paper 1

CLIMATE CHANGE:
BUILDING THE ADAPTIVE CAPACITY

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ABSTRACT: Canada and China co-hosted an international conference titled *Climate Change: Building the Adaptive Capacity* in Lijiang, Yunnan, China from 17-19 May 2004 on climate change adaptation science, management and policy options. This paper outlines the objectives of the conference, and provides brief introductions to each of the papers found in this peer-reviewed book. Each paper falls under one of the six themes: the keynote paper by Burton (2004) on the concept of an adaptation deficit; Canada-China Collaboration in Adaptation to Climate Change Research; Climate Change Impacts, Indicators and Assessments; Agriculture; Energy, Infrastructure and Growth; and Ecosystems and Biodiversity.

Keywords: climate change, adaptation, Canada, China, adaptive capacity

1. Introduction

Canada and China co-hosted an international conference titled *Climate Change: Building the Adaptive Capacity* in Lijiang, Yunnan, China from 17-19 May 2004 on climate change adaptation science, management and policy options. About 100 people met to hear experts share their global knowledge about adaptation to climate change with representatives from key international, Canadian and Chinese institutions, agencies and sectors. The conference assisted in:

- showcasing the most recent science, management and policy options available in the climate change adaptation community;
- strengthening the capacity of key Chinese institutions, and sectors such as agriculture, to identify and assess the sensitivities and vulnerabilities associated with climate change;

- promoting the integration of adaptation strategies into Chinese government development and planning initiatives; and
- enhancing the adaptive capacity of Chinese agencies to employ techniques, tools and approaches to climate change adaptation.

The conference program included keynote addresses from invited speakers such as Ian Noble, advisor on climate change adaptation to the World Bank; Richard Moss, director of the US Global Change Research Program; Ian Burton, president of the International Society of Biometeorology; Lin Erda, the Chinese Academy of Agricultural Sciences; Yongyuan Yin, researcher with the Meteorological Service of Canada; David Warrilow, UK Department of Environment, Gerry Metcalf, UKCIP, and Don MacIver, director of the Adaptation and Impacts Research Group, Meteorological Service of Canada. Sessions were held on developing and applying climate scenarios for adaptation science; adaptation science assessments; vulnerability and adaptation to climate change in socio-economic sectors; synergies and integration; integrated assessments and policy; and case studies on the Canada-China Cooperation in Climate Change (C5) Project; and the Integrated Assessment of Vulnerabilities and Adaptation to Climate Variability and Change in the Western Region of China (AS25) Project.

The conference marked the final reports from the adaptation science section of the CIDA-funded project titled *Canada-China Cooperation in Climate Change (C5),* as described in a subsequent paper of this book from the Conference, whose overall goal is to contribute to Canada's international climate change objectives, help China better address the issue of climate change while at the same time contributing to sustainable development and poverty reduction within the country.

The co-sponsors of the conference were many, and include: Assessments of Impacts and Adaptations to Climate Change (AIACC); United Nations Environment Program (UNEP); System for Analysis, Research and Training (START); Third World Academy of Sciences (TWAS); Canadian International Development Agency (CIDA); Chinese Meteorological Administration; China State Development and Reform Commission; Chinese Academy of Agricultural Sciences; International Society of Biometeorology; The Canada-China Cooperation in Climate Change (C5) Project; the Integrated Assessments of Vulnerabilities and Adaptation to Climate Variability and

Change in the Western Region of China (AS25) Project; Natural Resources Canada and the Meteorological Service of Canada, Environment Canada.

2. Building Adaptive Capacity to Climate Change

Climate change will result in a set of diverse and regionally-specific impacts on natural ecosystems and human societies. A growing literature suggests that while climate mitigation strategies are necessary to reduce greenhouse gas emissions from anthropogenic sources, those alone are unlikely to be sufficient. As studies have shown, the impacts of climate change from previous emissions of greenhouse gases over the past 150 years will have to be confronted by all countries. Therefore, pursuing a complementary strategy of enabling countries to adapt to climate change and negate many of the expected adverse impacts is equally, if not more, urgent (Adger and Kelly, 1999; Burton et al., 2002). To determine how countries are equipped to deal with the inevitable impacts of climate change requires an understanding of each country's adaptive capacity. A country's adaptive capacity is its talent and willingness to take the initiative in making adjustments to reduce the negative impacts of climate change. Fundamentally, adaptive capacity is the ability to respond to climate changes and then to initiate responses to these climate changes.

Adaptive capacity in ecological systems is related to genetic diversity, biological diversity, and the heterogeneity of landscape mosaics (Carpenter et al., 2001; Peterson et al., 1998; Bengtsson et al., 2002). In social systems, the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem-solving and balance power among interest groups play an important role in adaptive capacity (Scheffer et al., 2000; Berkes et al., 2002). Systems with high adaptive capacity are able to re-configure themselves without significant declines in crucial functions in relation to primary productivity, hydrological cycles, social relations and economic prosperity.

Adaptive capacity can be best understood with reference to vulnerability and resilience (Dayton-Johnson, 2004). Vulnerability is the tendency for people, ecosystems, communities, etc. to be damaged; while resilience is the opposite of vulnerability, and refers to the ability of people, ecosystems, communities, etc. to resist or recover from damage. Vulnerability and resilience are two sides of the same coin (SOPAC, 2004). Something is vulnerable to the extent that it is not resilient.

This international conference examined the building of adaptive capacity in China. One important aspect of that capacity is the information provided in the book from the Conference.

3. The Collection of Peer-Reviewed Papers

The primary role of this conference, and the title of the conference itself, refer to building the adaptive capacity to climate change. One major initiative to build capacity is in providing knowledge. This peer-reviewed collection of papers from the conference presents concepts, ideas, tools and other resources for assisting China, and in fact all countries, in adapting to the impacts of climate change.

The papers are organized in this book around the themes of the conference including the keynote paper on the adaptation deficit; Canada-China Collaboration in Adaptation to Climate Change Research; Climate Change Impacts, Indicators and Assessments; Agriculture; Energy, Infrastructure and Growth; and Ecosystems and Biodiversity.

3.1 The Keynote Paper – The Adaptation Deficit

The keynote paper is provided by Burton (2004). Burton introduces the concept of an adaptation deficit. Two types of adaptation are identified in the paper - Type I Adaptation, the everyday adaptation to weather and climate that has always been a feature of human life; and Type II Adaptation, the adaptation mandated under the UN Framework Convention on Climate Change (UNFCCC). Type I Adaptation is promoted as part of sustainable development, while Type II Adaptation relates to anthropogenic climate change and is subject to the rules and practices under the Convention. The two types of adaptation are similar but not identical. Type I Adaptation has traditionally assumed a stationary climate, and in Type II Adaptation, the climate is changing and the international community has a cost-sharing responsibility under the UNFCCC.

Burton suggests that there is a need to bring about a single seamless process of adaptation as Type I Adaptation has not been working very successfully considering that the losses from extreme weather and climate-related events are rising rapidly. This failure of current adaptation to keep pace with development is what Burton calls the adaptation deficit. Type II Adaptation could be developed under the Convention to help eradicate the adaptation deficit. This would require the development of a more formal adaptation regime under the Convention similar to the mitigation (Kyoto) regime that already exists. The paper concludes that, one, there is an unacceptably large and growing adaptation deficit; two, the adaptation deficit can be more effectively addressed by combining the UNFCCC work with the development process and mainstreaming climate risk; and three, by developing a more coherent and operational adaptation regime, there will be more confidence that the efforts to adapt to a changing climate will be rewarded with success.

Burton's keynote paper is followed by four short discussions that further the adaptation concept including Bass (2004) on measuring the adaptation deficit; Etkin (2004) on natural disasters and the growing gap of vulnerability; Fenech (2004) on natural capital and the adaptation deficit; and Mirza (2004) on addressing the adaptation deficit through funding.

3.2 Canada-China Collaboration in Adaptation to Climate Change

The second theme of Canada-China Collaboration in Adaptation to Climate Change begins with a linkage paper by MacIver (2004) on mainstreaming adaptation and impacts science into solutions. MacIver identifies the scientifically-sound knowledge, information, data, models, maps and policy strategies that have been used by the Adaptation and Impacts Research Group (AIR Group) of the Meteorological Service of Canada, Environment Canada over the past decade. MacIver views the adaptation process as an iterative, non-linear cycle that involves multi-disciplines, multi-agencies and all Canadians. MacIver presents the stages leading to adaptation outcomes including the knowledge creation and sharing process that involves scientific, technological, institutional, behavioral, political, financial, regulatory, and/or individual adjustments to the changing climate.

Jasmin et al. (2004) present a description of the successes of the Canada-China Cooperation in Climate Change (C5) Project funded under the Canada Climate Change Development Fund (CCCDF) of the Canadian International Development Agency (CIDA). C5 is organized around four components: awareness and outreach, national communication, adaptation and impacts and clean development mechanism. Jasmin details the most significant benefits of the C5 Project as an increased ability for China to address the issue of climate change (from emissions reductions through to adaptation), and the improved abilities for Chinese organizations and individuals to make decisions and take action that include climate change considerations.

Yin (2004) presents the integrated assessment approach designed for the project titled Integrated Assessment of Vulnerabilities and Adaptation to Climate Variability and Change in the Western Region of China, known as the AS25 project, a sub-project of the Assessments of Impacts of and Adaptation to Climate Change in Multiple Regions and Sectors (AIACC). The case study is the Heihe River Basin of China that provides an example of the integrated approach as an effective means for climate vulnerability assessment and the synthetic evaluation of the general desirability levels of a set of adaptation options through a multi-criteria and multi-stakeholder decision making process.

3.3 Climate Change Impacts, Indicators and Assessments

The third theme of Climate Change Impacts, Indicators and Assessments begins with a paper by Clinton et al. (2004) that provides an approach for quantitatively synthesizing the concepts of risk, impact, sensitivity and vulnerability with regard to climate change. Clinton et al. review approaches for the formulation of indicators for agricultural, water resources and socioeconomic vulnerability to climate change in the Heihe River Basin, an arid region of North West China. Quantitative issues involved with indicator formulation, computation and geographic allocation are discussed in this paper, with methods of fuzzy set construction finally proposed for continuous, categorical, and qualitative indicators.

Cohen (2004) presents work on a collaborative study of climate change and water management in the Okanogan region of British Columbia, Canada. An interdisciplinary approach is used, incorporating participatory processes as part of the research on regional adaptation experiences and consideration of future responses. Results of the hydrologic and water demand research efforts indicate that future climate changes are likely to result in reduced water supply, increased water demand, and an increased frequency of high risk years in which high demand and low supply occur concurrently. The Okanogan region has experienced droughts in recent years, and several communities and water purveyors have initiated measures to manage water demand. Cohen suggests that future climate change will require a portfolio of supply and demand measures, and needs to be considered as part of a basin-wide strategy that integrates with regional development plans.

Zhang et al. (2004) explores the relationship between climate change and war in China, by comparing high-resolution paleoclimatic reconstructions with the known incidence of war in China over the past millennium. The authors demonstrate a remarkable correlation between climate change and the incidence of war. Zhang et al. shows that wars broke out more frequently during cold phases, and suggest that the reduction of the thermal energy input during cold phases resulted in the shrinking of livelihood resources in the traditional agrarian society, which in turn led to armed conflicts or wars between states, tribes and peoples on the lands with different carrying capacity.

Bass and Etkin (2004) discuss whether climate change adaptation should focus on the use of existing, and the development of new, technologies or whether it should focus on the root causes of vulnerability - behavioural change and risk perception. The technological fix arguments are that resources should be put into promoting existing technologies that have been shown to be effective but underutilized, and the development of new technologies. The behavioural technique argues that behavioural change is essential, and the notion that one must choose either a technological or a behavioural solution is a false dichotomy. The paper concludes that technology will undoubtedly play a large and important role in climate change adaptation, but by itself is not sufficient to solve the adaptation problem. Behavioural changes are necessary as well - indeed they are likely to be the more crucial factor.

Bass (2004a) presents an interesting paper using an agent-based simulation model to conduct a large number of experiments, underlying the research into artificial life simulations and Holland's work with genetic algorithms and classifier systems. The research is based on the simulation platform, Complex Organization and Bifurcation Within Environmental Bounds, or COBWEB. COBWEB simulates how a system of autonomous agents adapts to variation and sudden changes in the resource base. COBWEB was set up as a generic system of agents in an environment, but can be configured to represent an ecosystem or a social system. In COBWEB, when the population is well adapted to its environment, an increase in resources is followed by an increase in population, which in turn is followed by decreasing resources, that is, the predator-prey pattern in ecology.

In environmental change experiments conducted for this paper, the system was most sensitive to changes in the energy cost of activities, particularly movement, and the amount of energy available from resources. This was highlighted in two sets of experiments designed to mimic invasive species and the response of the system to climate change, expressed as a change in the length of seasons. COBWEB also allows for experiments with communication and memory. A series of experiments was conducted with very low rates of resource production, in other words, a resource scarcity. Without communication, all of the agents died out. With communication, the probability of survival for the whole population increased by 50 percent. The simulations highlighted the characteristics of a well-adapted system and the importance of threshold values, energy, communication and memory in adapting to variability and change. A system that is well-adapted to its current environmental variability is characterized by a balance between population and resources that is quite resilient to minor changes in various parameters that define its environment. However, at the margins, there are threshold values which, when crossed, produce more significant changes. This paper demonstrates that adaptation to change was far more likely to be successful if the available energy was increased or remained constant although the impact could be somewhat mitigated throuh inceasing the level of communication. More importantly, these experiments raise the question as to the speed of innovation required to develop new strategies to adapt to change.

3.4 Agriculture

The fourth theme on agriculture has three papers, the first of which is Rong et al. (2004) selecting socio-economic indicators to examine the adaptive capacity of Northeastern China to the impacts of climate change on agriculture. The approach is focused directly on the underlying determinants of adaptive capacity. The analytic hierarchy process (AHP) method is used to prioritize indicators to assess the potential contributions of various aspects to the systems coping capacities. Indicators are compared and analyzed. Web-mapping technology is introduced to visualize and disseminate the results.

Fang et al. (2004) study the impact of past climate warming to crop yield to understand how climate change is impacting agriculture. However, it is difficult to separate the contribution of climate change and human activities because of the traditional means of calculating real yield, trend yield and fluctuant yield of rice crops. The main disadvantage of the traditional method is that it could not show the contribution of a climatic trend to the yield trend. In this paper, a new method is put forward to calculate a yield with a climate trend. In the new method, a reference period that satisfies the hypothesis of the traditional method is selected to construct a function on the dominant meteorological factor and climate influence coefficient by regression. The function can be used to calculate the climate's influence coefficient of other years. A case study on the contribution of climate change to rice yield change from 1952 to 2000 is made for this region. The results show that, although non-climatic forces have likely dominated the trends in rice per unit area yield in Heilongjiang province, the impact of climate warming on rice production becomes more and more prominent during the past 20 years. The real rice yield per unit area in the 1980s is 30.6 percent higher than that in the 1970s. The increased yield due to a warming climate was from about 12.8 to 16.1 percent of the real increased yield. The real rice yield per unit area in the 1990s is 42.7 percent higher than that in the 1980s. The increased yield due to warming climate was about 23.2 to 28.8 percent of the real increased yield.

Wang et al. (2004) calculate the average and standard deviation of the accumulated temperature from May to September for the period 1960-1999 in Northeast China. The result shows that the heat resource in almost all of Northeast China increased during this time period. According to the quantitative relation between the heat resource and rice yield per-unit-area of different rice varieties, a model is established to calculate the expected rice yield per-unit-area. The authors found that climate warming increased rice production in the Heilongjiang and Jilin provinces of China, and reduced rice production in most areas of Liaoning Province, China. So the impact of climate warming on crop yield and structure in China should not be ignored, though it is often credited to technology and economic benefit.

3.5 Energy, Infrastructure and Growth

In the fifth theme on Energy, Infrastructure and Growth, Auld and MacIver (2004a) provide evidence from around the world indicating that the costs of weather related disasters are increasing over time. In many cases, these weather-related disasters have resulted from the failure of our infrastructure and built environment to cope with extreme weather events, environmental degradation and the location of infrastructure in high risk locations. While debate still continues on whether or not climate variability and weather extremes have increased, other evidence suggests that vulnerabilities to climate events likely have increased. Auld and MacIver suggest that reducing societal vulnerability to weather related disasters under current and changing climate conditions will require a diverse and interconnected range of adaptive actions. These actions include hazard identification and risk assessment, comprehensive disaster management, improved predictions of high impact weather, better land use planning, strategic environmental and ecosystem protection, continuously updated and improved climatic design values for disaster resistant infrastructure codes and standards, more enforcement of building codes and improved structural design methods and materials. Steps taken today to reduce the impacts of weather hazards will provide new opportunities to learn how to better face the challenges of the future. The authors conclude that while several adaptation steps, both structural and non-structural, can be undertaken today to ensure that communities can withstand the climate of the future, other adaptation actions will be limited by considerable uncertainty in projections on future extremes and by the difficulties of retrofitting or changing the existing built environment.

Mirza (2004) focuses on the impacts of climate change on the Canadian energy sector, specifically the vulnerability of the power generation, transmission and distribution components to extreme weather events. Power output loss due to low lake levels on the Great Lakes in 1964 was estimated at 4.4 million Megawatt hours. During the ice storm of 1998 in eastern Canada, power transmission and distribution suffered a total insured loss estimated at CAN$3 billion. The damage to high voltage transmission towers, distribution systems and transformers raised serious questions about the robustness of the power distribution systems in Ontario and Québec. In general, the measures to cope with the situations were found to be inadequate. The author points to the future possibilities of more heat waves, ice storms and drought conditions in Canada due to climate change. Therefore, the energy sector may become more vulnerable unless adequate adaptation measures are designed and implemented.

Chiotti et al. (2004) explore the important role that the production and use of energy in a more sustainable manner can serve as an effective integrated response to climate change, specifically the role of energy efficiency and energy from renewables. The paper draws upon secondary and primary research and highlights similarities and differences in Canada and China. The authors focus on three policy priority areas if progress is to be made on accelerating the development of renewable energy and energy efficiency. First, it is necessary to level the playing field, which currently favours the conventional centralized energy systems for electricity generation, and invest in renewable energy sources in the same way. Second, it is necessary to invest in innovative technologies for renewable energy and energy efficiency to ensure future market readiness for emerging technologies. And thirdly, it is necessary to engage a wide range of decision-makers and the public in achieving this vision, particularly at the community level. In the case of China, the authors suggest that the solution may be to build on the trend of decoupling economic growth from energy consumption and adopt a normative approach to energy production and use that accepts economic growth as a necessary but not a sufficient condition.

Auld and MacIver (2004b) focus on the vulnerability of infrastructure to climate change through gradual changes in weather patterns and through increasing variability and potential increases in extremes. Climate change will affect the safety of existing structures, potential for weather disasters, design criteria and engineering of future structures and potential for premature weathering of all structures. Because infrastructure built in current times is intended to survive for decades to come, it is critically important that adaptation options to climate change be developed today and implemented as soon as possible. The climate change adaptation actions that will likely be required in future will be significant and numerous. At the same time, infrastructure will also be required to contribute to climate change mitigation actions.

The first step will be to identify gaps in current capacity for addressing climate variability and extremes. Such “no regrets” adaptation actions are available today and include measures such as enforcement of engineering codes and standards, efforts to reduce uncertainties in climatic design values and to update calculations, maintenance of the quality and length of climate data records and networks, consistent forensic analyses of infrastructure failures, regular maintenance of existing infrastructure and community disaster management planning. Where updated information is not available, the implementation of a Climate Change Adaptation Factor may provide an option to address deficiencies in existing design criteria conditions and to allow for projected trends in future climate conditions. Where the impacts of the future climate lie outside of existing experience and the coping ranges of infrastructure, adaptation options will need to be developed over time through "adaptation learning", along with better pre-disaster planning. Climate change adaptation will require that planners, their agencies, the engineering community and community decision-makers consider timeframes beyond statutory requirements and even beyond the lifetime of most individuals. Improved understanding of climate change impacts and the need for adaptation must be combined with "tough" actions that include better risk assessment of community climate change impacts and vulnerability, the identification and avoidance of development in vulnerable areas and ongoing incorporation of adaptation strategies into land use planning and community disaster management planning. The authors conclude that such actions will entail significant costs, disruptions to communities and require political commitment and cooperation between all levels of government.

Bass (2004b) examines the recent focus of efforts for future land-use planning in Ontario on the concept of Smart Growth. Smart Growth delimits areas where cities can expand and encourages higher densities of commercial and residential land use. Bass examines how Smart Growth strategies in Ontario, Canada influence the vulnerability of Ontario's urban environments to climate change through two specific impacts – increased storm water runoff and warmer summers. The paper concludes that Ontario's Smart Growth strategies both increase and decrease the vulnerability of Ontario urban environments to climate change. It is shown that Ontario Smart Growth strategies can be modified by increasing the vegetative components of the urban environment using approaches such as green roofs that ensure a decrease in the vulnerability of urban environments to climate change.

3.6 Ecosystems and Biodiversity

The sixth and final theme of the book is Ecosystems and Biodiversity and begins with a paper by MacIver and Wheaton (2004) that provides a look at forest biodiversity and its adaptation to climate change. Adaptation of forest biodiversity means taking into account a changing climate; improving the understanding of forest landscapes, ecosystems, species and genetics under climate change; adjusting the planning, planting, tending, protecting and harvesting of our future forests; and conserving native forest biodiversity. Not all forests are alike, nor do they share the same multi-taxa, adaptive life-cycles, feedbacks and threats. Given the life cycle of most forest species, the authors suggest that forest management systems will need to adjust their limits of knowledge and adaptive strategies radically to initiate, plan and enhance forest biodiversity in relative harmony with the future climate. Protected Areas (IUCN), Global Biosphere Reserves (UNESCO), Model Forests and Smithsonian Institution sites provide an effective community-based platform to monitor changes in forest species, ecosystems and biodiversity under changing climatic conditions.

Riedel (2004) provides an examination of the potentially significant impacts of climate change on human health and well-being in Canada. Some key concerns include an increase in illness and premature deaths from temperature stress, air pollution, and increases in the emergence and persistence of infectious diseases. The effects of climate-related natural hazards and extreme events on both physical safety and mental health are another concern. Although there will likely be some benefits to climate change, such as a decrease in cold-weather mortality, negative impacts are expected to prevail. Adaptation will be necessary to reduce health-related vulnerabilities to climate change. Some adaptation initiatives include the development of vaccines for emerging diseases, public education programs aimed at reducing disease exposure and transmission, and improved disaster management plans. The implementation of early warning systems for extreme heat is another effective adaptation strategy. The author concludes that successful adaptation to climate change will require coordinated efforts among different groups and the consideration of climate change in health care decision-making.

Taylor (2004) examines the impacts of climate change on the coastal zones around Canada's Great Lakes, the largest bodies of fresh water in the world. The majority of Canadians live within the Great Lakes drainage basins and many of the larger cities and industries are located along the shores of these lakes. The coastal zone is sensitive to climate change and all the global climate models indicate a lowering of lake levels, an increase in air and water temperatures, a change in the snow and rainfall and an increase in the severity and frequency of storm events. The paper describes examples of recent efforts to restore degraded habitats in places such as Hamilton Harbour, the Toronto Waterfront and the Bay of Quinte. Major adaptation options to climate change include changes to fisheries, modification to marinas, harbours and canals, changes in power output in hydroelectric dams, changes in property boundaries and access to water are a stress on coastal wetlands that serve as habitat for a wide variety of fish and wildlife. The author concludes that the involvement of local municipalities, conservation authorities, industry and farmers is essential in planning for a future sustainable environment in a changing environment.

He et al. (2004) provide results from investigations of the glacial system at Mt. Yulong, Lijiang, China since 1999. The paper shows that glaciers have greatly retreated after the Little Ice Age because of climate warming. The recent 50-year climate data at Lijiang, the closest meteorological station to Mt.Yulong, indicate that there are 2 to 3 year periodic changes for the local temperature and apparent 11 to 12 year periodic cycles for precipitation, showing a corresponding pattern with that in the northeastern part of India. During the most recent half-century, glaciers in Mt. Yulong have alternately retreated and advanced, with smaller amplitudes. Those glaciers on Mt. Yulong with the lowest latitude and smallest area have reduced in size by 60 percent from the Little Ice Age to the present. It is evident that there is a close relation between the atmospheric temperature and glacier retreat at Mt. Yulong. The authors conclude that global warming is the major and most important reason for glacier retreat in the Lijiang-Mt. Yulong region.

Roots (2004) provides a look at the impacts of climate on tourism and recreation at protected area and biosphere reserves. Tourism, in its many forms, has been stated by the United Nations to be the world’s largest industry. It is a world-wide activity, important in both developing and industrialized countries. It provides a significant part of the economy of many countries and is an important educational, physical and psychological element in the life of millions of people. A large portion of tourist activities is oriented toward experiencing nature, and the phenomena that are attractive to tourists are commonly sensitive to climate change. Many popular outdoor recreation activities depend upon environmental conditions remaining within a fairly narrow range of those prevalent at present. Any significant change of climate could have serious consequences for tourism and outdoor recreation. Roots concludes that adaptation of the tourist and recreation industry to climate change will require increased knowledge of climatic, hydrological, and ecosystem dynamics at appropriate scales to identify and appraise the sensitivity of tourist destinations and outdoor recreation sites.

Yu and Saprunoff (2004) examine plant species richness (spermatophyte) patterns along an elevation gradient in Hubei province of China using published elevation range data. The result shows a hump-shaped distribution, with high species richness in the middle elevation range from 800 to 1400 meters. The maximum value of species richness was observed at 1000 meters, and this is accounted for about 52 percent of the total number found in Hubei province. The observed pattern in the Hubei province is compared with reports from other regions, and is related to hypotheses published in the literature. Possible factors, such as resource availability, overlap of habitats, the total land area at each elevation band, hard boundary, and human activities, may underlie the patterns. The authors conclude that there is a need for greater efforts in conserving biodiversity in the high species richness areas of Hubei province.

The final paper of the book by Beaubien and Chen (2004) looks at what can be considered to be the most sensitive and easily-observed indicator of the biotic response to climate change - the timing of spring plant development. Spring bloom and leafing dates for perennial plants are largely controlled by heat accumulation, and trends in these dates can help reveal the rate of climate warming. These phenology data have been recorded in Canada for over a century, while the record in China goes back 3000 years. Analyses of phenology data show trends to an earlier onset of spring development in many temperate areas of the world, particularly over the last three decades. This trend has been detected also by remote sensing. Impacted sectors of society and the environment could include agriculture, forestry (including carbon sequestration), human health (for example, allergy seasonality), and biodiversity. The ecological implications include impacts at the level of species, populations, communities and ecosystems. The authors conclude that future cooperation to establish observation of key indicator plant species on a wide geographic basis could greatly enhance our understanding and monitoring of the effects of climate change.

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All other references appear as individual papers in this book.

methane and carbon sequestration. These projects are producing significant results in building China's policy and technological capacity.

Canada is therefore pleased to be among the sponsors of this conference on "Climate Change: Building the Adaptive Capacity." To quote Don MacIver of the Meteorological Service of Canada, responses to the threats to sustainable development posed by climate change "must include adaptation actions that will reduce vulnerabilities to climate variability and extremes and minimize negative impacts, maximize positive impacts, and allow both Canada and China to take advantage of opportunities that arise as a result of these climate changes."

In conclusion, I would like to return to the broader bilateral context within which our important cooperation on climate change takes place. Intensive expert-level exchanges such as this are key to the progress we all wish to see made toward truly sustainable development. Yet sustained engagement at the political level is important in facilitating such exchanges, and our two countries have enjoyed a favourable climate in that regard.

In October 2003, during the visit to China of Prime Minister Chrétien, Canada and China issued a Joint Statement on Strengthened Dialogue and Cooperation on Climate Change, which expresses the desire of both governments to expand and intensify bilateral efforts on climate change, including the development of new policies and technologies in a wide range of sectors including energy, transportation, agriculture, forestry and environment. The Statement mandated the formation of a bilateral Climate Change Working Group to identify opportunities for cooperation and develop a program of work.

Climate change will continue to figure prominently as we move forward on our active bilateral agenda. It is a key component of the broader Canada-China dialogue that is central to Canada's efforts both to seize the opportunities and overcome the unique challenges of the 21st century. In that spirit, I wish you every success in your work here in Lijiang and in the months and years ahead.