

A Feasibility Assessment to Study Societal Adaptation and Human Health Impacts under Various Future Climate Scenarios Anticipated in the Canadian Prairies

Report on Prairie Round Table Discussions

by

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Abstract

Climate change could alter the health status, directly or indirectly, of populations on the Canadian Prairies. However, the health effects of climate change on Prairie residents, and short-, medium-, and long-term adaptation measures that will be required, are largely unknown. We invited various stakeholders in four sectors (Government, Industry, Academia, and Public) to participate in Round Table Discussions (RTDs) in order to obtain a balanced perspective for the future directions that research might take regarding human health and climate change. Discussions took place in each Prairie province with the following objectives: to identify meaningful and feasible human health and climate change research questions specific to the Prairie region; to identify resources available for the conduct of research into the relationship between human health and climate change; and, to identify opportunities for public outreach and education regarding adaptation to climate change. Our results indicate that there is a need for greater collaboration between physical sciences and health sciences, a need to better understand future climate scenarios, and a need to understand how these scenarios could affect the health of human populations on the Canadian Prairies. Other significant issues of high priority to Prairie stakeholders were: water quality and quantity, economic effects of climate change, air quality and other pollutants, adaptation capacity posed by the future climate challenges, new disease burdens, agriculture and rural health, and, finally, risk communication and public outreach. The interdependence of adaptation on measures to mitigate climate change could not be ignored in any of the discussions.

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List of Acronyms

C-CIARN	Canadian Climate Impacts and Adaptation Research Network
ENGO	Environmental Non-Governmental Organization
FYI	For Your Information
GCM	General Circulation Model
GHG	Greenhouse gases
ILO	Intensive Livestock Operations
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Governmental Organization
PARC	Prairie Adaptation Research Collaborative
RTDs	Round Table Discussions
SES	Socio-economic status

Preface

The Prairie Adaptation Research Collaborative (PARC) was formally established on March 24, 2000. It was the first node of approximately 12 to be established by the Canadian Climate Impacts and Adaptation Research Network (C-CIARN). The 12 identified nodes represent the geographical regions within Canada and the various sectors that would be affected by climate change. PARC is a facilitative, interdisciplinary research collaborative that addresses the impacts of, and necessary adaptations to climate change in the Prairie provinces. The initial call for proposals was in April 2000, and of the 32 successful grant applications, only one was to address the human health aspect of climate change. While the focus of our activity is on *adaptation* (i.e., shorter-term prevention strategies), many participants in the Round Table Discussions recognized that medium-to-longer term considerations also necessitated a focus on *mitigation* (i.e., longer-term prevention strategies) to reduce human-induced impacts on climate.

Climate Change is a significant issue globally, gaining the attention of all sectors of society. The world's expert panel on climate change (i.e., the Intergovernmental Panel on Climate Change (IPCC)) predicted in their Third Assessment Report* that Earth will experience a 1.4-5.8°C increase in average global atmospheric temperatures by 2100. However, this is a global average and therefore not all parts of Earth will experience the same predicted warming. In fact, some areas are expected to experience cooling.

According to General Circulation Models (GCMs) that predict future climate scenarios under varying greenhouse gas (GHG) concentrations, land areas will warm more rapidly than the global average, and in the northern latitudes temperatures will probably exceed the global average warming by more than 40% (IPCC, 2001). Canada includes a vast area of land in the northern hemisphere, and therefore will be affected greatly by global warming and climate change. Some of the impacts predicted through climate change are: sea level rise, exaggerated hydrological cycle bringing forth more extreme and more frequent severe weather events, more extreme heat related events, and a change in the distribution of ecosystems and their respective flora and fauna.

Climate and weather patterns are intimately linked to human health. It is from these things that we protect ourselves using technological advancements. It is also the environment and the climate that supports human existence. As Canadians, we are fortunate to enjoy a universal health care system and a social support network that will aid Canadians in times of crisis. Our present system currently can cope with the demands of nature and the disasters that sometimes ensue. However, health infrastructure and policy are based on today's climate, weather, social structure and societal expectations. As climate change continues to exert its effects, there will be increased pressure placed on Canada's social support structures, and questions will begin to arise concerning how much of its social support system can, and will, be funded publicly under expected climate change demands.

* Intergovernmental Panel on Climate Change, Third Assessment Report 2001: Climate Change 2001: Impacts, Adaptations, and Vulnerability. Summary for Policy Makers. <http://www.ipcc.ch>

Much of the research to date on climate change and human health has been from a global, continental or country perspective. Yet, within each continent and even within each country, there are different eco-regions (Prairie, Tundra, Coastal) that will experience, and will need to adapt to different climate change impacts. Within Canada, no research to our knowledge has been conducted to investigate the human health effects from climate change in the Prairie region. Although climate modeling (GCMs) has predicted future climate scenarios for the Prairies, the human health consequences associated with the changed scenarios have not been addressed. The purpose of applying epidemiology and public health to adaptation is to minimize the impacts of extreme weather events on human health and well-being, in addition to the utilization of health care services.

Human health and climate change is a relatively new area of research in Canada, although the idea of climate change and climate variability from anthropogenic causes has been around for several decades. To conduct pioneering research on climate change and human health on the Canadian Prairies, meaningful hypotheses must be tested. From the perspectives of the various stakeholders residing on the Canadian Prairies (academic, industry, government, and public), the purpose of this study is to identify the most pertinent research areas and priority questions in need of answers.

Section I: Introduction: Why Round Table Discussions?

Of 32 successful grant applications awarded funding by PARC, this project was the sole one to investigate the relationship between human health and climate change on the Canadian Prairies. Because no known prior research was identified that studied human health adaptation measures needed in the wake of climatic change in the Prairie region, it was our intent to:

- a) Examine the linkages and commonalities among the various sectors potentially affected by climate change (i.e. industry, government, academia, and public sectors);
- b) Establish a network of research collaborators and potential stakeholders concerned with the health effects of climate change on people residing on the Canadian Prairies for the purpose of providing information and opinions on the relevant components of the research process;
- c) Identify priority research areas and questions, potential outreach opportunities, and target audiences for increasing public awareness of individual adaptation strategies in the face of climate change and human health from the perspectives of the stakeholders and collaborators[†]; and
- d) Present an in-depth literature review, based on current knowledge, investigating the potential human health impacts from the various climate scenarios predicted by GCM models in the Prairie Region.*

Methods

Using an established PARC network, the networks of the co-investigators on this grant, and internet searches, individuals and organizations were identified to be potentially affected by climate change in the Canadian Prairie region. Four main sectors were identified, Government, Industry, Academia, and Public (NGO/ENGO). E-mail correspondence was employed as the medium for establishing contact. Two hundred and forty-five individuals were initially contacted, all of whom have health or climate change expertise or experience, or have had prior research experience with either health, climate change or a related area. The initial inquiry regarded whether the particular organization would be interested in participating in discussion groups, and becoming a part of a Canadian Prairie resource network regarding climate change and human health. In addition, we encouraged the recipients to forward the initial contact letter and attachment to any other person or organization known to have an interest in climate change and human health issues (snowball sampling).

Through this initial endeavour, it came to our attention that some individuals and organizations were interested in the research project, but could not participate because of time constraints. At this point, a For Your Information (FYI) copy list was initiated. This

[†] This objective is slightly revised from that in the original proposal through the additional focus on “priority research areas and questions”

* Because of PARC’s reduced funding for future research competitions, this objective was narrowed from that of producing an in-depth research proposal. However, an in-depth research proposal will be prepared for Fall, 2001 grant competitions.

allowed individuals to remain informed through periodic updates. Members of the agreed participant list and the FYI copy list totaled 47.

Judging from the locations and availability of the agreed participants, three RTDs were scheduled in three Prairie cities: Regina (February 20, 2001), Winnipeg (February 21, 2001), and Edmonton (February 22, 2001). The total number of attendees at all three RTDs was 20*. The discussions were designed to answer three questions: a) What is (are) the most pressing issue(s) regarding climate change and human health that your sector faces today that needs further research consideration?; b) What resources would your sector have available, or could be made available, for the conduct of relevant research and/or the dissemination of research findings?; and c) What is your sector doing to reach, educate, and extend public consciousness, mitigation or adaptation to climate change, and could these efforts be expanded? If so how? Each RTD lasted three hours and, in addition to discussion, each participant wrote their responses to each question on separate pieces of paper. Additional participation was via e-mail by individuals that could not attend. The number of e-mailed submissions was 7.

This report is the synthesis and analysis of the RTDs and e-mail responses to the above three questions. In **section two** of this report the answers to the three questions are outlined. **Section three** reflects on the general discussion and emerging ideas brought forth in the RTDs that went beyond the three questions. This includes innovations, and adaptive and mitigative solutions to the research topics introduced in the first section. In addition, this section identifies the barriers or considerations that must be addressed or anticipated when conducting climate change and human health research. The **final section** contains recommendations and conclusions. The Appendices provide a visual representation of question one, a participant e-mail address list, and a detailed description of the second and third research questions for information purposes, resource sharing, idea generation, and potential collaboration.

This report is only part of the agreed upon deliverables required by PARC under the grant. Objective (d) is to provide a detailed literature review, analyzing future climate scenarios and their plausible and possible human health impacts in the Prairie region. The literature review is to be reported by the end of June 2001, and will be distributed to all participants and FYI list members.

*The final 20 was not a fraction of the original 47 on the FYI and Participant lists. Because the RTDs were not closed, 5 additional participants that were not originally on the participant or FYI list also attended the discussions.

Section II: Research Findings

The Round Table Discussions had three specific goals:

- To identify meaningful and feasible climate change and human health research questions specific to the Prairie region;
- Identify the resources each sector would have available for the conduct of research or for the dissemination of findings regarding climate change and human health; and
- Identify current public outreach and educational opportunities regarding adaptation and mitigation to climate change.

Although it was not our original intent, this report could provide a general framework for judging the relevance of research projects that pertain to climate change and human health in the Prairie region. The framework thus could be of assistance with respect to resource allocation for future climate change and human health research.

Question 1. What is (are) the most pressing issue(s) regarding climate change and human health that your sector faces today that needs further research consideration?

Three primary themes were raised by all sectors for priority attention. As such, these could be seen as priority areas for future climate change and human health research on the Prairies. Appendix A contains a diagrammatic representation of how these three core areas could provide answers to climate change and human health research questions.

1. Climate Scenarios. It is necessary to understand what future climate might result from climate change, not only for the Prairie region, but also on a sub-regional or local scale. This is necessary for planning short-, medium-, and long-term adaptation strategies. This is likely best done through GCMs that provide a powerful tool for modeling changes in Prairie weather under various conditions. However, GCM modeling on small areas is very uncertain, which is one barrier to climate change and human health research in the Prairie region as noted in Section III, General Discussion of Emerging Issues. In addition, a need was identified to define regional impacts according to eco-regional boundaries, rather than by geo-political boundaries.

- What are the potential climate scenarios to which humans will have to adapt (positive and negative) in the Prairie region over the short-, medium-, and long-terms?

2. Linking Climate Scenarios to Human Health. We must establish and define the linkages, characteristics, and nature of the relationships between future climate scenarios and human health outcome variables at local and regional levels. We must address the questions:

- What are the probable direct and indirect impacts on human health of different climate scenarios? What are the consequences of these scenarios for the population in terms of biological threats, economic impacts on farmers, food production and safety hazards, and the associated health implications?

- How could socio-economic status (a well-established determinant of health) change in various population segments with respect to the future climate scenarios expected by GCMs?
- What health outcomes should be considered for effective surveillance and monitoring?
- What are the historical relationships concerning the effects of weather, climate and climate variability on human health? Does baseline scientific knowledge regarding these relationships exist for the Prairies?
- How will the health of individuals and populations be affected by hotter summers and milder winters in the Prairie region in the short-, medium-, and long-terms?
- How applicable to the Canadian Prairies is the research completed elsewhere (e.g., internationally)?

3. Partnering between the Health and Physical Sciences. Climate change and human health research requires multidisciplinary, multi-sectoral and interdepartmental efforts. A concern raised was the lack of networking among sectors and between departments that: a) will be directly or indirectly affected by climate change; b) need to collaborate for basic research on the health effects of climate change and; c) have to plan and implement adaptation strategies, not forgetting the benefits to be derived from adopting appropriate medium-to-long term mitigation measures. In general, there is a split between the physical sciences and the health sciences communities.

In addition to these three areas, climate change and human health research topics and questions can be expanded to encompass more specific regional concerns. They are listed below as additional themes (numbered 4-10) in no particular order.

4. Water Quality and Quantity. All sectors recognized that water quality and quantity issues are and will continue to be extremely important for the Prairie region in many different ways. Some areas or regions may suffer from a lack of water resources, and others may have more flooding; all regions could experience large rainfall events within a short period of time, possibly overwhelming current infrastructure capacity. Questions that arose included:

- Will the Prairie region have safe potable water and in sufficient quantities to satisfy the Prairie region, the individual provinces, and small, localized areas within each province?
- Will the switch from grain production to more water intensive livestock operations (ILOs) be sustainable under various future climate scenarios with respect to water quantity?
- How will water quality change as a result of ILOs?
- What impacts will runoff from ILOs have on human health in terms of water quality and quantity?
- What might happen to water quality (i.e., potable water availability) with increased large precipitation events and flooding, especially areas serviced by aquifers? For example, during the Red River flood in Manitoba in 1998, water from aquifers mixed with that from the sewer systems.

5. Economic effects of Climate Change on the Public Health System. Several participants felt it was important to put a dollar figure on how climate-induced changes will affect the provision of medical services (directly and indirectly). Specifically:

- What human and financial resources will be necessary to service an already stressed public health system (e.g., not enough physicians)?
- What is our current economic capacity for emergency response to disasters?
- In addition to an economic impact from climate change on the health system, what health resources (short- and longer-term, positive and negative) will be needed for health sector planning?
- Could new financial difficulties arise in any major employment sector (e.g., agriculture) adding new stresses to health?
- What will be needed in terms of socio-economic support and infrastructure to mitigate and adapt to the effects of climate change on health?

6. Air Quality and Other Pollutants. Air quality and the synergistic effects of pollutants on human health when combined with a changing climate were considered important. With heat, photochemical reactions convert fossil fuel emissions to secondary pollutants that amplify the already harmful effects of smog to respiratory health. Questions arising include:

- What is the relationship between climate change and pollutant levels, and what would be the human health effects of these levels (singly and in combination)?
- How will climate change affect common pollutants (e.g., industrial, fire smoke, pesticide application), and how will these pollutants affect human health?
- What are some of the synergistic effects between air quality (e.g., smog) and weather (e.g., more high/extreme heat days)?
- Will there be a need to implement higher standards for dealing with the cumulative fate and toxicity of pollutants that snowball over time and that may change in composition with higher surface temperatures?
- After shifting to a more energy efficient society in which homes become more airtight, will indoor air quality decrease? Could radon concentrations increase?
- If the environment becomes more humid, will there be a new challenge of mould toxicity?

7. Adaptation Capacity and Future Challenges. In order to adapt to climate change, it was felt that an inventory was needed of the present capacity of society to adapt, in addition to an estimation of what adaptation (and mitigation) measures would need to be implemented for the future. To have a vision of where society will be in 5 or 10 years time would be valuable for planning adaptation (and the associated mitigation) strategies.

Questions that need to be addressed included:

- What is the current capacity of communities to adapt to climate change in terms of infrastructure, behaviours, emergency response, and the ability to cope with emerging infectious diseases?
- What additional infrastructure will be needed to help adapt to the future effects of weather on health? What associated mitigation measures would be appropriate?
- Can our current sewer systems and water treatment facilities cope with more frequent flooding events?

- How will costs of goods and services, livelihoods, and personal choice be affected by climate change?
- Historically, where have people been most vulnerable to high temperatures (e.g., top floors of brick buildings) and what adaptation measures have been successful in the past (e.g., lighter coloured buildings)?
- What are the characteristics of homes pleasing to people, but are energy efficient and have a minimal impact on the environment?
- What are the new safety challenges that might arise from global warming in the transportation sector?

8. New Disease Burdens. Concern was expressed relating to the changes in the distribution of human, animal, and crop diseases (human- and animal-ecosystem health relationships) as temperature rises and international travel increases. Questions included:

- Does climate change have the potential to increase bacterial/insect populations, and what are the consequences of this along the food chain?
- Will warming allow for higher levels of disease and more bacterial growth in animals that may transfer to humans?
- How will climate change affect food safety?
- What changes in the frequency and severity of vector- and rodent-borne diseases are expected from climate change?
- What potential new populations of insects are expected?
- What is the historical relationship between vector-borne diseases and unusual concurrent weather patterns, and could this relationship be used to indicate whether extreme weather events are good predictors of outbreaks?
- Will Post Traumatic Stress Disorder and other mental health issues become more prominent?

9. Agriculture and Rural Health. The Prairie region has historical roots in agriculture, and this industry relies heavily on weather and climate for agricultural outputs and the livelihood of its residents. The unpredictability of climate can greatly affect crop yields and possibly force agricultural communities to change success strategies. Therefore, the health and welfare of farmers, the residents of rural communities, and the agricultural industry were noted as being important to participants. Questions arising included:

- How is climate change likely to affect the mental health and stress levels of farmers?
- What are the potential effects of migration and the infestation of new insect species on crop yields?
- What are the health effects of a major shift in economy (from grain production to intensive livestock operations) or the need to change farm management (e.g. transportation costs, pesticide and fertilizer usage) on rural communities?
- Will rural communities experience more allergy/respiratory problems, and will pesticide residues, odours, dusts, and allergens be disseminated for longer periods?
- Will ozone depletion increase skin cancer owing to the predominance of outdoor work?

10. Risk Communication and Public Outreach. More effective risk communication and public outreach strategies must be developed in order to transfer scientific knowledge to the public and to successfully target populations for implementing both adaptation and mitigation measures. Questions arising included:

- What is the public's perception of the health risks and benefits from climate change?
- How do we target an aging population that may not be sensitive to these environmental issues?
- Where and how do people begin to educate themselves about climate change and human health issues (e.g., how do we simplify the massive amount of literature)?
- How can we provide accurate, easily understood information to the public, which changes their ideas and behaviours in a positive, pro-health manner?
- How can research findings and adaptation and mitigation strategies be presented to society most effectively?
- How do we take global climate change and health issues and place them in a context to which individuals can relate?
- How can the science of climate change and human health deliver a message that could influence health policy?
- What are the social and cultural barriers that prevent sincere and honest communication of science and health issues and how do we address them?
- Which populations are most vulnerable with respect to climate change and human health?
- What targeted messages will need to be developed for the various sub-populations with respect to age, sex, vulnerability and socio-economic status?

Question 2. What resources would your sector have available, or could be made available, for the conduct of relevant research and/or the dissemination of research findings?

The Prairie region is rich with expertise and information resources to conduct climate change and human health research. Each sector has available a number of resources to promote and support research in this area. (Please see Appendix B for a more detailed breakdown of the resources available from each sector. The e-mail addresses of the participants are contained in Appendix C.)

Government:

- Various departments have money available to fund research projects either directly or indirectly.
- Existing networks and user groups can be utilized to disseminate research information.
- Considerable expertise in the physical sciences (e.g., climate, meteorology, extreme weather climate modeling, scenarios modeling, GIS applications, and hydrology).
- Health science expertise (e.g., toxicology, epidemiology, surveillance, data analysis, and experience in conducting health assessments).
- Maintain a wide variety of climatological (e.g., hydrometric, temperature weather network, precipitation, and limited water quality data) and health databases (e.g. descriptive data, hospitalizations, physicians visits), in addition to air quality data.

- Workshops and presentations for stakeholders and in-reach programs for employees.
- Links to other organizations.
- Communication links with public and media.

Industry:

- Utilization of their existing communication system with employees and the community.
- Help leverage studies.
- Trade journals, newsletters, and websites.
- Time available for guidance in identifying epidemiological and weather records, writing or editing publications.
- Identify agencies likely to be interested in the topic from the point of view of risk management and scenario occurrence.
- Education in training opportunities linked to well-educated senior management.

Academic:

- Networks available from current research in the area of climate change.
- List-serve participation for the dissemination of information.
- Ability to incorporate study results into university course curricula, assignments, and work-study programs.
- Availability of a database that overlays rural municipality boundaries over the Prairie provinces.
- Socio-economic vulnerability/socio-economic adaptability modeling of the impacts of climate change at the local level (Regional Municipalities).
- Expertise in climate and health research, statistical modeling, multivariate air mass approach, weather data analysis and GIS.

Public:

- Elaborate networking systems, print materials, and public education programs for the dissemination of research findings.
- Limited funds available for research that is of interest to their stakeholders.
- Links to various other NGOs/ENGOS, health organizations, and the government.
- Conferences.

Question 3. What is your sector doing to reach, educate, and extend public consciousness, mitigation or adaptation to climate change, and could these efforts be expanded? If so how?

Please see Appendix B for a more detailed description of the various outreach and educational programs.

Government:

- Have extensive education (K-12 and general public) outreach programs province-wide and local.
- Participate in the organization and promotion of workshops on understanding the use of future climate scenarios.

- Presentations tailored to ecosystem health for their stakeholders on climate change science and impacts (e.g., industry, agriculture).
- Activities and events (e.g., Special Weeks, Earth Day, and Commuter Challenge).
- In some departments, a science communication strategy has not been fully developed.
- Promotes and coordinates education and outreach on climate change in Alberta (Climate Change Education Hub).
- Specific department advertisement campaigns on busses, print, TV, radio and billboards.
- In-reach for employees.
- Without having answers to the core areas with a reasonable degree of certainty, it is difficult to engage in outreach

Industry:

- The message is a negative one and might meet with some resistance.
- In-reach programs for employees that explain the relationship between greenhouse gas emissions and energy use.
- Workshops available for the community on climate change (e.g., The ABC's of Climate Change).

Academic:

- Developing a visual medium for health risk communication.
- University class materials and course curricula.
- Climate change workshops and conferences.
- Projects that relate large-scale climate change issues to the local and individual level.
- University classes with respect to how science can effectively communicate with the public.
- Provision of expert opinion (climate variability/change and health) to community environmental campaigns.

Public:

- Health education materials (websites, magazines, print material and maintenance of a library for public use).
- Educational programs.
- Answer calls from the public.
- Annual conferences and regular contact with their member networks.

Section III: General Discussion and Emerging Issues

Discussions with Round Table Participants were informative and offered much more information than simply answers to the initial questions. Discussion included the *innovative* and creative use of interdisciplinary resources as possible solutions and how to enhance *adaptive and associated mitigative strategies*. In addition, discussion touched on the potential *barriers* that may need to be overcome for climate change and human health research, adaptation, and the associated mitigation strategies that will need to be recognized and accepted by society.

Innovations

a) *Piggyback*. Funding agencies could potentially acquire two studies from one by expanding the effort by an increment (e.g., 30%) and therefore ask potential researchers to add another relevant part, or question, to the initial experiment or questionnaire in order to promote climate change and health research.

b) *Education in training*. There are many well-educated senior management figures that need and want to mentor. Some consulting firms invest in students as a means to confer the future direction of their businesses.

c) *Outreach: opportunities and innovative ways to communicate to stakeholders*. Public health is an excellent driver for raising awareness about climate change at the policy and societal levels. However, health research has to be presented to the public in an effective and innovative way to have the greatest impact on policy and societal adaptation. Using GIS and cartography techniques as a visual medium, health research and risk communication can be more effectively communicated to the public. The possibility of designing interactive video games with “what-if” scenarios for use by school-aged children would benefit education and outreach.

d) *The Socio-Economic Vulnerability and Socio-Economic Adaptability (SEV/SEA) Project at the University of Winnipeg*. This project measures the impact of climate change on Prairie communities by taking large-scale information (e.g., future climate scenarios) and shrinking it to the community and even to the farm level (e.g., individual and community economic impacts). Thus, the impacts from climate change become individual because the model details how climate change can affect each farmer economically. Attaching a dollar figure for losses and gains may be a powerful motivator for societal adaptation. In addition, this project has available a database that lays Rural Municipality boundaries over the Prairie provinces.

e) *Climate and Health Research Program (CHRP), Department of Earth and Atmospheric Sciences, University of Alberta*. This ongoing research program and its affiliated researchers have been studying issues such as heat stress and health, the synergistic effects of air pollution and weather on human health, and the relationship between ENSO events, weather, and mosquito transmitted diseases. The innovative methods developed as part of CHRP can be used in research on climate-health relationships in the Prairies. These

methods include air mass-based weather classification, air quality and health data time series analysis, statistical analysis including spatial analysis and methods for small areas and populations, and GIS for analysis and visualization.

f) *Government.* Environment Canada is driving to gain a better handle on what the future climate scenarios are, mostly in terms of extreme weather. Research is mainly event driven and localized.

g) *Forums are needed for bringing together ministries of health and environment.* It has been uncommon for ministries of health and those of the environment to jointly discuss issues pertaining to health linkages related to environmental degradation. Great benefit could arise from organizing a workshop for health and environmental related fields for future networking and collaboration.

h) *Gathering of PARC research teams.* Advantage could be gained if each PARC research team could present their research to all other research teams in order to learn about, and possibly use, the linkages and networks built by other projects. In addition, this opportunity would allow for the evaluation of potential overlap and collaboration in research endeavours.

i) *Multivariate Air Mass Approach.* The external environment not only consists of precipitation, temperature, and solar radiation, it also includes humidity, pollen, dust, and particulates, which are housed within air masses. This unique approach could sum many small parts into a larger whole, and could be combined with GCM or regional climate model-derived climate scenarios for use in impact and adaptation research applied to the Prairies.

Adaptation and Mitigation

a) *Government leaders.* Presently, individual customers are demanding energy efficient building designs. Because the Government occupies most building space, they set the standard for spending on technology, innovation and energy efficiency. Therefore, the Government at all levels must lead the way for future building design standards.

b) *5-10 year strategic outlook.* Forward movement in adaptation and the associated mitigation strategies require having an end goal in sight. Working towards the objective will require starting at the end and working backwards using a time line to organize the steps in which the goal is to be achieved. Climate change and human health research and policy should incorporate this strategy into research designs and decision-making processes.

c) *Energy efficient building designs.* There is a need for building designs that promote a sense of well-being and comfort without compromising the environment. Natural lighting and solar energy within energy efficient buildings may actually enhance well-being and health owing to the tendency of these building types to be brighter and more airy.

d) *Educating K-12.* Education of school-aged children is an adaptation and mitigative strategy that could have a substantial impact in the long-term. Governments and NGOs have targeted many outreach programs specifically to school-aged children. However, attempts should be made to introduce climate change education more formally into school curricula.

e) *Historical Data Analysis.* Understanding how individuals and society have adapted to climate variability in the past may uncover some short-term adaptations for the future. Learning from mistakes and triumphs could decrease adaptation costs and the time spent between inventing and implementing adaptation measures.

Barriers

a) *Media.* The media is an important way in which to relay human health and climate change research findings and adaptation measures to the public. However, the media can distort images, print partial stories, or even miss the entire message. It was noted at each discussion that the interface between science/research and the media has to be utilized. However, a sound strategy must be adopted in order to communicate the climate change and human health adaptation message effectively. Consultation with editors was noted as being one potentially effective strategy.

b) *Fear Mongering.* Health is a useful vehicle and a potentially powerful tool to bring climate change issues into the forefront of the public consciousness. But, health also has the potential to scare society. Using fear tactics is a poor way to attempt to change societal behaviour. While it serves to gain the attention of the public, recidivism rates are high. Climate change research on human health must consider both the positive and negative aspects if credibility is to be maintained. Trustful and honest communication that does not instill panic or use fear as the driving force for change is essential.

c) *Future climate scenarios.* An important aspect of adapting to future health impacts from climate change is to have reliable and credible climate scenarios. However, there are limitations on the ability of large-resolution GCMs to provide precise projections of potential climate futures in the Prairie region. Temperature projections are most reliable; however, precipitation and extreme weather event projections are more uncertain.

d) *Human health indicators.* Finding and utilizing good human health indicators with which to measure the health effects of climate change may be difficult. For example, asthma may seem to be a good indicator of respiratory health, but people sometimes treat themselves, thus leaving no record for research purposes. In addition, “diagnostic creep” and confusion of asthma with other respiratory ailments may further devalue asthma as a quality indicator of changing respiratory health as it relates to climate change. Another health indicator could be mortality, which involves fewer uncertainties than cause-specific morbidity. Other possible health indicators are infectious diseases. Climate change is likely to affect the distribution and frequency of infectious diseases because in many cases they are connected to biological and ecological systems (which are expected to change through climate change). These diseases would possibly be more likely to be recorded,

incidence and distribution can change over the short- and longer-terms, and they are relatively stable (e.g., they are not likely to be misdiagnosed or the definition of their diagnosis will change).

e) *Networking*. Networking activities inevitably increase the demand on an individual's time. Most people already have busy schedules. A lack of incentives to justify the extra time to participate in a network makes establishing networks a very difficult task. Therefore, incentives need to be provided to motivate and make participation possible for the various stakeholders and increase interaction across traditional academic disciplinary boundaries. In addition, incentives could be viewed as a mechanism that would help stakeholders to regard climate change and human health issues as part of their agenda. The nature of incentives does not need to be only monetary.

Section IV: Summary, Recommendations and Conclusions

Health and well-being factor into all aspects of human life. Thus, it is difficult to view human health and climate change research as distinct from all other ongoing climate change research. This research endeavour attempted to incorporate the various perspectives from four main sectors (Government, Industry, Academia, and Public) in order to gain a balanced perspective on the feasibility of human health adaptation research in the face of climate change on the Canadian Prairies.

According to the IPCC Third Assessment Report^{*}, climate change appears inevitable and likely to be greater than previously thought. Thus, residents in all regions of Canada must become focused on adapting to future climate scenarios specific to their geographical area/eco-region.

Networking among the four sectors proved to be much more difficult than asking for participation in Round Table Discussions. Only 12 of the original 26 committed participants attended a Round Table Discussion; 5 individuals attended from the open invitation; 3 individuals attended from the FYI copy list; and, 7 responded through e-mail.

A limitation of this report is that certain industries were not represented. Some industries (e.g., those that deal with agriculture/livestock production, pesticides) might be very interested in the issue but we did not contact them. Despite these challenges, our research was able to engage in a meaningful exchange of information with what seems to have been a reasonable representation of individuals and organizations from each of the four sectors. Certainly, excellent discussions and ideas were generated which are documented in this report.

From the RTDs and e-mailed responses, it was noticed that almost all sectors had similar concerns regarding the priority research questions and topics with respect to human health and climate change. Through analysis of the proceedings it became apparent that several research areas needed better definition before other research topics could be investigated. The first question is one of acquiring an understanding of the possible future climate scenarios in the Prairie region. Second, from the scenarios, health scientists and other related scientists (e.g., ecologists and entomologists) could begin to define the nature of the relationship, linkages, and characteristics between climate change and human health. This could be accomplished by examining historical records where the scenarios have played out in the past, or by using current literature comparing health outcomes from similar scenarios that have occurred in other regions in the world. Third, and finally, the need to address the split between the health sciences and physical sciences communities was noted.

Defining these initial three domains is important for several reasons. First, climate change and health scientists need to have a good understanding of what future climate scenarios are most likely to arise with warmer global temperatures in order to promote the best adaptive strategies with respect to direct human health impacts (e.g., more severe weather

^{*} Intergovernmental Panel on Climate Change, Third Assessment Report 2001: Climate Change 2001: Impacts, Adaptations, and Vulnerability. Summary for Policy Makers. <http://www.ipcc.ch>

events). Second, how the various future climate scenarios could affect human health indirectly (e.g., if vector-borne diseases move northward, or if increased stress-related disease occurs in farmers) is important in planning for future possible disease burdens that current health care strategies may need to incorporate. Finally, networking the various departments and sectors intimately involved in climate change research is fundamental for the advancement of human health and climate change adaptation research.

All RTD participants were aware of some of the future climate scenarios expected in the Canadian Prairies. However, how these would eventually be connected to human health research projects was less familiar.

This report classifies the possible domains in which future climate scenarios could affect human health into seven thematic categories (see Section II, Question 1, themes numbered 4-10). These themes are: water quality and quantity, economic effects of climate change on the public health system, air quality and other pollutants, adaptation capacity and future challenges, new disease burdens, agriculture and rural health, and risk communication and public outreach. Within each theme, research questions associated with regional/local issues of the stakeholders within each sector were identified. Although the research questions within each of the themes were identified by the participants, these are not necessarily exhaustive. The hope is for additional research that will build on the insights provided here. During the RTDs, many innovative suggestions were put forward because participants were able to generate new ideas based on interactive discussion.

Finally, participants recognized the need to overcome potential barriers to climate change and human health research. Barriers also were noted concerning adaptation and associated mitigation strategies (see Section III: General Discussion of Emerging Issues, for a more detailed description of innovations, adaptation and mitigation, and barriers). They also need to be overcome.

Recommendations

1. Climate change and human health research needs to be based on solid principles. Therefore, it is recommended that the initial three thematic areas (future climate scenarios, linking future climate scenarios with human health, and the partnering between the physical sciences and health sciences) be defined more adequately.

This research endeavour has attempted to identify the various individuals and organizations that could be directly or indirectly affected by climate change. Therefore, partnering between the physical sciences and health sciences has begun in the Prairie region. However, future proposed research should include a coordinator capable of devoting time to facilitating networking and the ongoing dissemination of results to stakeholders for feedback and re-incorporation into the research process. In this regard incentives are needed for academics, institutions, and stakeholders to interact across traditional disciplinary boundaries, to encourage inter-disciplinary and also trans-disciplinary research, and make climate change and human health issues a part of their agenda.

Solutions to systemic problems are not going to be found through exclusive adherence to the reductionist paradigm.

Meaningful climate change and human health research needs to be based on sound climate scenarios and plausible human health outcomes. There is a real need to couple global and regional models, and for climate scientists to: 1) provide usable, appropriately-scaled climate projections to climate impacts and adaptation researchers; and 2) suggest the “best” scenarios to end users who rarely have the needed background to distinguish between models in terms of accuracy, robustness, and reliability. Thus, increased interaction with climate modelers and end users is necessary. In this regard, the nature of the relationship between future climate scenarios and human health could then be defined more adequately, and more specific research questions could be investigated. For example, with an increase in surface temperatures by 3°C, what vector-borne diseases should the Prairie region need to plan for? Once these linkages are understood, more effective and efficient human health research should be piggybacked onto the physical science research of climate change wherever possible.

Uncovering the link between future climate scenarios and human health could be accomplished by examining historical records where the scenarios have played out in the past, or by using current literature that compares health outcomes from similar scenarios that have occurred in other regions in the world. Historical climate variations or extremes (e.g., drought, heat waves, extreme weather events, or flooding) have been recorded and, where possible, these scenarios could be linked to health databases during the same time period. Outcome variables then could be used for surveillance and monitoring of health conditions, in addition to providing a framework for the allocation of health care resources in the future. A review of the current literature is being undertaken as the second deliverable under the present PARC grant. It is due by the end of June, 2001.

2. Mitigation is an important component of, and often not easily separated from, adaptation. Canada and other countries will be experiencing the effects of climate change in the future. Thus, adaptation is necessary for the short-, medium-, and long-term, but it should include mitigation measures whenever possible to lessen the need for adaptation in the future (medium- and longer-term outlooks). This may be especially important with respect to outreach, educational opportunities, and media relations. In terms of human health, emissions reductions are an important element of adaptation to climate change. It also has a role for long-term mitigation.

From the adaptation perspective, emissions from fossil fuel combustion acts in synergy with warmer temperatures creating new air pollutants. For example, ground-level ozone is notably higher as temperatures increase. These new air pollutants exacerbate the air quality problem from the emissions themselves, and significantly contribute to respiratory problems. Therefore, we recommend education to the general public as well as the promotion of climate change being incorporated into the agenda of K-12 education programs. Education that is targeted, standardized and consistent with best available knowledge, based on the most current information would be optimal. From the mitigation perspective, reductions in emissions from fossil fuels combustion will likely reduce the

extent and severity of the current weather cycle precipitated by past impacts on the global warming from human activity. A science communication strategy on climate change adaptation and mitigation options should be developed, and delivered. Periodic evaluation and revision would be essential in the face of every-changing information and realities.

3. We recommend that a workshop should be organized that presents all PARC research projects. This would provide an opportunity to learn from other research projects, collaborate with research teams, and share the knowledge and experiences of conducting climate change research. A workshop would allow for the networking of expertise in areas that are crucial to human health and climate change research (e.g., scenario development and prediction).

Because health is an important component of all aspects of life, human health and climate change research or data collection should be effectively piggybacked on other research projects for little additional cost. For example, questionnaires regarding the economic impact of climate change on farming practices may effectively introduce several health-related questions. In addition, innovations developed by other research projects could be effectively implemented for use in human health research (e.g., GIS, air mass classification, spatial statistics, small area analysis).

4. Possibly through C-CIARN, a national forum for health and the environment, centering on adaptation to climate change and related issues, should be organized. This would provide the opportunity to merge the health and physical science fields nationally. Again, a forum of this type would identify new resources and innovations to make human health and climate change research more efficient. Networking and collaboration of expertise in the various fields would be facilitated.

5. A strategy by which research findings, adaptations, and possible mitigation strategies should be disseminated to the public, should be developed by PARC for use by all of the research teams funded under PARC. In other words, the need exists for media advocacy, or the conscious use of the media to move the climate change agenda forward. Health is a powerful tool that brings the global phenomenon of climate change into focus for the individual.

Conclusions

Round Table Discussions were effective in achieving their objectives of: identifying meaningful and feasible climate change and human health research questions specific to the Prairie region; identifying the resources each sector would have available for the conduct of research or the dissemination of findings regarding climate change and human health; and, identifying current public outreach/educational opportunities regarding adaptation and mitigation to climate change. In total, 27 individuals and organizations contributed to the attainment of the objectives.

Results indicate that there is a need for greater collaboration between physical sciences and health sciences, a need to have a better understanding of the future climate scenarios and

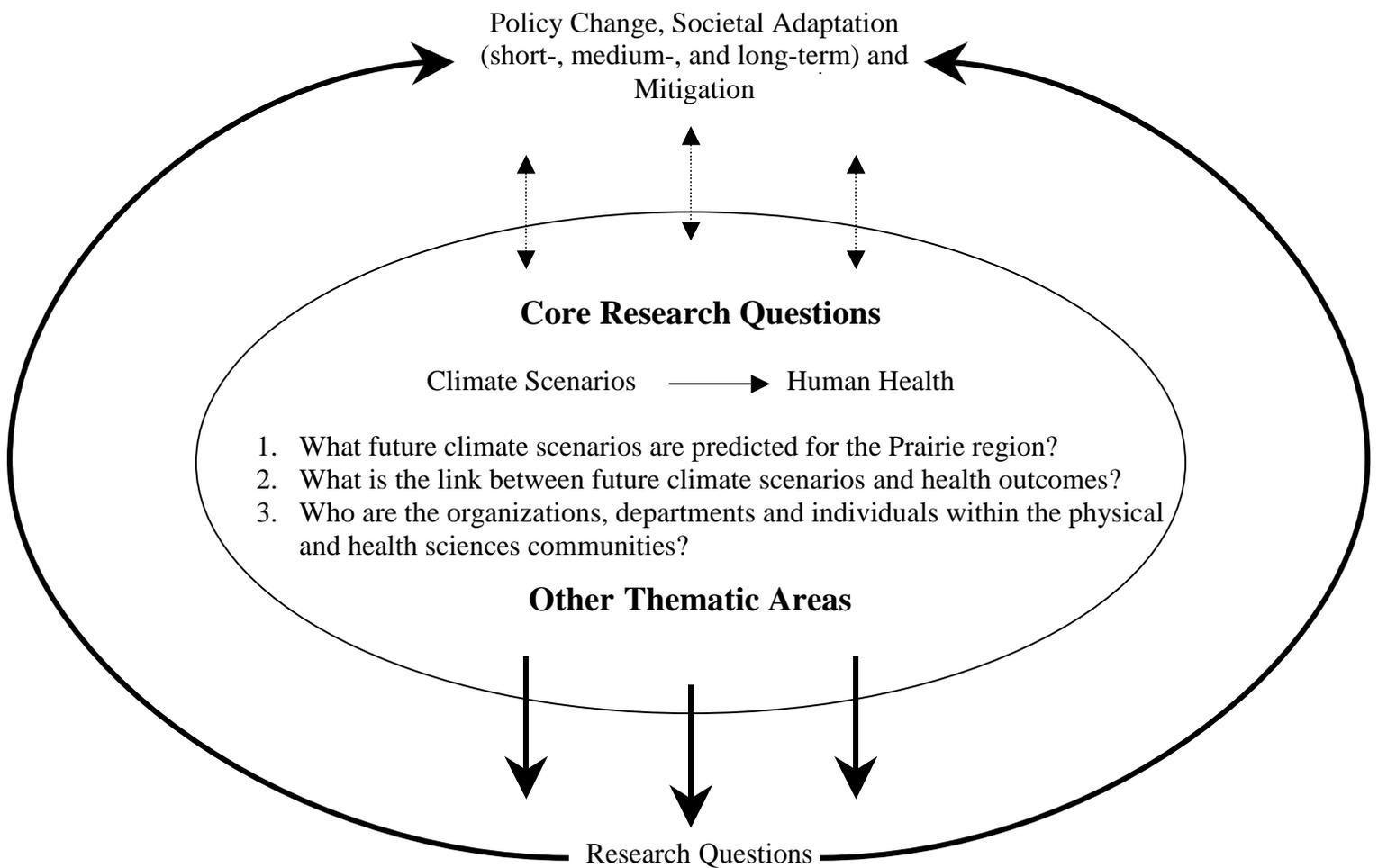
how these scenarios could affect the health of human populations on the Canadian Prairies. In addition, water quality and quantity, economic effects of climate change on public health, air quality and other pollutants, adaptation capacity and future challenges, new disease burdens, agriculture and rural health, and risk communication and public outreach were of high priority to Prairie stakeholders.

Several innovations, and adaptation and mitigation opportunities/strategies were identified that could benefit and further future climate change and human health research. Some of these include: piggybacking a research question on an already funded research question for only a marginal incremental cost; the SEV/SEA project currently being completed at the University of Winnipeg; on-going climate/air quality/health research with the Climate and Health Research Program at the University of Alberta; Environment Canada being motivated to understand how climate change may affect the frequency of severe weather events; and, a need to focus on K-12 education. However, barriers must also be overcome or at least be considered when initiating human health and climate change adaptation research. Barriers include: media distortion of climate change and human health issues; fear mongering as a driver of societal adaptation; limitations of GCM modeling; selection of appropriate human health indicators; and, the difficult task of networking.

Final recommendations were based on the results of the Round Table Discussion results and the conclusions drawn from the general discussion and emerging issues (Section III). Final recommendations include: a clearer definition of the three primary research themes; consideration of mitigation commitment with adaptation; the need for PARC research teams to present research projects for one another to generate resource sharing, networking, and collaboration; suggest to C-CIARN the organization of a research forum between the health and physical sciences communities; and, the need to develop a media advocacy strategy by PARC.

Appendix A

How the three core areas of priority research could provide answers to climate change and human health research questions.



Appendix B

Resources, Dissemination of Findings, and Outreach Opportunities.

Each sector and departments within each sector have their own networks, linkages, public outreach, employee in-reach strategies, educational programs, and funding sources for climate change research. As discussed in this report, it is important to share information and program development or innovation so that research dollars and energy is used optimally. Below is a list of some of the resources available to Prairie-based climate change researchers. It should be noted that only items for which specific contact information could be provided have been included below; other resources are known to be available. Therefore, the reader should treat this Appendix simply as a starting point. More effort than available under the current PARC grant would be needed to provide a more complete listing.

National:

1. Environment Canada (EC). Environment Canada has considerable expertise in meteorology, climatology, hydrology, and GIS applications. They also maintain climate databases (hydrometric, temperature, water quality databases (limited), and precipitation) and the weather network.

Climate and weather:

Jim Ross, Head, Climate Archives Section, Environment Canada, Edmonton, AB.
ph (780) 951-8875, fax (780) 495-3529, email jim.ross@ec.gc.ca

Water quantity:

Merle Moore, Applications Coordinator, Water Survey of Canada, Prince Albert, SK.
ph (306) 306-953-8574, fax (306) 953-8542, email merle.moore@ec.gc.ca

Water quality:

Bing Chu, QA/QC Coordinator, Water Survey of Canada, Regina, SK.
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<http://www.ec.gc.ca/envhome.html> or <http://www.ec.gc.ca/climate/index.html>.

2. Climate Change Action Fund (CCAF). There are four components to CCAF. Individuals or organizations interested in submitting proposals for funding under the CCAF should contact the appropriate CCAF component directly.

http://www.climatechange.gc.ca/english/actions/action_fund/index.shtml

3. Transport Canada (TC). TC is well-aware of its role in global climate change issues and takes a very proactive approach to the mitigation of climate change. TC provides funding support through their Moving On Sustainable Transport (MOST) program.

http://www.tc.gc.ca/envaffairs/MOST/Main_e.htm.

4. A useful international site, which is the United Nations Framework Convention on Climate Change <http://www.unfccc.int/>. This link provides information on the Kyoto Protocol.

Provincial or Regional

1. Alberta Heritage Foundation for Medical Research (AHFMR). Each year AHFMR awards over \$40 million in grants and awards in five program areas.
<http://www.ahfmr.ab.ca/frames1.html>
2. Alberta Agriculture, Food, and Rural Development. This website features pests and diseases that affect agriculture, and ranching operations which include vertebrate pests, plant diseases and insects and livestock diseases, among others. Through *Land, Water and Climate* link there is a variety of links including environmentally sustainable agriculture, and climate and air quality.
<http://www.agric.gov.ab.ca/>
3. Alberta Environment and the Bureau of Climate Change. These two websites offer an overview of the Government of Alberta's rationale for their involvement in climate change issues, the challenges of emissions reductions in Alberta, and involvement in initiatives mitigating or adapting to climate change. Mitigation and adaptation includes: alternative energy, education and outreach, and effective action in agriculture, among others.
<http://www.gov.ab.ca/env/climate/index.html> and <http://www.gov.ab.ca/env/>
4. Alberta Environment. Alberta Environment offers formal education programs targeted to K-12, pre-service and in-service teachers, in addition to environmental education and educational resources on climate change. Some materials are to be used in a classroom setting and other resources are available to the general public.
http://www.gov.ab.ca/env/resedu/edu/ee_res.html
5. Alberta Lung Association (ALA). Their mandate is to raise funds to support respiratory research, community health education programs and professional education in Alberta and NWT. The ALA's greatest strength is communication with the public. In addition, they have an extensive network with other lung associations and have excellent public education outreach programs. <http://www.ab.lung.ca> or Canadian Lung Association: <http://www.lung.ca> and in French: <http://www.lung.ca/fr/>
6. Clean Air Strategic Alliance (CASA). CASA is a not-for-profit partnership, its memberships include representatives from government, industry and non-government organizations. CASA has been actively involved in climate change issues and has initiated a multi-stakeholder Climate Change Project Team in November, 1998.
<http://www.casahome.org/>
7. City of Regina. The City of Regina has a climate change education program called 'Cool Down the City' which revolves around special events. In addition, the city has a 'Green Ribbon Community Climate Change Advisory Committee' that focuses on a strategy that will move Regina closer to their GHG emission reduction targets.
http://www.cityregina.com/content/info_services/environmental/climate.shtml

8. Climate Change Central. Climate Change Central is a private-public partnership between Alberta businesses, governments and the environmental community. It offers climate change partnership opportunities, intelligence, and funding.

<http://www.climatechangecentral.com/>

9. Community Animation Program (CAP). CAP is a joint initiative of Health Canada and Environment Canada that involves the Prairie and Northern Region. Its focus is to contribute to the sustainability and health of Canadian communities.

<http://www.mb.ec.gc.ca/community/ecoaction/cap/ba02s00.en.html>

10. Dr. Colin L. Soskolne. Dr. Soskolne is from the University of Alberta, Department of Public Health Sciences, Epidemiology Program. Dr. Soskolne has interest in the implications for public health from a decline in ecological integrity from several different standpoints. Dr. Soskolne was instrumental in producing the “Discussion Document” on Ecological Integrity and Human Health, for the World Health Organization in 1999

accessible at: <http://www.who.it/Emissions/Globaleco/globaleco.htm>. A summary of this document is at: <http://www.elements.nb.ca/theme/health/colin/who.htm>

Dr. Soskolne’s home page is at: <http://www.med.ualberta.ca/PHS/staff/soskolne/>

11. Dr. Ed Cloutis, University of Winnipeg, Department of Geography. His areas of interest include remote sensing, Geographic Information Systems (GIS), planetology, and spectroscopy. Currently Dr. Cloutis is working on the SEV/SEA (Socio-Economic Vulnerability or Socio-Economic Adaptability) impacts of climate change on Prairie Communities at the Regional Municipality level, which is funded by PARC. The project has also generated a network of approximately 160 contacts, which have provided advice and/or guidance with climate change research.

<http://www.uwinnipeg.ca/~geograph/faculty.html>

12. Dr. Karen Smoyer-Tomic. University of Alberta. Dr. Smoyer-Tomic has been researching the relationships among climate, air quality, human health, and socio-economic factors in Canada and the U.S. since 1989. In addition to her research into the health impacts of and potential for adaptation to climate change, she is active in the Science/Policy/Media interface, which focuses on how science can effectively communicate with the public through the media. She also is involved in various list serves and has expertise in air mass-based weather classification methods, multivariate and spatial statistical modeling (including small areas/populations), and the use of large weather, air quality, health, and census datasets.

<http://www.ualberta.ca/~eas/People/profs/smoyer.htm>

Climate and Health Research Program (CHRP) webpage

<http://www.ualberta.ca/~ksmoyer/chrphome.htm>

Situating Place in Health Research (SPHR) webpage

<http://www.ualberta.ca/~ksmoyer/webpage/home.htm>

13. ECOMatters. ECOMatters is an environmental consulting company that specializes in detailed understanding of basic processes in terrestrial and aquatic environments. An ongoing project is addressing the concern of manure management and the possible impacts of the phosphorus in the manure on streams and rivers.

www.ecomatters.com/

14. Innovation and Science Research Investments Program (ISRIP). This is a competitive funding program offered by the Government of Alberta in the amount of \$30 million. Three distinct funding streams will allocate money that will support selected science and research initiatives of strategic importance to Alberta.

<http://www.gov.ab.ca/is/research-grant/>

15. Institute of Health Economics (IHE). The IHE is an independent, not-for-profit organization that delivers health economics, health outcomes and health policy research and related services.

<http://www.ihe.ab.ca/index.htm>

16. Manitoba Conservation (Energy) Program Division: Climate Change Branch. There is funding information (through MCCAF) and published material on climate change. In addition, there are free energy efficiency workshops for new homebuilders and current homeowners.

<http://www.gov.mb.ca/natres/energy/index.html>

17. Manitoba Climate Change Action Fund (MCCAF). Priority areas for funding include education and outreach, impacts and adaptation, technical innovation and energy efficiency. <http://www.gov.mb.ca/natres/energy/mccaf/mccaf-brochure.html>

18. Prairie Adaptation Research Collaborative (PARC). <http://www.parc.ca>

19. RL&L Environmental Services Ltd. RL & L is a professional consulting firm specializing in aquatic biology and research on large rivers and in remote environments. They offer comprehensive project services in the fields of water quality analysis, environmental engineering and hydrology, and reclamation planning.

<http://www.rll.ca>

20. Saskatchewan Research Council (SRC). A branch of the SRC focuses on the assessment of climatic hazards and the development of strategies that reduce the negative impacts from climatic variability and allow for benefit from the positive impacts.

<http://www.src.sk.ca/climatology.html>

21. Solar Energy Society of Canada Inc (SESCI). SESCO promotes the increased use of solar and other renewable energies in Canada. To promote these goals SESCO has developed programs in three broad areas: education, technical development, and public policy. SESCO also has a network of approximately 600 members.

www.solarenergysociety.ca

22. Syncrude Ltd. ABCs of Climate Change. Syncrude Ltd. invests in employee education, training, and on-the-job development. Every fifth employee has attended a workshop explaining the relationship between climate change and GHG emissions and energy use. Syncrude Ltd. also has participated in the *ABC Program: Action by Canadians on Climate Change*. The ABCs include seminars, personal action exercises and tools that provide climate change information to help staff of Canadian organizations reduce greenhouse gas emissions.

http://www.syncrude.com/enviro/action_plan00/education.html

23. Toma and Bouma Management Consultants. The website should be up and running soon. www.tomaandbouma.com

Appendix C

Participant e-mail address list.

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