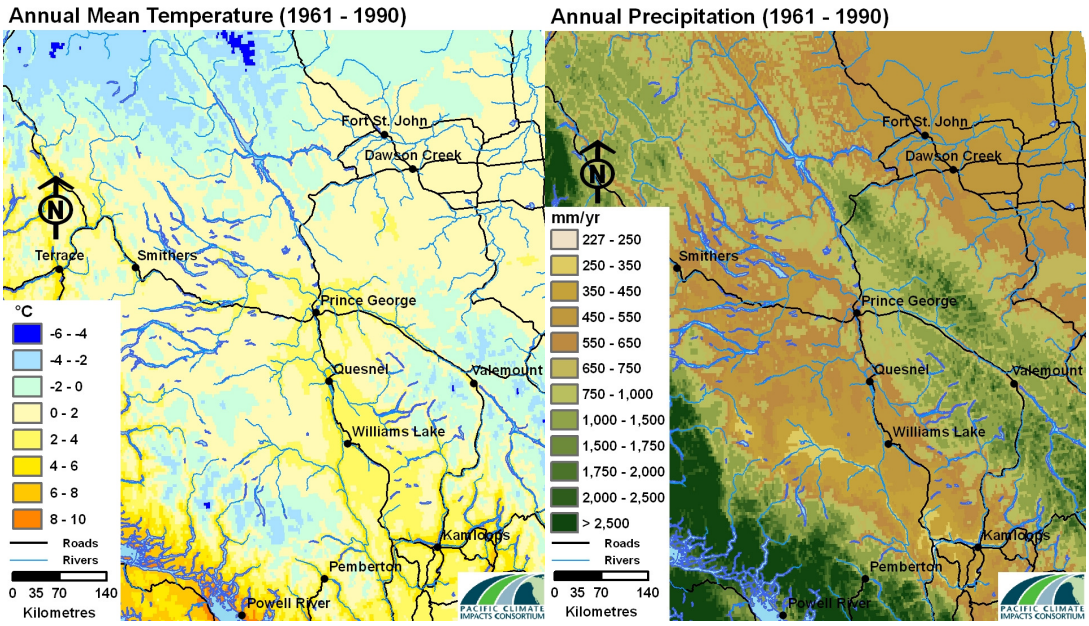






PRISM Climatology (Maps)

Annual mean temperature and precipitation (1961-1990) climatology is provided with data from the Precipitation-elevation Regressions on Independent Slopes Model (PRISM). PRISM interpolates station-based measurements of monthly and annual temperature and precipitation to regularly spaced grid cells (Daly et al., 1994). Orographic effects are modelled by employing a digital elevation model (DEM) and regression techniques (Daly et al., 1994). Stations are weighted to account for "spatial variation in climate caused by elevation, terrain orientation, effectiveness of terrain as a barrier to flow, coastal proximity, moisture availability, a two-layer atmosphere (to handle inversions), and topographic position (valley, midslope, ridge)" (Daly, 2006). Complex climatic extremes, such as rain shadows, coastal effects, and temperature inversions, were modelled with the assistance of expert knowledge[2]. Station data used to create PRISM in BC and the Yukon was provided by Environment Canada and the global historic climatology network (GHCN) (Simpson et al., 2005).

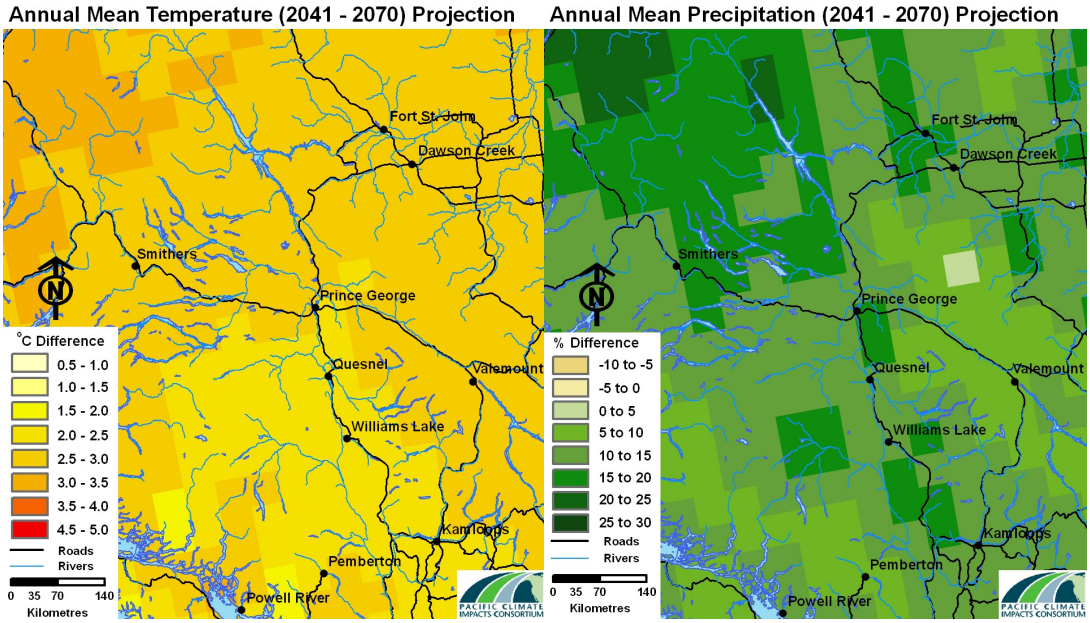


[2] http://www.prism.oregonstate.edu/

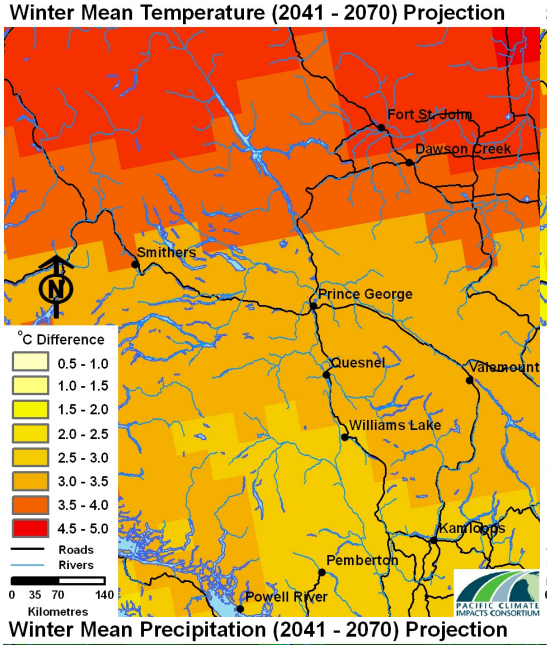
RCM Projections (Maps)

Projections of future climate are provided from the Canadian Regional Climate Model (CRCM4) at a resolution of 45 km. Results are presented as a difference from the 1961-1990 baseline for the 2050s (2041-2070). Projections are from the latest version of the CRCM4, which is forced (through boundary conditions at the edges of its domain – North America) by the ~350km resolution projection form the Canadian Global Climate Model (CGCM3) following the A2 emissions scenario (run 4). Both the regional and global models are numerical representations of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes. Currently, atmosphere, ocean, and sea ice interactions are coupled with those occurring on land in GCMs, which provides a comprehensive representation of the climate system.

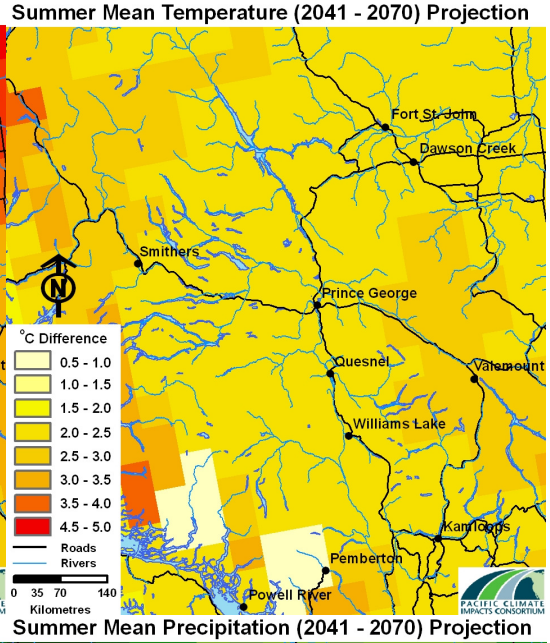
Because the CRCM is at a higher resolution it represents elevation, physical and dynamical processes as well as land surface characteristics in more detail than a GCM. However, RCMs are less economical to run than GCM. Thus, there are less runs of RCMs than there are of GCMs and the projections shown here are from only one model, run with only one emission scenario A2. From studies of GCM results, we know that for the 2050s more uncertainty is contributed by the various models than by different emission scenarios. The A2 and B1 emission scenarios are commonly explored. A2 is considered to be a "business as usual" scenario and B1 reflects greenhouse gas levels that result when we use more "alternative" energy sources. By the 2080s, or the 2071-2090 period, emission scenarios have a stronger influence on the strength of the change in temperature and precipitation.



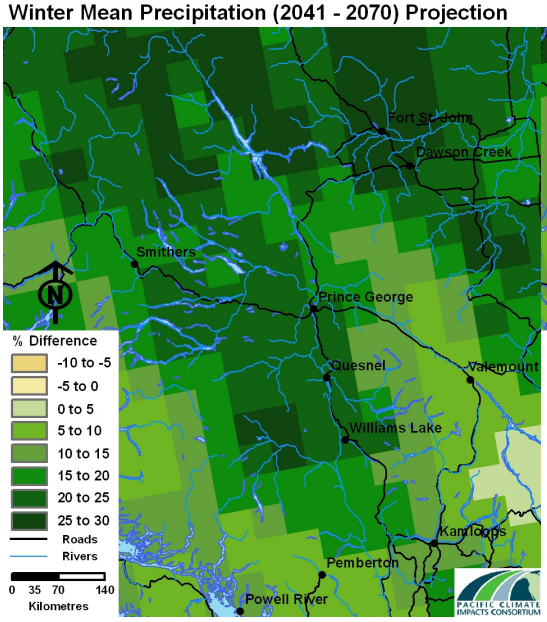
Winter Mean Temperature (2041 - 2070) Projection



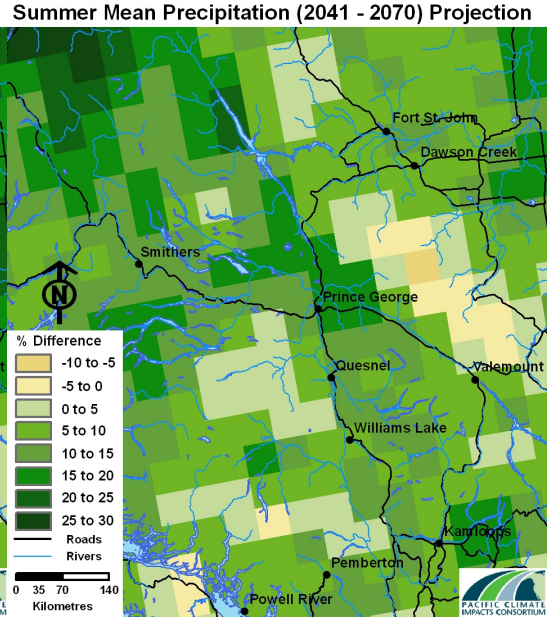
Summer Mean Temperature (2041 - 2070) Projection

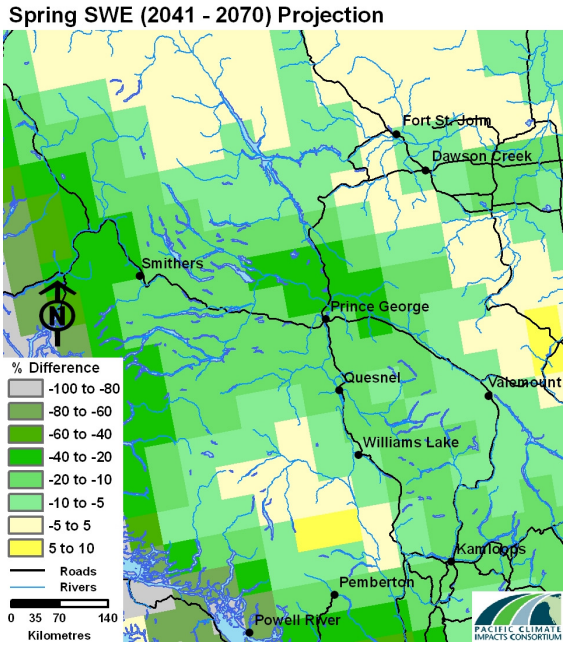


Winter Mean Precipitation (2041 - 2070) Projection



Summer Mean Precipitation (2041 - 2070) Projection



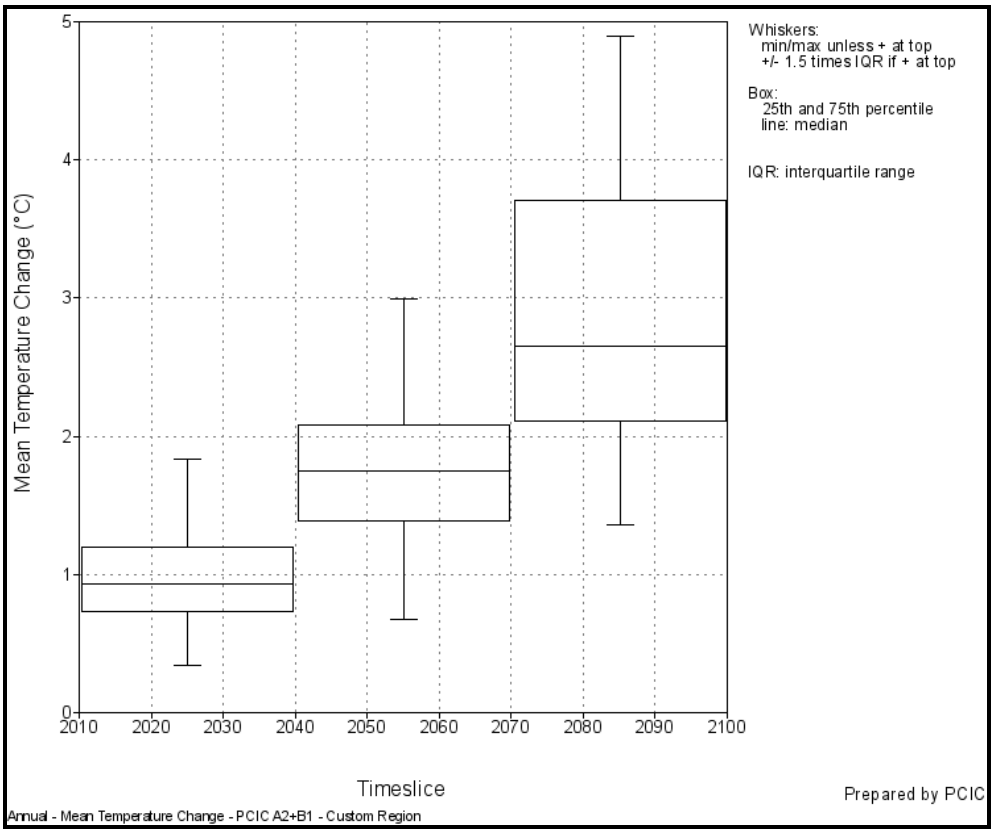


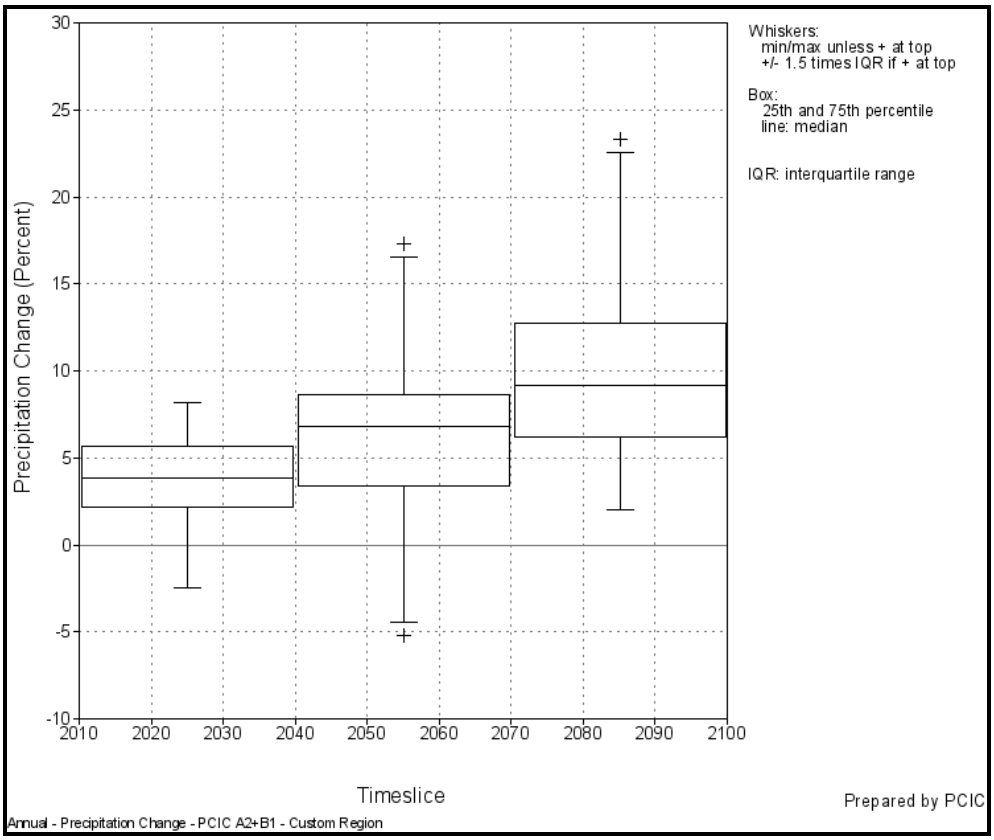
GCM Projections (Boxplots)

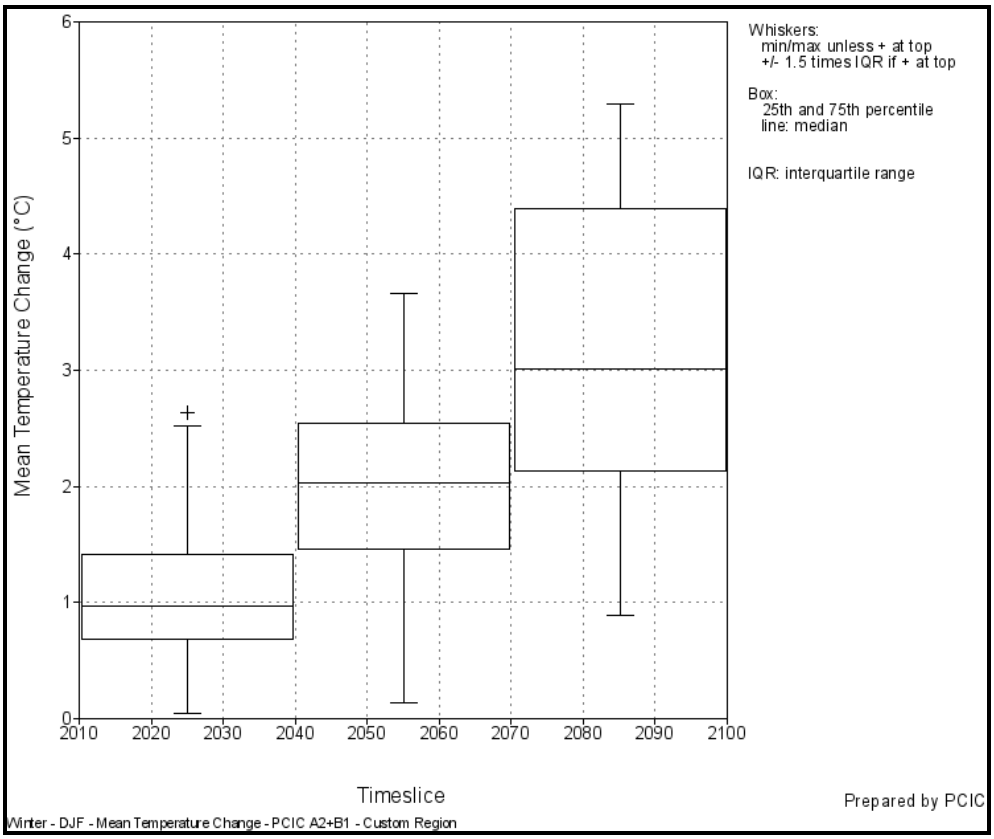
Climate projections of temperature and precipitation from 30 Global Climate Model projections are presented for those model grid squares that are within or in close proximity to the North-Central BC region. Box plots show the range of values projected by the various models with the "whiskers" at the end of the vertical lines to indicate the highest and lowest model projections. The top and bottom of the box shows the 25th and 75th percentiles and the horizontal bar within the box indicates the median value of the model projections. Thus, 50% of the projections are enclosed by the box. Hence, boxplots are valuable for showing both the climate change projected by the majority of model runs as well as the level of variation among models.

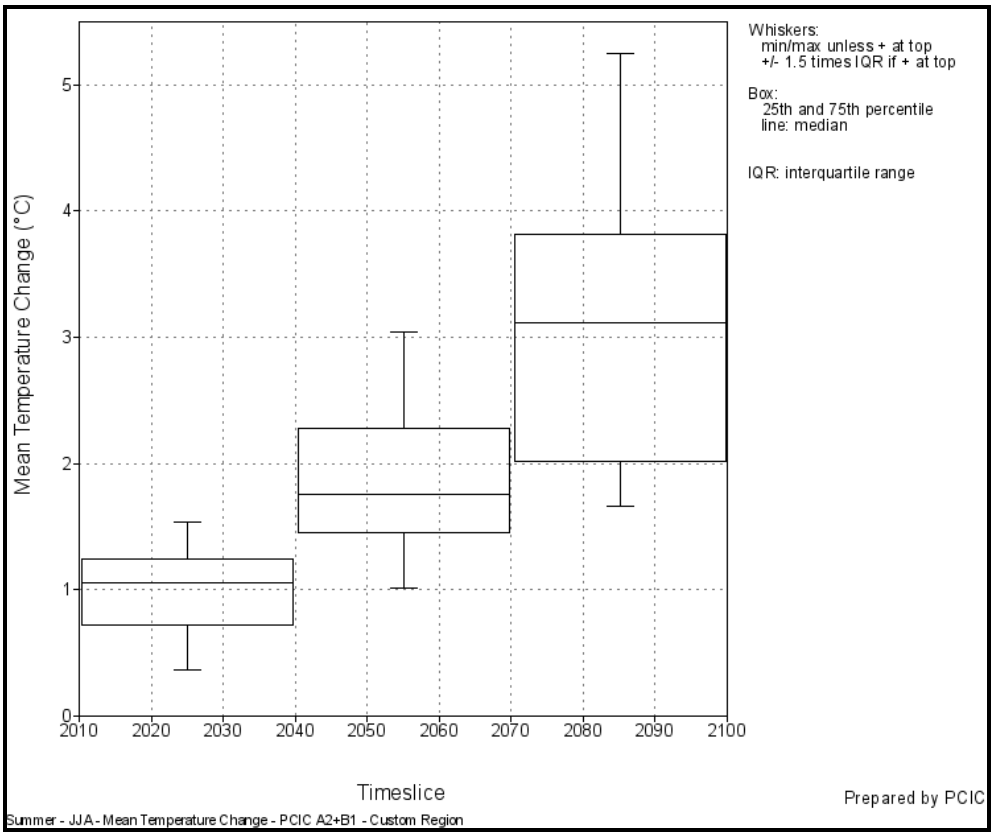
For the North-Central BC region, the CGCM3 following the A2 emissions scenario projected changes to temperature and precipitation that were warmer and wetter than the 75th percentile of 30 GCM projections. Thus, it is probable that the CRCM4 results, because they are forced by the CGCM3 following the A2 emissions scenario, are on the warmer and wetter end of a spectrum of results. Further information on RCMs will soon be available from the North American Regional Climate Change Assessment Program (NARCCAP), which has set out to systematically investigate the uncertainties in future climate chance projections at a regional level. This will be done by running multiple RCMs with multiple GCMs over North America[3].

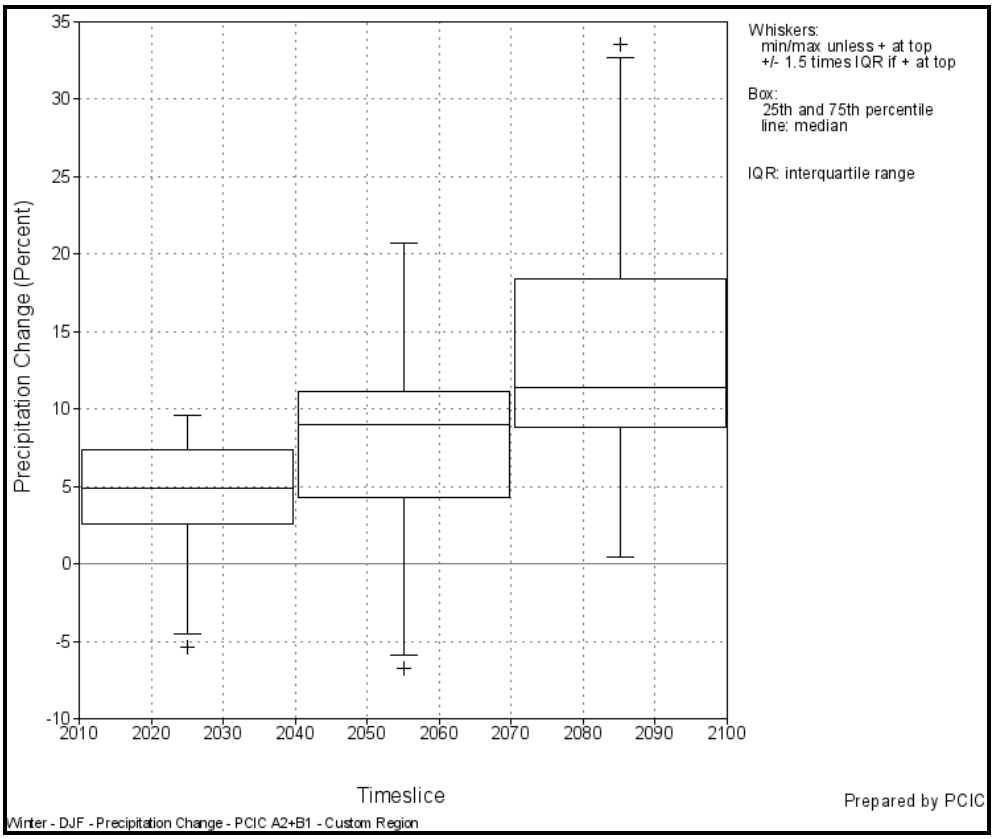
[3] http://www.narccap.ucar.edu/index.html

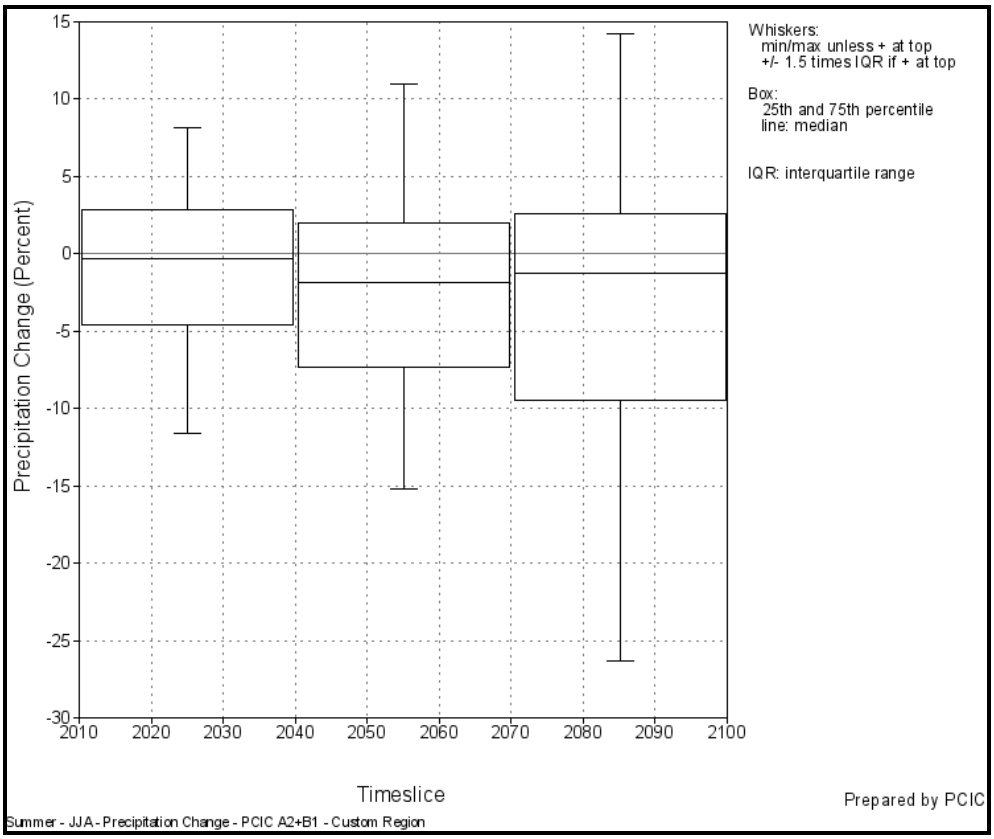

Mean Temperature Change (°C)
Timeslice
Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Prepared by PCIC
Annual - Mean Temperature Change - PCIC A2+B1 - Custom Region


Precipitation Change (Percent)
Timeslice
Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Prepared by PCIC
Annual - Precipitation Change - PCIC A2+B1 - Custom Region


Mean Temperature Change (°C)
0
1
2
3
4
5
6
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Timeslice
Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Prepared by PCIC
Winter - DJF - Mean Temperature Change - PCIC A2+B1 - Custom Region


Mean Temperature Change (°C)
0
1
2
3
4
5
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Timeslice
Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Prepared by PCIC
Summer - JJA - Mean Temperature Change - PCIC A2+B1 - Custom Region


Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Precipitation Change (Percent)
Timeslice
Prepared by PCIC
Winter - DJF - Precipitation Change - PCIC A2+B1 - Custom Region


Whiskers:
min/max unless + at top
+/- 1.5 times IQR if + at top
Box:
25th and 75th percentile
line: median
IQR: interquartile range
Precipitation Change (Percent)
Timeslice
Prepared by PCIC
Summer - JJA - Precipitation Change - PCIC A2+B1 - Custom Region

Appendix B: Visions for PIBC Workshop Focus Groups

Prince George Visioning Exercise
Flooding and Stormwater: Forecast #1:

Planning Shortcomings:

- Strategies that properly address flooding and stormwater issues in Prince George with regards to climate change are not included in upcoming Official Community Plans, Integrated Community Sustainability Plans or other documents;
- Flood management plans continue to be made without using future streamflow and precipitation data, and the floodplain is boundaries are not changed; or
- A flood management plan is created but proves to be ineffective because it is made using incomplete information, not designed to account for changing conditions, or not regularly evaluated and amended in order to ensure that it is effective; or
- An adaptation plan is created but does not involve or is not properly communicated to stakeholders, and there is not sufficient understanding and support of the strategies to ensure that they are implemented; or
- An adaptation plan is created but is not properly implemented because it lacks a strong vision to guide it, is not included in appropriate policy documents or the policy proves to be ineffective because it not backed up with strong regulations.

Development of the City of Prince George:
Development continues in Prince George in a 'business as usual' format with with some climate change mitigation improvements incorporated as a result of the GHG reduction strategy[1]. A flood risk assessment is completed in 2009 without taking climate change projections adequately into consideration and the flood plain boundaries are not changed. The study concludes that the Nechako River needs to be dredged. Development continues fairly close to flood prone and sensitive riparian areas, in adherence to the current flooding bylaw[2]. Stormwater infrastructure continues to be designed and maintained to withstand current precipitation levels, and not future projections.

Prince George in 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Extreme precipitation (as well as other extreme weather) events occur much more frequently in the region[1].

Prince George is affected by high water events on an almost annual basis, and 100 year flood events occur on the Fraser River at an interval of nearly 1:5 years[3]. The

dredging of the Nechako river must be repeated after every flooding event at great cost to the city. High midwinter temperatures and extreme precipitation events lead to flooding at unpredictable times of the year. The city is forced to spend millions of dollars annually reacting to emergency situations related to flooding, and this overextends its emergency response units. Access roads flood periodically, crippling industry in the City for weeks at a time, and putting residents at great risk. The large amount of impermeable areas within the city make flooding events worse, as rainfall heads straight back to the rivers. There are no storage areas available to temporarily retain stormwater. The city is unable to upgrade its inadequate stormwater drainage system because of the huge costs associated with this. The city begins to consider relocating large numbers of residences, and urges the Provincial government work with them to invest in costly large scale flood management infrastructure (such as a dam).

Prince George Visioning Exercise
Flooding and Stormwater - Forecast #2:

Planning Successes:

- A climate change adaptation strategy that addresses flooding and stormwater management is created for the city of Prince George. The plan uses state of the art climate projections and relevant local data, and is evaluated and amended regularly to account for changes new climate information. To deal with the uncertainty there is an emphasis on creating resiliency;
- Adaptation plans are outlined in a centralized policy document(s) that includes a strong community vision. The plan is enforced with regulatory backing;
- Plans include creative strategies to influence practices (such as building design and onsite retention) that are typically outside the realm of Community plans; and
- Possible mitigation co-benefits are exploited along with adaptation

Development of the City of Prince George:

Development continues in Prince George, adhering to the strategies and regulations outlined in a comprehensive climate adaptation plan (which may be its own plan or incorporated into an existing plan). This plan includes short and long term adaptation planning strategies, and bylaws to enforce them. Development takes place well away from flood prone areas, which are left in their natural state to be enjoyed as parkland, and to increase natural flood protection. Existing infrastructure in flood prone areas is retrofitted to withstand floods. Stormwater retention ponds are built throughout the city, and new developments include sloughs and have strict permeability requirements.

Prince George in the 2050s:

As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation.

Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Extreme precipitation (as well as other extreme weather) events occur much more frequently in the region[1].

The effects of the frequent flooding events in the region are minimized because they effect mostly 'no development' and parkland zones. Natural wetlands are in a functional state and mitigate flooding, as do the stormwater retention ponds throughout the city. The existing stormwater infrastructure in the city does not have to be upgraded to account for higher precipitation because of the capacity of the retention ponds. Water from the retention ponds is used for household purposes, which helps to protect fresh water resources and saves the city money. Permeability within the city is kept high because of strict zoning and paving standards. Roads that cross the flood prone areas double as dykes and ensure that there is emergency access available to the existing infrastructure in the floodplain.

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[1]Walker and Sydneysmith. 2008. British Columbia: in From Impacts to Adaptation; Canada in a Changing Climate 2007, edited by Lemmen, Warren, Lacroix and E. Bush. Government of Canada. Ottawa ON. P. 329-386
[2]Bylaw 7855: restricts development within 3.0 vertical m and 30 horizontal m from a watercourse. Available at:
http://www.city.pg.bc.ca/city_services/cpd/newzoning/bylaw7855.pdf
[3]2005:http://www.city.pg.bc.ca/city_services/utilities/waterconservation/water_conservation_plan.pdf
[4]Milly et al. 2002. Increasing risk of great floods in a changing climate. Nature. 41

Prince George Visioning Exercise
Water Quality and Quantity -- Forecast #1:

Planning Shortcomings:

- Strategies that address water and climate change in the City are not included in upcoming Official Community Plans, Integrated Community Sustainability Plans or other documents; or
- A comprehensive water conservation plan is implemented but not amended to account for changing climate conditions, or not regularly evaluated and amended in order to ensure that it is effective; or
- An adaptation plan is created but is not properly implemented because it lacks a strong vision to guide it, is not included in appropriate policy documents, or the policy proves to be ineffective because it not backed up with strong regulations.
- An adaptation plan is created (or improved) to mitigate water use but is unsuccessful as the public and key stakeholders fail to begin to regard water as a valuable and limited resource in the city, and mitigate their usage.

Development of the City of Prince George:
Development continues in Prince George in a 'business as usual' format with with some climate change mitigation improvements incorporated as a result of the GHG reduction strategy[1]. The City tries to lead by example and reduces municipal water

usage in parks and buildings. The public does not follow suit, and attempts to limit household water usage are regarded as an infringement of personal rights. The water metering initiative is unsuccessful and local educational campaigns fail[2]. Continued growth persists near the boundaries of the City, away from current water sources. Many more wells must be drilled throughout the city to meet the growing demand for water in different areas. The supply network remains unconnected so that each area must have its own water supply. Development continues in a standard fashion, and more and more permeable areas become pavement.

Prince George in 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Although precipitation has increased, much of it occurs in intense rainfall events, so there is also an increase in droughts[3].

During summer months, different areas within Prince George frequently face water shortages. The continued development upstream along the Nechako River and on important recharge areas causes the primary groundwater aquifer to become contaminated. Because of the high number of wells drawing from the aquifer, the contamination cannot be contained, and many high producing wells are no longer usable, or the water must be extensively treated. The city must impose strict water use restrictions and limit its growth as it struggles to supply and treat an adequate supply of water for its residents. Water treatment becomes a major expense for the municipality.

Prince George Visioning Exercise
Water Quality and Quantity - Forecast #2:

Planning Successes:

- A climate change adaptation strategy that addresses water quality and quantity management is created for the city of Prince George. The plan uses state of the art climate projections and relevant local data, and is evaluated and amended regularly to incorporate new climate information. To deal with the uncertainties there is an emphasis on creating resiliency;
- The Water Conservation plan is redrafted to aggressively mitigate water use in all sectors of the city. The plan is referred to in centralized policy documents that include a strong community vision. Plans are enforced with regulatory backing;
- Water plans include creative strategies to influence practices (such as landscaping) that are typically outside the realm of Community plans; and
- Possible mitigation co-benefits are exploited along with adaptation

Development of the City of Prince George:
Development continues in Prince George adhering to the strategies and regulations outlined in the comprehensive water conservation plan (which may be its own plan or incorporated into an existing plan). This plan includes short and long term strategies to preserve and protect water, and bylaws to enforce them. The City pledges to not drill any more wells into the Lower Nechako River Aquifer, and calls for the decommissioning of some of the wells when they reach the end of their useful lives. Development is encouraged in regions that are close to water supplies by strong incentives. To further reduce the stresses on the water system, the city begins to explore other sources of water. Wastewater and stormwater starts to be used for agricultural and outdoor residential usage. Effluent from the pulp mills is used for nearby agricultural purposes. Private water sources are closely monitored to ensure that they do not harm the aquifer.

Prince George in the 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Although precipitation has increased, much of it occurs in intense rainfall events, so there is also an increase in droughts[3].

Residents of Prince George do not notice effects of climate change on the quality or quantity of their water supply. Development is concentrated near to the existing high producing wells, which supply the entire city with an inexpensive source of fresh, clean water. A successful mitigation campaign reduces demand, as does the usage of stormwater and greywater outdoors. Industry and Agriculture have a strategy to use mill effluent to water nearby crops that saves both parties money. The city saves millions of dollars a year due to the reduced demands on water supply and treatment. Prince George continues to enjoy a reliable supply of clean water. This becomes a major selling feature for the city and it enjoys steady growth, while much of the rest of the province endures serious water shortages.

References:

[1]**City of Prince GHG Reduction Plan RFP:**
http://www.city.pg.bc.ca/city_services/supply/2005_documents/P05-26.pdf
[2]City of Prince George Water Conservation Program:
http://www.city.pg.bc.ca/city_services/utilities/waterconservation/water_conservation_plan.pdf
[3]**Walker and Sydneysmith. 2008. British Columbia: in From Impacts to Adaptation; Canada in a Changing Climate 2007, edited by Lemmen, Warren, Lacroix and Bush; Government of Canada, Ottawa, ON, p. 329-386**

Prince George Visioning Exercise
Infrastructure - Forecast #1:

Planning Shortcomings:

- Strategies that properly address infrastructure issues in Prince George with regards to climate change are not included in upcoming Official Community Plans, Integrated Community Sustainability Plans or other documents;
- Infrastructure continues to be cited and designed based on current weather conditions, and not with future climates in mind; or
- An infrastructure plan is created but proves to be effective because it is made using incomplete information, not designed to account for changing information, or not regularly evaluated and amended in order to ensure that it is effective; or
- An adaptation plan is created but does not involve or is not properly communicated to stakeholders, and there is not sufficient understanding and support of the strategies to ensure that they are implemented; or
- An adaptation plan is created but is not properly implemented because it lacks a strong vision to guide it, is not included in appropriate policy documents or the policy proves to be ineffective because it not backed up with strong regulations.

Development of the City of Prince George:
Continued growth persists within the existing infill boundary of the City, including regions near to flood and landslip prone areas (although the present flooding bylaw is followed[2]). A new Development Costs Chargeout bylaw is not approved, and the same general infrastructure servicing model continues to be used to cost recover through a flat tax within the city. A flood risk assessment is completed in 2009 without taking climate change projections into consideration, and the flood plain maps do not change. Infrastructure is designed to withstand present climatic conditions, and building and transportation construction codes are not amended to consider future climate scenarios. Infrastructure continues to be built with the same materials, in the same locations, and maintained in the same fashion.

Prince George in 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Extreme precipitation (as well as other extreme weather) events occur much more frequently in the region[1].

Prince George is affected by high water events on an almost annual basis, and 100 year flood events occur on the Fraser River at an interval of nearly 1:5 years[1]. Prince George must spend millions of dollars annually repairing buildings that are damaged due to flooding. Roads are frequently closed due to high water and landslip events.

Periodically important access roads close, crippling industry in the City for weeks at a time and putting residents at great risk. The large amount of impermeable areas within the city make flooding events worse, as rainfall heads straight back to the rivers. Increases in freeze thaw cycles seriously affect the roads in Prince George, and crews must work all summer to fill in potholes left as a result of the previous winter - just in time for the cycle to start again. Road maintenance budgets triple from current rates to deal with increased ice conditions, and increased salt use contaminates the land and water. Building roofs periodically collapse under the heavy snow loads caused from increased precipitation and warmer temperatures.

Prince George Visioning Exercise
Infrastructure - Forecast #2:

Planning Successes:

- A climate change adaptation strategy that addresses infrastructure management is created for the city of Prince George. The plan uses state of the art climate projections and relevant local data, and is evaluated and amended regularly to account for changes new climate information. To deal with the uncertainty there is an emphasis on creating resiliency;
- Adaptation plans are outlined in a centralized policy document(s) that includes a strong community vision. The plan is enforced with regulatory backing;
- Plans include creative strategies to influence practices (such as building material requirements) that are typically outside the realm of Community plans; and
- Possible mitigation co-benefits are exploited along with adaptation.

Development of the City of Prince George:

Development continues in Prince George, adhering to the strategies and regulations outlined in a comprehensive climate adaptation plan (which may be its own plan or incorporated into an existing plan). This plan includes short and long term adaptation planning strategies, and bylaws to enforce them. Infrastructure is developed to withstand future climates, and there is a focus on resiliency to account for unexpected change. The plans evolve to take into account improved infrastructure building technologies.

Prince George in the 2050s:

As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Extreme precipitation (as well as other extreme weather) events occur much more frequently in the region[1].

The effects of the frequent flooding and landslip events in the region are minimized because they effect mostly 'no development' and parkland zones. Permeability within the city is kept high because of strict zoning and paving standards. Roads that cross the flood prone areas double as dykes and ensure that there is emergency access available to the existing infrastructure in the floodplain. Buildings within the floodplain are retrofitted to withstand potential damages. Due to strong incentives, infill development takes place in the city in a centralized fashion. Roads are constructed to withstand the more frequent freeze thaw cycles. The extra costs are offset by the lower number of total road kilometres in the city. Building density increases to minimize infrastructure service and maintenance requirements.

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[1]Walker and Sydneysmith. 2008. British Columbia: in From Impacts to Adaptation; Canada in a Changing Climate 2007, edited by Lemmen, Warren, Lacroix and E. Bush. Government of Canada. Ottawa ON. P. 329-386

[2]Bylaw 7855: restricts development within 3.0 vertical m and 30 horizontal m from a watercourse. Available at: http://www.city.pg.bc.ca/city_services/cpd/newzoning/bylaw7855.pdf

[3] City of Prince George Water Conservation Program: http://www.city.pg.bc.ca/city_services/utilities/waterconservation/water_conservation_plan.pdf

[4]Milly et al. 2002. Increasing risk of great floods in a changing climate. Nature. 415.

Prince George Visioning Exercise
Implementation - Forecast #1:

Planning Shortcomings:

- A climate change adaptation strategy is not made to account for upcoming Climate Change in Prince George; or
- Adaptation Plans are made and not implemented because they were designed in a sporadic decentralized fashion without a strong unifying vision and regulatory backings to enforce them; or
- Adaptation change plans are implemented but do not prove to be effective because they are made using incomplete information, not adapted to account for changing conditions, or not regularly evaluated and amended in order to ensure that they are effective,

Development of the City of Prince George:

Development continues in Prince George in a 'business as usual' format with continued growth within the existing infill boundary of the City. Development continues in flood prone areas and sensitive riparian areas, although the flooding bylaw is generally followed[1]. The same general infrastructure servicing model is used to cost recover through a flat tax. Infrastructure is designed to withstand present climatic conditions, and not future climate scenarios. Water use continues in a generally unmitigated fashion, as the voluntary water metering and conservation education plans outlined in the water conservation strategy[2] are unsuccessful. Forest

fire risk is accounted for using the community based forest model with dead tree removal, but without a strong replanting strategy.

Prince George in 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Although precipitation has increased, much of it occurs in intense rainfall events, so there is also an increase in droughts.

Prince George is affected by flooding events on an almost annual basis, and 100 year flood events occur on the Fraser River at an interval of 1:5 years[1]. Prince George must spend millions of dollars annually responding to flooding, and upgrading its inadequate stormwater drainage system. Increases in freeze thaw cycles seriously affect the roads in Prince George, and crews must work all summer to fill in potholes left as a result of the previous winter - just in time for the cycle to start again. The extensive road network is subject to frequently flooding, and maintenance budgets triple from current rates to deal with increased ice conditions, snow loads and road failures. Fragile ground water sources become contaminated from the large number of wells, and Prince George faces serious clean water shortages**.**

Prince George Visioning Exercise
Implementation - Forecast #2:

Planning Successes:

- A climate change adaptation strategy is created for the city of Prince George;
- Adaptation plans are outlined in a centralized document, using state of the art modelling information and relevant local data;
- Adaptation Plans are implemented and enforced with regulatory backing;
- Plans are evaluated on an annual basis and amended to account for new climate change data;
- Plans include creative strategies to influence practices (such as building design and landscaping) that are typically outside the realm of Community plans; and
- Possible mitigation co-benefits are exploited along with adaptation

Development of the City of Prince George:
Development continues in Prince George, adhering to the strategies and regulations outlined in a comprehensive climate adaptation strategy (which may be its own plan or incorporated into an existing plan). This plan includes short and long term adaptation planning strategies, and bylaws to enforce adaptation rules. Due to strong incentives, infill development takes place in a centralized fashion close to water supplies and away from flood prone and high fire risk areas. Infrastructure is designed to withstand future climate projections, and water use is mitigated in order to

maintain local groundwater sources. Building density increases to minimize infrastructure service and maintenance requirements.

Prince George in the 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Although precipitation has increased, much of it occurs in intense rainfall events, so there is also an increase in droughts.

The effects of the frequent flooding events in the region are minimized because they effect mostly 'no development' and parkland zones. Natural wetlands are in a functional state and also provide a barrier against flooding, as do the stormwater retention ponds throughout the city. Roads that double as dykes are built to withstand increased freeze-thaw cycles, and the extra costs in construction are offset by savings in maintenance, and reduced numbers of roads in the city. Water pricing and infrastructure taxing encourages development in a centralized fashion that is close to available water sources. Prince George continues to enjoy a reliable supply of clean water and is not forced to limit growth, while most of the rest of the world prepares for serious shortages.

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[1]**Bylaw 7855: restricts development within 3.0 vertical m and 30 horizontal m from a watercourse. Available at:**
http://www.city.pg.bc.ca/city_services/cpd/newzoning/bylaw7855.pdf
[2]City of Prince George Water Conservation Program.
2005:http://www.city.pg.bc.ca/city_services/utilities/waterconservation/water_conservation_plan.pdf
[3]**Milly et al. 2002. Increasing risk of great floods in a changing climate. Nature. 415. : p. 514-517.**

Prince George Visioning Exercise
Communication - Forecast #1:

Communication Shortcomings:

- Stakeholders are not properly engaged in creating a community vision that includes climate change adaptation;
- The public remains sceptical of the ability to the community to adapt to climate change. They do not trust uncertain climate change projections and refuse to support strategies based on their outputs. Community members remain unconvinced of the risks associated with inaction, and oppose spending money and resources on actions;
- Industry and agricultural representatives oppose adaptation actions, claiming that they will ruin their businesses;
- The seriousness of the issue of adapting to climate change is not properly communicated to elected officials, so they do not pass bylaws and other legislation; and

- The planning department, which is already incredibly busy, does not have the time or resources available to them to create adaptation plans.

Development of the City of Prince George:
Development continues in Prince George in a mostly 'business as usual' format with some climate change mitigation improvements incorporated as a result of the GHG reduction strategy[1]. Continued growth persists within the existing infill boundary of the City, including regions near to flood prone areas and sensitive riparian zones (although the present flooding bylaw is followed[2]). A new Development Costs Chargeout bylaw is not approved, and the same general infrastructure servicing model continues to be used to cost recover through a flat tax within the city. A flood risk assessment is completed in 2009 without taking climate change projections into consideration, and the flood plain maps do not change. Infrastructure is designed to withstand present climatic conditions, and not future climate scenarios. Water use continues at current rates, and the voluntary residential water metering and conservation education plans outlined in the Water Conservation Strategy[3] are unsuccessful. Forest fire risk is accounted for using the community based forest model with dead tree removal[4], but without a strong strategy to ensure that seedlings survive in future climates.

Prince George in 2050s:
As current models predict; annual temperatures in Prince George in 2050 rise by an annual average of 2.5 °C over current levels, and 3.2 °C in the winter. Annual Precipitation increases by 15%, with a 22% increase in winter precipitation. Snowpack declines annually by 18%, reflecting an increase in precipitation falling as rain instead of snow. Although precipitation has increased, much of it occurs in intense rainfall events, so there is also an increase in droughts[5].

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Prince George Visioning Exercise
Communication - Forecast #2:

Planning Successes:

- Stakeholders create a hopeful community vision that addresses the need for climate change adaptation;
- The public is made aware of climate change adaptation, and the costs associated with not acting on the issue. They demand that actions be taken to minimize the risks and maximize the potential benefits to the community;
- Farmers and Industries in the city incorporate climate change adaptation into their business plans;
- Elected officials recognize the need for action, and pass appropriate legislation; and
- A planner is hired to focus on climate change adaptation, and given appropriate resources and support.

Development of the City of Prince George:

Development continues in Prince George, adhering to the strategies and regulations outlined in a comprehensive climate adaptation strategy (which may be its own plan or incorporated into an existing plan). This plan includes short and long term adaptation planning strategies, and bylaws to enforce adaptation rules. Due to strong incentives, infill development takes place in a centralized fashion close to water supplies and away from flood prone and high fire risk areas. Infrastructure is designed to withstand future climate projections, and water use is mitigated in order to maintain local groundwater sources. Building density increases to minimize infrastructure service and maintenance requirements.

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References:

[1]**City of Prince GHG Reduction Plan RFP:**
http://www.city.pg.bc.ca/city_services/supply/2005_documents/P05-26.pdf
[2]**City of Prince George Bylaw 7855:**
http://www.city.pg.bc.ca/city_services/cpd/newzoning/bylaw7855.pdf
[3]City of Prince George Water Conservation Program:
http://www.city.pg.bc.ca/city_services/utilities/waterconservation/water_conservation_plan.pdf
[4] **City of Prince George Community Forest:**
http://www.city.pg.bc.ca/rec_culture/parks/urbanforestry/communityforest/
[5]**Walker and Sydneysmith. 2008. British Columbia: in From Impacts to Adaptation; Canada in a Changing Climate 2007, edited by Lemmen, Warren, Lacroix and Bush; Government of Canada, Ottawa, ON, p. 329-386**
[6]**Milly et al. 2002. Increasing risk of great floods in a changing climate. Nature. 415: p. 514-517.**

Appendix C: PIBC Workshop Focus Group and Integrated Session Posters

Appendix D PIBC Conference Questionnaire

Background Information:

For the purpose of this survey please focus on climate change adaptation and not mitigation. The international Panel on Climate Change defines adaptation as '*the adjustment in natural or human response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities*'. Adaptation is about planning for the impacts that will occur as a result of climate change (i.e. taking into account increased flooding events), whereas mitigation focuses on reducing greenhouse gas emissions.

Part A. You, and your experience with climate change adaptation

1. Please provide your complete job title:_____

_____

2. Are you a consultant? **Yes / No**

3. Please circle the order(s) of government(s) / client groups that you most frequently work with:

a. First Nations	**b. Municipal**	**c. Regional**	**d. Provincial**
e. Federal	**f. Private sector**	**g. NGOs**	**h. Other**

4. Please circle the type(s) of activities that you most frequently engage in for your job:

- Prepare policy
- Advise politicians
- Prepare bylaws/regulations
- Enforce bylaws/regulations
- Community involvement
- Prepare development proposals
- Review development proposals
- Project and team management
- Undertake research
- Other (please specify) _____
- Other (please specify) _____

5. Please circle the number from 1 to 5 that you feel best represents your knowledge of climate change adaptation?

1. (no knowledge)
2. (minimal knowledge)
3. (some knowledge)
4. (extensive knowledge)
5. (expert knowledge)

6. Have you been involved in climate change adaptation planning before?
Yes / No

6b. If yes, please briefly describe when, where, and how:

_____
_____
_____

Part B. Climate change adaptation in your community

7. Which community or region do you live in? (If you've been working in/with a different community than you live in recently, and are more familiar with their planning practices, please name that community instead.)_____
_____(This will hereafter be referred to as 'your community'.)

8. Are you currently involved in the local planning processes in your community?
Yes / No

9. Please fill out the chart on the adjoining page by rating each of the impacts related to climate change based on how you feel that they will affect your community and the province. Do this by circling the corresponding number in each cell for the different impacts on your community, on your community in 50 years, and on BC (or Yukon) in 50 years. Please use the following ranking criteria:

0. don't know.
1. no effect.
2. little effect - no or minimal planning is required.
3. moderate affect that should be planned for.
4. Large effect that should be strongly considered.
5. Severe effect that needs to be planned for.

(Please raise your hand if you would like a better explanation of how to fill out the chart!)

Climate Change Impact	Effect this impact is **currently having on your community**	effect this impact **will have on your community in 50 years**	effect impact **will have on BC* in 50 years**
Forest impacts (fires, composition, disease)	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Increased river flooding	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Sea level rise	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Increase in severe weather events	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Health issues	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Slope stability / landslips	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Water shortages	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Water quality degradation	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Effects to building infrastructure	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Effects to transport - ation infrastructure	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Effects to storm - water infrastructure	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Agricultural affects/changes	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Degradation of permafrost	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Other_____ _____	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Other_____ _____	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
Other_____ _____	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5

*please indicate if you are filling this chart out for the Yukon and not BC-thanks!

10. Has your community taken proactive measures to begin to consider climate change adaptation? **Yes / no / Don't know**

10b. If you answered yes, please briefly explain the initiative(s) that are occurring:_____
_____
_____
_____
_____

11. Please rank the 3 top barriers that limit your community from incorporating climate change adaptation into its plans by placing the numbers 1, 2 and 3 (1=biggest barrier, 2=2nd biggest barrier, etc) beside the corresponding barrier:

___ **Lack of climate change adaptation knowledge within planning community**

___ **Lack of climate change adaptation knowledge within political community**

___ **Lack of funding for climate change adaptation actions**

___ **Planners too busy to focus on future adaptation**

___ **Limited public interest in climate change measures**

___ **Lack of localized data to provide future climate projections at local scales**

___ **Lack of action plans to assist communities in taking adaptation action**

___ **Other (please explain:**_____**)**

___ **Other (please explain:**_____**)**

12. Do you feel that policy actions related to planning for community adaptation to climate change actions should be outlined in:

a) **Official Community Plans (OCPs)** **Yes / No**

b) **Integrated Community Sustainability Plans (ICSPs)** **Yes / No**

c) **In separate adaptation documents** **Yes / No**

d) **Regional Documents** **Yes / No**

e) **Provincial Documents** **Yes / No**

f) **Other (please specify):** _____ **Yes / No**

g) **Other (please specify):** _____ **Yes / No**

Thank you very much for your participation in the survey. Please put the 'survey' box by the door on your way out, or leave it at the registration desk afterward if you need more time.