

# Adaptation to Climate Change: A Policy Review



Resource Futures International

This report examines the current state of adaptation in  
developing countries from a Canadian perspective.

Resource Futures  
International

1945 Fairbanks Ave.  
Ottawa, Ontario  
Canada K1H 5Y2

613.235.4343

613.235.9916



**Adaptation to Climate Change:  
A Policy Review**

**Prepared for:  
Canadian International Development Agency  
October 31, 2001**



## TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	iv
1.0 Adaptation - Concepts and Definitions.....	1
1.1 Purpose .....	1
1.2 Introduction .....	1
1.3 Adaptation and Adaptive Capacity.....	2
1.4 Nature of the Issue.....	3
1.5 Impacts.....	4
1.6 Vulnerability.....	6
2.0 Adaptation – International Policies and Processes .....	7
2.1 Policy Drivers.....	7
2.2 International Adaptation Policy Development.....	7
2.3 Major Country Positions and Initiatives.....	9
2.4 Involvement of International Organizations .....	11
3.0 Canadian Engagement in the Climate Change Issue .....	13
3.1 Background .....	13
3.2 National Climate Change Process .....	13
3.3 Canada and Climate Change in the Developing World .....	15
3.4 Canadian Scientific Knowledge and Applications.....	16
3.5 Canadian Technologies .....	17
3.6 Canadian Capacity Building .....	18
3.7 Canada’s Developing Country Experience.....	19
4.0 Adaptation Policy Framework .....	19
4.1 Policy Needs.....	19
4.2 Baseline Conditions.....	20
4.3 Assessment Of Impacts And Vulnerabilities.....	21
4.4 Response Options .....	22
4.5 Adaptation Management .....	23
5.0 Adaptation Project Management.....	24
5.1 Project Design Parameters.....	24
5.2 Linkage with Other Issues and Initiatives.....	25
5.3 Decision Tools .....	26



5.4	Support Systems.....	27
5.4.1	Education .....	27
5.4.2	Training .....	27
5.4.3	Performance Measurement.....	28
5.4.4	Communications .....	28
6.0	<b>Building and Enhancing the Capacity to Adapt to Climate Change .....</b>	<b>28</b>
6.1	Challenges and Opportunities.....	28
6.2	Planning for Change and Uncertainty: A Rationale for Enhancing Community Preparedness and Resilience.....	30
6.2.1	Temporal and Spatial Concerns .....	30
6.2.2	Political and Public Constituencies.....	31
6.2.3	Practicality Issues Regarding Project Identification and Design.....	32
6.2.4	The Relevance Challenge .....	32
6.3	Adaptation Project Identification .....	33
6.3.1	Programmes and Practices for the Use and Conservation of Freshwater Ecosystems .....	34
6.3.2	Forest and Agriculture Practices .....	34
6.3.3	Coastal Zone Management .....	35
6.3.4	Awareness Raising.....	35
6.3.5	Land Use Planning for Hazardous Areas .....	36
6.3.6	Codes, Guidelines and Incentives.....	36
6.3.7	Institutional and Policy Capacity Building .....	36
6.4	Adaptation and Strategic Environmental Assessment.....	37
6.5	Conclusion.....	41
	<b>REFERENCES.....</b>	<b>43</b>
	<b>ANNEXES</b>	
	ANNEX I: The Adaptation Assessment Form .....	45
	ANNEX II Sources for Further Information .....	49
	ANNEX III Definitions and Terminology .....	50
	ANNEX IV: Assessment of Regional Vulnerability.....	52



## EXECUTIVE SUMMARY

The purpose of this report is to examine the current state of adaptation in developing countries from a Canadian perspective. Adaptation, as defined by the Intergovernmental Panel on Climate Change (IPCC) is defined as “the degree to which adjustments are possible in practices, processes or structures of systems to projected or actual changes of climate.” Adaptation can be a response to adverse effects, to vulnerabilities, or to opportunities; and the entity that does the adapting can be people, social and economic sectors and activities or managed or unmanaged natural (physical and biological) systems. Adaptation to climate change can be either reactive or proactive depending on timing, goals and motives. Natural adaptation in physical, biological and human systems is reactive; adaptation in human systems can be reactive or proactive.

Adaptation is an important consideration in two climate change policy streams – *impact assessment* and *response strategies*. *Impact assessment* is an attempt to understand the potential effects of climate change and includes consideration of what adaptations are likely in the natural or other systems under stress. *Response strategies* include actions to confront the effects of climate change and should recommend adaptation measures to support the systems under stress.

Climate change is an additional stress on systems already affected by increasing resource demands, unsustainable management practices and pollution, which in many cases may be equal to or greater than the stress of climate change. Recent regional climate changes, particularly temperature increases, have affected physical and biological systems in many parts of the world. Variability in local weather conditions is expected to increase so that extreme weather-related events will become more common, more severe, and potentially more damaging to local communities and local ecosystems. These stresses will interact in different ways across regions but are expected to reduce the ability of some environmental systems to provide, on a sustained basis, key goods and services needed for successful economic and social development, including adequate food, clean air and water, energy, safe shelter, low levels of disease and employment opportunities. Adaptation has the potential to reduce the adverse impacts of climate change, though adaptation measures and actions (natural or directed) will incur costs and will not prevent all damages.

Many of the countries, regions and communities of the developing world that are most vulnerable to climate change are also under stress from population growth, resource depletion and poverty. Consideration and inclusion of climatic risks in the design and implementation of development initiatives in these areas can encourage sustainable development that reduces vulnerability or enhances adaptive capacity to climate change. Decisions at all levels of decision-making, from local or community level to national governments and multinational organizations, can impact on adaptive capacity.

The United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Bonn Agreement and Marrakesh Accord contain provisions calling on the developed world to address the impacts of climate change on developing countries. Canada is in a strong position to contribute significantly to international initiatives on adaptation responses. Canadian strengths include: a highly-respected scientific community that offers a considerable array of knowledge, talent and experience; development and application of technologies for climate change mitigation and adaptation; a unique multi-stakeholder approach to the issue of climate change that has



built public awareness and broad consensus for action; and extensive experience with international aid, including assistance programming in areas related to adaptation.

A policy framework for climate change can provide a rationale and order to the formulation, assessment and adoption of adaptation measures, projects and programs. From a development perspective, climate change adaptation policies should be integrated with other environmental and socio-economic policies, as well as with the decision-making apparatus of other development assistance programs. An Adaptation Policy Framework should be built around four main components: Baseline Conditions, Assessment of Impacts and Vulnerabilities, Response Options and Adaptation Management.

Effective adaptation management provides CIDA and other aid agencies with an opportunity to develop programs to assist developing countries in planning and implementing actions for a future influenced by climate change. Climate change can result in harm to people, communities and ecosystems over the long-term through gradual changes in climate (where results are difficult to predict) and in the short-term through increased frequency and magnitude of extreme weather events. In recent decades weather-related extreme events have been increasingly devastating in developing countries in terms of economic costs and the loss of human life. An adaptation programming approach focused on preparedness for extreme weather events is particularly well-suited to Canadian development programming. The extreme conditions and negative impacts associated with extreme-weather events have disproportionately negative effects on the poor, which corresponds to CIDA's development focus on poverty alleviation.

Resource Futures International (RFI) recommends that adaptation programming concentrate on influencing human practices and preparedness that can influence the capacity of ecosystems and human communities to withstand and adapt to the impact of climate change. The rationale for this recommendation includes:

- *Temporal and spatial concerns* – The time horizons of climate change are long-term and there is little human experience to gauge appropriate response actions. Extreme weather events are expected to generate negative effects in the short-term, which can be at least partially mitigated through decisions and actions taken by people and communities.
- *Political and public constituencies* – Adaptation projects can be viewed as preparedness initiatives that will help to reduce the negative impacts of extreme-weather events. This focus allows climate change funding to impact on an area strongly supported by the Canadian public, and builds support for climate change programming in developing nations where increased awareness of short-term benefits of climate change programming can help to increase public acceptance of the goals of the UNFCCC.
- *Practicality issues regarding project identification and design* – The focus on extreme weather events is related to real-life experience and time frames, and many programming options can be implemented with limited financial and human resources – a concern of both developing countries and development agencies.
- *The Relevance Challenge* – Positive outcomes and results that are relevant to the needs of aid recipients are expected of development programming. Preparation for extreme weather events can be justified on the basis of meeting short-term needs (including water, food supply, land use), as well contributing to the long-term sustainability of ecosystems and communities.

The impact of climate change, including extreme-weather events, can be influenced by human decisions and actions. Thus, adaptation programming should focus on intervening environmental and human factors that can



mitigate the harmful and negative impacts. These factors include human land use practices and other management options that interact with the climate, weather and environmental conditions that influence the impacts of climate change. These factors also improve the capacity of local communities to recognize, predict and respond to these changes.

The recommended adaptation focus on human activities that influence the vulnerability of ecosystems and communities to climate change leads to the identification of priority programming areas. Programming in these recommended areas can be relatively low-cost, appropriate to the recipient community, and achieve results in the short-term. The priority areas recommended by RFI as amenable to adaptation planning are:

- Forests and Agriculture Practices; and
- Coastal Zone Management.



# Adaptation to Climate Change: A Policy Review

## 1.0 Adaptation - Concepts and Definitions

### 1.1 Purpose

The purpose of this document is to examine the current state of adaptation in developing countries from a Canadian perspective. The report will examine: the issue of adaptation, international policies and processes, Canadian engagement in adaptation, the incorporation of adaptation concerns in policy development and project management. As well, the report includes a conceptual framework for building and enhancing capacity to adapt to climate change, and a framework for incorporating adaptation in the Canadian International Development Agency (CIDA) Strategic Environmental Assessment process.

The document is prepared primarily for CIDA development officers, but will have application for multiple users, including developing country partners and multi-lateral agencies.

### 1.2 Introduction

Over the last decade, especially since the 1992 Earth Summit in Rio de Janeiro and later following the Conference of the Parties (COP) 3 meeting in Kyoto in 1997, a massive global effort has been undertaken to understand and assess climate change and its potential impacts on the world's physical, biological and socio-economic systems. Climate change has the potential to alter the ability of the Earth's systems (land, atmosphere and oceans) to provide goods and services essential for sustainable economic development. Enormous amounts of funding have been allocated by regional, national and international entities to address the issue. Resources have been marshaled by all sectors to develop and debate approaches to the long-range global problem. A voluminous literature has been developed on the science of climate change and climate variability and on possible measures to mitigate the anthropogenic emissions of greenhouse gases that are contributing to global warming and its associated effects. Yet, despite these efforts, consideration of adaptation to climate change has taken only a marginal part in the national and international processes.

The approach taken by international agreements has been to drive climate change policies through emission reduction commitments. The *United Nations Framework Convention on Climate Change* (UNFCCC) signed by 154 nations following the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (the Earth Summit) had, as its primary objective, the stabilization of atmospheric concentrations of greenhouse gases at a level that prevents dangerous anthropogenic interference with the climate system. The Convention also called for this level to be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.

The *Kyoto Protocol to the UNFCCC*, signed at the Third Conference of the Parties to the UNFCCC (COP 3) in December 1997, commits developed countries to collectively reduce their emissions of six greenhouse gases by a



total of 5.2 percent by the period 2008 to 2012. Both the UNFCCC and the Kyoto Protocol call on the signatories to develop national programs to address climate change, carry out technology transfer and provide new and additional resources to developing countries, and promote and develop education and training programs. Nevertheless, emission reductions are the driving force of both instruments. The provisions of the Kyoto Protocol stipulate that 55 Parties representing 55 percent of 1990 Annex I carbon dioxide (CO<sub>2</sub>) emissions must ratify the Protocol before it comes into effect.

More recently, the resumed Sixth Session of the Conference of the Parties (COP 6, Part II), held in Bonn, Germany from July 16 - 27, 2001, sought to conclude negotiations on the operational details of the 1997 Kyoto Protocol, which were left unfinished at the previous COP 6 session in November 2000 in The Hague. Delegates from about 180 countries achieved a surprising consensus and the resulting *Bonn Agreement* reflects political compromises that were made regarding four major components of the Kyoto Protocol - carbon sinks, Kyoto flexibility mechanisms, compliance, financing. All of these components focus on achievement of GHG emission reductions although the Bonn discussions also led to increased international funding for adaptation initiatives in developing countries.

The Canada Climate Change Development Fund, (CCCDF), a \$100 million initiative within the Official Development Assistance (ODA) program administered by the Canadian International Development Agency (CIDA), is part of Canada's response to global climate change. It is built around four programming areas, one of which, the Adaptation Program, seeks to help developing countries reduce their vulnerability to climate change while adapting to its adverse impacts.

### 1.3 Adaptation and Adaptive Capacity

The concept of adaptation is relatively new to the climate change research community but it has a longer history of use in such related fields as ecology, natural hazards and risk management. “Adapt” means to make suitable (or to fit some purpose) by altering (or modifying). “Adaptation” refers to both the process of adapting and the condition of being adapted. “Adaptive capacity” indicates the extent to which a physical, biological, socioeconomic or human system may accept or undertake adaptation. A detailed description of the theory and science of adaptation is provided by Smit et al., 1999.

The climate change literature contains numerous different expressions of adaptation, varying according to specific circumstances or applications. For example:

- “the process through which people reduce the adverse effects of climate on their health and well-being, and take advantage of the opportunities that their climatic environment provides” (Burton, 1992);
- “adaptation to climate change includes all adjustments in behavior or economic structure that reduce the vulnerability of society to changes in the climate system” (Smith et al., 1996);
- “human adaptation involves adjustments to enhance the viability of social and economic activities and reduce their vulnerability climate, including its current variability and extreme events as well as longer term climate change” (Smit, 1993);
- “any adjustment, whether passive, reactive or anticipatory, that is proposed as a means of ameliorating the anticipated adverse consequences associated with climate change” (Stakhiv, 1993); and



- “adaptability is the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate” and that “adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions” (Watson et al., 1996).

The last of these examples is the definition that is of most common usage in the Intergovernmental Panel on Climate Change (IPCC) literature. However, all of these examples are useful and correct in their own fashion. They all reflect differences in the scope, application and interpretation of adaptation, and differences in response to two fundamental questions:

- **Adapt to what?** Adaptation can be to climate change, to climate variability, to climatic extremes, or simply to climate. Adaptation can be a response to adverse effects, to vulnerabilities, or to opportunities. Adaptation can be in response to current, actual or projected conditions, changes or consequences.
- **Who or what adapts?** The entity that does the adapting can be people, social and economic sectors and activities, managed or unmanaged natural (physical and biological) or ecological systems, or practices, processes or structures of systems.

Adaptation to climate change or climate variability can be natural or directed. Natural adaptation occurs without the deliberate intervention of an informed decision maker. Directed (or planned) adaptation requires strategic actions based on an understanding or awareness or acceptance that climate is changing and that action is needed to respond to such changes.

Adaptation can be either reactive or proactive depending on timing, goals and motives. Reactive adaptation takes place after the impacts of climate change or variability have occurred, while proactive adaptation takes place before the anticipated impacts or effects are apparent. Natural adaptation, in physical, biological and human systems is clearly reactive; directed adaptation in human systems can be both reactive and proactive.

Adaptation is an important consideration in two climate change policy streams – impact assessment and response strategies. Impact assessment is an attempt at understanding the potential effects of climate change and, therefore, includes consideration of what adaptations are likely in the natural or other systems under stress. Response strategies include measures and actions to confront the effects of climate change and include (or should include) consideration of what adaptations are recommended to support the systems under stress. Research, analysis and implementation of adaptation options and adjustment processes are necessary if governmental, institutional, and private sector entities are to make climate sensitive sectors more resilient to climate variability, and to limit the damage from or take advantage of potential long term changes in climate.

#### 1.4 Nature of the Issue

In 1988, the United Nations Environment Program (UNEP) and the World Meteorological Organization established the IPCC to assess scientific research on climate change, including its environmental impacts and potential remedial measures. The IPCC engaged a large number of leading scientists in a wide range of relevant fields and has played a critical role internationally in providing a rationale for global action on climate change. In its Third Assessment Report (IPCC, 2001a), which was approved for release in January 2001, Working Group I of IPCC reached the following conclusions:

- Concentrations of atmospheric greenhouse gases such as carbon dioxide and methane have increased as a result of human activities;



- The global average surface temperature increased during the 20<sup>th</sup> century by 0.6 +/- 0.2 degrees C;
- The globally averaged surface temperature is projected to increase by 1.4 to 5.8 degrees C over the period 1990 to 2100;
- Global average sea level rose between 0.1 and 0.2 metres during the 20<sup>th</sup> century; and
- Global mean sea level is expected to rise by 0.09 to 0.88 metres between 1990 and 2100.

The projections indicate that the warming will vary by region, and will be accompanied by increases and decreases in precipitation. Changes are expected in the variability of climate, and the frequency and intensity of some extreme climate phenomena. These features of climate change will act on natural and human systems. The geographical extent of damage and loss, and the number of systems affected, will increase with the magnitude and rate of climate change. The IPCC concludes, from the collective evidence, there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems.

Recent regional climate changes, particularly temperature increases, have already affected physical and biological systems in many parts of the world. Observed changes include shrinkage of glaciers, thawing of permafrost, later freezing and earlier break-up of ice on rivers and lakes, lengthening of growing seasons in mid and high latitudes, poleward and altitudinal shifts of plant and animal ranges, declines in some natural populations and earlier flowering of trees and emergence of insects. In most cases the direction of change to the physical and biological systems is consistent with that expected of known mechanisms which have been well researched in many long-term studies. The probability that the observed changes, and their direction, can occur by chance alone is negligible.

Another dimension of climate change will be the variability in local weather conditions which, for many regions, will mean that extreme weather-related events will become more common, more extreme, and potentially more damaging to local communities and local ecosystems. Indeed many experts are predicting a general increase in both the incidence and severity of these events. Weather related events, including hurricanes, storm surges, excessive rainfall, drought episodes, extreme high temperatures and their direct and indirect impacts, especially when coupled with long-term average shifts in temperature, precipitation and sea level, pose a significant threat to many ecosystems and communities.

## 1.5 Impacts

The contribution from IPCC Working Group II to the IPCC Third Assessment Report addressed specifically the issues of climate change impacts, adaptation and vulnerability. In its report (IPCC, 2001b), Working Group II pointed to systematic long-term studies that document recent temperature related regional climate change impacts on physical and biological systems. In these studies, hydrology, glacial retreat and sea-ice data could represent decadal to century trends. Terrestrial and marine ecosystem data might reflect trends of at least two decades. The IPCC used 16 regional studies covering about 100 physical processes over most regions of the world and which varied in length from about 20 to 150 years. There were also 44 regional studies of over 400 plants and animals, which varied in length from about 20 to 50 years, but these were confined mainly to North America, Europe and the southern polar region. Knowledge of the biological system impacts in the developing countries of Africa and Asia has been recognized as a gap that needs to be addressed.



Some natural systems can be especially vulnerable to climate change because of their high sensitivity to changing conditions and/or their limited adaptive capacity. Such natural systems include glaciers, coral reefs and atolls, mangroves, boreal and tropical forests, polar and alpine ecosystems, prairie wetlands, and remnant native grasslands.

The scientific studies show that human health, ecological systems and socioeconomic sectors (e.g., hydrology and water resources, food and fibre production, coastal systems and human settlements) are all sensitive to changes in climate including both the magnitude and rate of climate change as well as to changes in climate variability. Many regions are likely to experience adverse effects of climate change some of which are potentially irreversible. Conversely, some effects of climate change are likely to be beneficial.

Climate change represents an important additional stress on those systems already affected by increasing resource demands, unsustainable management practices and pollution, which in many cases may be equal to or greater than those of climate change. These stresses will interact in different ways across regions but can be expected to reduce the ability of some environmental systems to provide, on a sustained basis, key goods and services needed for successful economic and social development, including adequate food, clean air and water, energy, safe shelter, low levels of disease and employment opportunities. Those countries or regions that experience low rates of economic growth, rapid increases in population and ecological degradation may become increasingly vulnerable to potential changes.

In its Third Assessment Report (IPCC, 2001b), the IPCC lists the following projected adverse impacts on human and socioeconomic systems:

- A general reduction in crop yields in most tropical and sub-tropical regions for most projected increases in temperature;
- A general reduction, with some variation, in potential crop yields in most regions in mid-latitudes for increases in annual-average temperature of more than a few degrees Celsius;
- Decreased water availability for populations in many water-scarce regions, particularly in the sub-tropics;
- An increase in the number of people exposed to vector-borne diseases (e.g. malaria) and water-borne diseases (e.g. cholera), and an increase in heat stress mortality;
- A widespread increase in the risk of flooding for many human settlements from both increased heavy precipitation events and sea-level rise; and
- Increased energy demand for space cooling due to higher summer temperatures.

IPCC also listed the following beneficial impacts:

- Increased potential crop yields in some regions at mid-latitudes for increases in temperature of less than a few degrees Celsius;
- A potential increase in global timber supply from appropriately managed forests;
- Increased water availability for populations in some water scarce regions – for example, in parts of southeast Asia;



- Reduced winter mortality in mid and high-latitudes; and
- Reduced energy demand for space heating due to higher winter temperatures.

The impacts of future changes in climate are expected to fall disproportionately on the poor. The resulting effects are expected to be greatest in developing countries in terms of loss of life and damage to investment and the economy. Relative percentage damages to Gross Domestic Product (GDP) from climatic extremes have been greater in developing countries than in the developed world (IPCC, 2001b). Adaptation has the potential to reduce the adverse impacts of climate change, though adaptation measures and actions (natural or directed) will incur costs and will not prevent all damages.

## 1.6 Vulnerability

Vulnerability is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the sensitivity of a system to changes in climate (the degree to which a system will respond to a given change in climate, including both beneficial and harmful effects) and the ability to adapt the system to changes in climate (the degree to which adjustments in practices, processes or structures can moderate or offset the potential for damage or take advantage of opportunities created, due to a given change in climate). Under this framework, a highly vulnerable system would be one that is highly sensitive to modest changes in climate, where the sensitivity includes the potential for substantial harmful effects, and one for which the ability to adapt is severely constrained (Watson et al., 1997).

The IPCC Working Group II produced a Special Report on the regional impacts of climate change and an assessment of vulnerability (Watson et al, 1997). The Special Report was prepared in response to a request from the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC. It addresses the question posed by the COP to the UNFCCC as to the degree to which human conditions and the natural environment are vulnerable to the potential effects of climate change.

The Special Report assesses vulnerabilities rather than impacts. That is, because of the uncertainties associated with regional projections of climate change, the report assesses sensitivities and vulnerabilities of ten continental or sub-continental regions, rather than attempting quantitative predictions of the impacts of climate change on these specific regions. The regional approach reveals wide variation in the vulnerability of different populations and environmental systems caused by differences in local environmental conditions, socioeconomic and political conditions and degrees of dependence on climate sensitive resources.



Article 2 of the UNFCCC explicitly acknowledges the importance of natural ecosystems, food production and sustainable economic development. The IPCC Special Report's assessment of regional vulnerability to climate change therefore focuses on ecosystems, hydrology and water resources, food and fibre production, coastal systems, human settlements, human health, and other sectors or systems (including the climate system) that are important to the regions encompassing the Earth's land surface. See Annex 4 for a summary of this information.

## 2.0 Adaptation – International Policies and Processes

### 2.1 Policy Drivers

Human, physical and biological systems may adapt naturally to climate change. However, where the options and incentives are greater (especially for human systems), planned or directed adaptation may supplement the natural processes. The IPCC concludes that “adaptation is a necessary strategy at all scales to complement climate change mitigation efforts” (IPCC, 2001b). Development of such strategies must draw upon the experience of dealing with climate variability and climatic extremes as well as the breadth of knowledge available from local, regional, national and international research and study of the impacts of climate change.

The adaptive capacity of human systems is dependent on such factors as wealth, technology, education, information, skills, infrastructure, access to resources and management capabilities (IPCC, 2001b). There is potential for both developed and developing countries to improve or acquire adaptive capacity but, nations and communities are highly variable in terms of the above factors, and the developing countries, particularly the least developed countries, are less endowed in this regard. Consequently, the developing world has less capacity to adapt to climate change. The developing world is more vulnerable to the impacts of climate change just as it is more vulnerable to other environmental, economic and social stresses. Therefore, the effects of climate change such as loss of life and damage to investment and the economy are expected to be greater in developing countries.

Many of the countries, regions and communities of the developing world that are vulnerable to climate change are also under stress from population growth, resource depletion and poverty. Consideration and inclusion of climatic risks in the design and implementation of development initiatives in these areas can help to encourage equity and development that is more sustainable and that reduces vulnerability or enhances adaptive capacity to climate change.

In many countries, governments are seeking help and advice on the potential impacts of climate change on their environment, society and economy. There are usually two fundamental questions:

- How significant are the impacts of climate change?
- What can or should be done to prevent or modify these impacts?

Clearly, assessment of impacts and preparation of adaptation response strategies go hand-in-hand. Data and information regarding impacts is needed to help determine the urgency and desirability of adaptation policies and actions. Responses and decisions involve choices at all levels of decision-making from local or community level to national governments and transnational organizations.

## 2.2 International Adaptation Policy Development





The UNFCCC and the Kyoto Protocol contain provisions relating to the impacts of climate change, and of response measures aimed at mitigating climate change, on developing countries.

Article 4.8 of the UNFCCC calls on Parties to consider actions to meet the needs and concerns of developing countries and specifically refers to small island countries and countries whose economies are highly dependent on fossil fuel. Article 4.8 states *“that action related to adaptation follow an assessment and evaluation process, based on national communications and other relevant information, so as to prevent maladaptation and to ensure that adaptation actions are environmentally sound and will produce real benefits in support of sustainable development”* and further *“encourages Parties to exchange information on their experience regarding the adverse effects of climate change and on measures to meet their needs arising from these adverse effects.”*

Article 4.9 of the UNFCCC refers specifically to the needs and special circumstances of the least developed countries, especially with respect to funding and transfer of technology.

Article 3.14 of the Kyoto Protocol echoes the provisions of the UNFCCC by requiring the Annex 1 Parties (to the UNFCCC) to strive to implement their emission targets in a manner that will minimize adverse social, environmental and economic impacts on developing countries. This is not a particularly adaptation-oriented provision and reflects the strong mitigation and emission reduction philosophy of the Kyoto Protocol. However, negotiations have continued in these areas and policies, measures and actions related to adaptation have begun to receive increased coverage in the international discussions.

At COP 3 in Kyoto, the Parties adopted a decision that requested the Subsidiary Body for Implementation (SBI) to launch a process to identify actions to meet the needs of developing countries arising from the adverse impacts of climate change and the impact of response measures. At COP 4 in Buenos Aires, the Parties agreed on a work program on this matter that was intended for completion by COP 6 in November 2000 in The Hague. By September 2000, the Parties, through their subsidiary bodies such as SBI and SBSTA, had developed a text for discussion and negotiation at COP 6. This report set out options for addressing the concerns of developing countries over the adverse impacts of climate change and the impact of the implementation of response measures. The report:

- *Recognized* “that low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, drought, and desertification, and developing countries with fragile mountainous ecosystems are particularly vulnerable to the adverse effects of climate change,”
- *Reaffirmed* “that the specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration,”
- *Affirmed* “that responses to climate change should be coordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter, taking into full account the legitimate priority needs of developing countries for the achievement of sustained economic growth and eradication of poverty,” and
- *Acknowledged* “the efforts already made by Parties to meet the specific needs and concerns of developing country Parties, in particular the least developed countries, with regard to adaptation.”

The SBI/SBSTA report provided a long list of information needs and recommended methodologies for addressing the issue of adaptation. It also recommended the linkage of policies and actions to other international environmental agreements such as the *United Nations Convention to Combat Desertification*. However, the report submitted to COP 6 contained a considerable amount of bracketed text that required high level negotiation and resolution. Also, the report included references to the controversial issue of funding of adaptation measures in developing countries – an issue that could not be resolved satisfactorily and which contributed to the eventual breakdown of the talks in The Hague.

The issue of adaptation funding has developed from elements of the Clean Development Mechanism (CDM), an international emissions reduction instrument proposed under the 1997 Kyoto Protocol. The CDM allows Annex I countries to make investments in emission reduction projects in non-Annex I countries; the emission reductions that are achieved may be added to the investing nation's emissions cap. The Kyoto Protocol, in establishing the CDM, called for a share of the proceeds from project activities under the CDM to be made available for the adaptation needs of developing countries. While supportive of the principle of adaptation funding, developing countries opposed this specific provision. Their position was that imposing a levy on CDM activities would reduce the investment attraction of CDM compared to other international mechanisms such as Joint Implementation (joint activities of only Annex I countries) and international emissions trading and, therefore, less potential funding would be available to the developing world. On the other hand, Annex I or developed countries opposed extension of the levy to the other mechanisms.

During the early discussions in The Hague at COP 6 on the SBI/SBSTA submission, consensus appeared to be emerging for new and additional funding for adaptation, capacity building, and technology transfer needs in developing countries. There was still serious concern that the proposal fell short of the expectations of the developing countries and, going into the final high-level sessions at The Hague, the critical negotiating issues related almost exclusively to financial concerns. The talks at The Hague failed, but in the resumed sessions of COP 6 in July 2001 in Bonn, agreement was reached to establish a *special climate change fund, a least developed countries fund, and an adaptation fund* which will be financed through a share (2%) of the proceeds from CDM projects and other sources.

Despite the difficulties regarding the financial issues, the principles and actions on climate change impact assessment and adaptation strategies that were proposed in the SBI/SBSTA report and subsequently discussed at COP 6 are expected to survive the intergovernmental relations turmoil. It is expected that the Subsidiary Bodies to the UNFCCC (SBI and SBSTA), the IPCC and UNEP will continue to address the development and implementation of adaptation measures.

### 2.3 Major Country Positions and Initiatives

Through instruments such as the UNFCCC, the Kyoto Protocol, and other related international agreements such as the Biodiversity Convention and the Convention to Combat Desertification, countries of the world have recognized the potential impacts of climate change. Many are taking action to address the issues but the measures vary according to political, social and economic factors. The developing world, which will likely bear the brunt of the negative impacts of climate change, is recognizing the need for, and trying to define the levels of, help and assistance that will be necessary to deal with the future social and economic adjustments. Countries of the developed world, while assessing the potential costs and benefits of climate change to their own regions, are also



attempting to define, among many competing priorities, the international assistance that they can provide for both climate change mitigation and climate change adaptation purposes.

### *United States*

Even before President Bush announced in Spring 2001 that the United States would not support the current provisions of the Kyoto Protocol, the U.S. Congress was strongly opposed to passing any measures that could be viewed as an endorsement of the protocol. In the lead-up to the ultimately failed talks of COP 6 at The Hague in November 2000, U.S. officials made it clear that the United States would consider ratification and implementation of the Kyoto Protocol only if major developing countries such as China and India participated in climate change mitigation actions beyond the level of the Clean Development Mechanism. The U.S. also wanted full and unrestricted international emissions trading. President Bush has held to these positions, as well as introducing questions regarding the scientific basis for projected climate change impacts and insisting that mandatory emission reductions will undermine the U.S. economy.

However, U.S. opposition to Kyoto does not necessarily mean inaction on the climate change front. There are elements of the U.S. federal, state and local governments, prominent institutions and other private sector organizations (e.g. Pew Centre on Global Climate Change) that support voluntary actions and partnerships to address the issue. There is interest, for example, in identifying trade opportunities in renewable energy technologies through the Clean Development Mechanism and in subsidies or tax credits for research and development.

The U.S. spends over \$3 billion annually on climate change research and mitigation activities in addition to international assistance programs. In 1999, the U.S. spent about \$1 billion on a Climate Change Technology Initiative, creating tax incentives and technology investments to promote technology development. In 1999, the U.S. also spent about \$1.7 billion on its Global Change Research Program.

Through the U.S. Country Studies Program, supported by ten federal agencies, the United States has been providing technical and financial support to 56 developing countries and countries with economies in transition on five continents to assist them in conducting climate change studies. The studies have enabled these countries to develop inventories of their anthropogenic emissions of greenhouse gases, assess their vulnerabilities to climate change, and evaluate response strategies for mitigating and adapting to climate change. Financial and technical assistance has been given to developing countries to use the results of their climate change country studies and to develop action plans for implementing mitigation and adaptation measures.

### *Germany*

Under the Kyoto Protocol, Germany has a greenhouse gas emissions reduction target of 8% below 1990 levels and, as part of the European Union burden sharing agreement, Germany has committed to deliver a 21% reduction. Germany's ability to reach this target is partly because of the East/West German merger and the subsequent closing of many highly emitting industrial plants in the east.

The government of Germany promotes itself as a world leader on climate change. The UNFCCC secretariat is housed in Bonn, COP 1 was held in Berlin, COP 5 and COP 6 (Part 2) were held in Bonn. The focus of mitigation measures in Germany has been in the energy sector and the country is a major exporter of energy efficient and renewable energy technology and has been active internationally in Eastern Europe, the former Soviet Union



States, and large developing countries such as China and Brazil. Germany is expected to become more active in CDM initiatives with developing countries.

### *Japan*

Like Germany, a strong focus of Japanese efforts on climate change is the energy sector and development of new and more energy efficient technologies. Japan has indicated that it will increase its efforts to assist developing countries in dealing with the impacts of climate change and has been an enthusiastic advocate of the Kyoto mechanisms such as CDM. Japan is working bilaterally with Russia, China, Eastern Europe and other Asian countries on energy conservation and energy efficiency projects.

### *United Kingdom*

Under the European Union burden sharing agreement, the U.K. has committed to a 12.5% reduction of greenhouse gas emissions. Largely as a result of the huge shift from coal to natural gas in the energy sector initiated by the former Thatcher Conservative government, the U.K. has made good progress towards its target and its major present concern is the transportation sector. Although the U.K. has been a strong advocate of increased commitment by developing countries to climate change response actions, it has also recognized the difficulties faced by these regions and has increased its levels of international assistance on climate change issues. U.K. sponsored projects underway include energy efficiency improvements to coal-fired power stations in India, clean coal technology projects in China, and assessment of potential for CDM projects in Brazil, Indonesia, Malaysia, and South Africa.

### *China*

The People's Republic of China is a developing country with a huge population. The current per capita GDP is only about 800 US\$. There are about 50 million people living under the poverty line. As a consequence, China's major missions are to eliminate poverty, to develop its country, and to provide the huge population with basic needs. On the other hand, the Chinese government also pays much attention to environmental protection and global climate change, and it actively takes many response measures in cooperation with other countries to combat global climate change. Although China does not have a GHG emissions reduction commitment under the Kyoto Protocol, it has recognized the impact of global climate change on its sustainable development. Therefore, China consistently pays attention to GHG mitigation and actively participates in relevant activities, including the development of CDM projects, so as to promote its domestic sustainable development as well as to help developed countries to realize a part of their GHG mitigation obligations.

## **2.4 Involvement of International Organizations**

An array of international institutions and organizations are supporting a wide range – technically, financially, geographically – of climate change related initiatives in the developing world. Like the international assistance efforts of the Annex I countries of the developed world which have largely been seeking greenhouse gas emission reductions in other parts of the globe to complement their domestic achievements, the international agencies have tended to focus on technology-dominated mitigation projects. Increasingly, however, these agencies are





giving attention to climate change impact and vulnerability assessments, adaptation planning, and the identification and implementation of adaptation options. Capacity building is becoming a more important element of these programs as developed countries recognize their need for institutional and other infrastructure to support the social and economic changes required by the range of environmental shifts brought on by climate change.

An example is the program *Caribbean Planning for Adaptation to Climate Change* that is receiving financial support from the **Global Environment Facility** (GEF) through the **World Bank**. The project is being executed by the Organization of American States and coordinated by the University of West Indies. The overall objective is to support Caribbean countries in preparing to cope with the effects of climate change, particularly sea level rise in coastal marine areas. This project, which could be a useful model for other multi-state regions (e.g. South Pacific islands), involves vulnerability assessment, adaptation planning, and capacity building linked to the adaptation planning. For further details refer to [www.cpacc.org](http://www.cpacc.org).

A second example is the program *Assessments of Impacts of and Adaptation to Climate Change in Multiple Regions and Sectors* (AIACC). Funded by the GEF and implemented by the **United Nations Environment Program** (UNEP), this program will consist of forty to fifty individual research projects aimed at assessment of climate change impacts and adaptation for the most vulnerable regions and sectors. The program is intended to develop capacity in the regions to address these issues through training, technology transfer and interaction with international assessment teams. Further details may be found at [www.start.org/Projects/AIACC](http://www.start.org/Projects/AIACC).

Another example is the *National Communications Support Programme*, funded by the GEF and implemented by the **United Nations Development Programme** (UNDP) and the UNEP. The Programme was established to provide technical support to enhance the capacity of non-Annex I parties to prepare their initial National Communications. The initiative includes support for vulnerability and adaptation assessments, and workshops have been held in: West, South and East Africa, Asia, the Pacific, Arab States, Europe and the Commonwealth of Independent States, the Caribbean, Central America and South America. As well the UNDP has developed the *Adaptation Policy Framework* (reviewed at a workshop hosted by Environment Canada in Montreal), and a number of other documents related to adaptation. Further details may be found at [www.undp.org/cc/whatnew.htm](http://www.undp.org/cc/whatnew.htm).

Future activities of the international program and funding agencies will be influenced by political and economic factors. For example, the U.S. reluctance to support the Kyoto Protocol, and the potential failure of the Protocol to mitigate climate change, could remove incentive to fund international projects directly related to greenhouse gas emission reduction efforts. On the other hand, the U.S. position could galvanize action among previously uncooperative partners to deal with the inevitable environmental impacts that are projected to occur. The consensus reached at Bonn, with the U.S. on the sidelines, is an example. Publicity about the U.S. position will also reach a broader audience, building greater public awareness of the plight of the most vulnerable regions – especially the small island states and other coastal regions of the developing world.

As public education and awareness of climate change increases and as the linkages with other international environmental issues (e.g. biodiversity, desertification) and socio-economic issues (e.g. population pressures, food production, poverty) become even more apparent, there should be continuing incentive for the major international and transnational organizations to provide financial and other support to projects of global significance.

Further information on the policies, goals, structures and programs of the World Bank and other major international organizations may be obtained at the websites listed in **Annex I**.

### 3.0 Canadian Engagement in the Climate Change Issue

#### 3.1 Background

The following review of Canada's role in international policy and program development on climate change, its national policies and programs, and its ongoing involvement in international assistance programs primarily through the Canadian International Development Agency (CIDA), points to a number of Canadian strengths and contributions which the country may offer in the area of adaptation in developing countries.

Canada's legislative structure of federal, provincial, territorial and municipal governments is distinctive among the other members of the developed world. Provincial governments have primary responsibility for managing resources, with shared federal/provincial jurisdiction over protection of the environment. Environment Canada and Natural Resources Canada are the two principal agencies responsible for coordinating climate change policy at the federal level. (In recent years, Environment Canada has taken the lead on international matters and Natural Resources Canada has led the domestic processes.) Consensus building within the different levels of government is crucial for advancing Canadian climate change policies and strategies. Coordination between federal and provincial governments and between energy and environment departments is handled jointly through the Canadian Council of Ministers for the Environment (CCME) and the Canadian Council of Energy Ministers. Both provide direction to the National Air Issues Coordinating Mechanism (NAICM), which was established in 1993 to provide a framework for coordinating actions on major air issues of transboundary, national or international scope. The NAICM produced Canada's first National Action Program on Climate Change (NAPCC) in 1995.

Canada's ratification of the UNFCCC in 1992, and the resulting National Action Plan on Climate Change (NAPCC), set a target of stabilization of Canadian greenhouse gas emissions at 1990 levels by 2000. The target was not met and, indeed, December 1999 estimates by Natural Resources Canada projected emissions in 2010 to be 27% above 1990 levels. However, it is also estimated that, in the absence of the programs and actions promoted by NAPCC, projected emissions would have been much higher.

At the 1997 COP 3 meeting in Kyoto, Canada accepted a new greenhouse gas emissions reduction target of 6% below 1990 levels by 2008-2012. This is an ambitious target and, according to recent Natural Resources Canada estimates ([www.nrcan.gc.ca/es/ceo/update.htm](http://www.nrcan.gc.ca/es/ceo/update.htm)), a Business as Usual Emission Projection would have Canadian greenhouse gas emissions some 26% above the target level in 2010. Immediately after the negotiation of the Kyoto Protocol, Canadian First Ministers met and agreed that climate change is an important global issue that Canada must do its part to address, but that this must be done without asking any region to bear an unreasonable burden. With this policy direction, Energy and Environment Ministers agreed in April 1998 to engage governments and stakeholders in a process to develop a national climate change implementation strategy.

#### 3.2 National Climate Change Process

Sixteen multi-stakeholder Issue Tables were set up under the coordination of the National Air Issues Coordinating Committee (NAICC), which is the operating arm of the NAICM (for details of these Tables refer to [www.nccp.ca](http://www.nccp.ca)).





The Tables were established to provide advice to governments and enable maximum stakeholder involvement in the national process. The primary mandate of the Tables was to develop options for reducing greenhouse gas emissions in different sectors, with other responsibilities including the provision of advice on cross-cutting issues such as public education and technology development. A key group in the process was the Analysis and Modeling Group that was charged with the task of determining the economic costs of meeting Canada's emissions reduction target under the Kyoto Protocol. Unfortunately, less attention was paid to the economic costs of climate change itself and very little attention was given to the costs (and benefits) of adaptation to climate change.

Of more significance to this report on adaptation policies was the creation of a Science, Impacts and Adaptation Table. Under the management of the Canadian Climate Program Board, this Table developed recommendations for a climate monitoring, research, impacts studies and adaptation program. For the impacts and adaptation component of its mandate, the Table recommended various research, capacity building and adaptation governance initiatives, including the establishment of a Canadian Climate Impacts and Adaptation Research Network. Recommendations of the Science, Impacts and Adaptation Table were integrated into the *Canadian National Implementation Strategy on Climate Change* (NIS) and the *First National Climate Change Business Plan*, both of which were released by the Energy and Environment Ministers in October, 2000 (National Climate Change Process, 2000b and 2000c).

The NIS has as its vision "Canadians taking effective action – at home and abroad – to reduce the risks of climate change, to realize opportunities and to protect and improve our quality of life". Components of the NIS cover both mitigation and adaptation, require a connection between international and domestic contexts, and include calls for action to:

- *inform, educate and build awareness of the science and impacts of climate change, including the capacity to adapt...; and*
- *equip decision-makers with the knowledge, capacity and experience to make informed decisions and lay the foundations for future actions...to reduce scientific uncertainty in areas important to Canada's objectives and increase understanding of impacts as a basis for developing options to adapt to climate change.*

While the development of the NIS and First National Business Plan was dominated by consideration of greenhouse gas emission reductions and other climate change mitigation tools, the need for adaptation options and strategies is explicit in the documents. There is frequent reference to climate change impacts, vulnerabilities at national and regional scale, adaptive capacity of sectors and regions, and linkages with the international community and particularly the developing world. The NIS explains that "*adaptation measures range from acting to reduce vulnerability to climate change to stopping activities that are not sustainable under the changed climate or moving particular activities or systems*". The NIS further notes that "*adaptation requires taking action to reduce the negative impacts of climate change throughout Canada and taking advantage of any positive impacts (e.g. warmer and longer growing seasons). Future adaptation may include water conservation measures (to adapt to reduced availability of water and changing energy supply and demand), emergency preparedness and response, and future-oriented reviews of building and land-use standards, codes and regulations.*" Finally, the NIS calls for Canadian contributions to global efforts to understand the climate, its future evolution and possible impacts and for development of adaptation response strategies.

In the First National Business Plan, a series of federal, provincial/territorial and multilateral initiatives are identified that aim to improve the organization of the research community and increase the amount of research focused on climate change impacts and adaptation. Other more policy-oriented actions are identified to provide guidance to adaptation strategy development. A number of specific regional projects are listed, such as adaptation research in the fishery sector of British Columbia and a Prairie Adaptation Research Cooperative.

A further product of the National Climate Change Process was *A Compendium of Canadian Initiatives – Taking Action on Climate Change*, which accompanied the release of the NIS and First National Business Plan (National Climate Change Process, 2000a). The Compendium showcased climate change initiatives by all levels of government across Canada, grouped according to the five themes of the NIS. It provided a comprehensive listing of programs and projects with three areas of particular relevance to adaptation: Impacts and Adaptation; Climate Change Action Fund - Impacts and Adaptation; and International Initiatives. The volume and variety of initiatives summarized in these sections of the Compendium demonstrate considerable Canadian experience and strength in this field.

### 3.3 Canada and Climate Change in the Developing World

Through involvement with the United Nations and its subdivisions such as the UNEP, through financial links to the World Bank, GEF and associated institutions, the hosting of important international environmental conferences and forums, the encouragement of institutions such as the International Institute for Sustainable Development (IISD) in Winnipeg, and direct aid and assistance programs, Canadians and Canadian governments have assembled an extensive history of experience with the environmental concerns of the developing world. Canada is a signatory to the main United Nations agreements (climate change, biodiversity, desertification) that are of particular relevance to the current and future well-being of many developing countries.

The *Compendium of Canadian Initiatives on Climate Change* (NCCP, 2000a) lists a number of Canadian led or sponsored activities in the developing world, including:

- APEC Energy Working Group – primary vehicle for multilateral energy cooperation and information sharing with the Asia-Pacific region, including China;
- Climate Change Knowledge Network – coordinated by the IISD, the goal is to improve the capacity of developing (and developed) countries to build an effective, sustainable and equitable climate change regime; and
- Hemispheric Energy Initiative – primary vehicle for multilateral energy cooperation and information sharing with Latin America; Canada chairs the climate change working group with Argentina.

Many CIDA ODA projects contain a climate change element and the Government of Canada considers support for climate change projects in other countries as a primary component of its Action Plan 2000 on Climate Change. The Federal Budget 2000 included a commitment of \$100 million over four years to help developing countries undertake climate change related projects. This has been the basis for the Canada Climate Change Development Fund (CCCDF). Approved projects in the Adaptation Program component of the CCCDF include:

- Vulnerability and Adaptation in Indian Agriculture in the Context of Climate and Economic Changes;
- Adapting to the Impacts of Climate Change in the Jiquilisco Bay Coastal Zone, El Salvador;
- Adapting to Climate Change in the South Pacific Region; and



- Capacity Building Support for Adaptation to Climate Change in the Sahel.

CIDA has indicated that it intends to target further activities and projects in Small Island States, Bangladesh, Central America and Sub-Saharan Africa.

Canada's International Development Research Centre (IDRC) also supports Canadian climate change programming in developing countries through the funding of research projects. The Environment and Natural Resources Management program supports research in areas related to adaptation, including:

- International Model Forest Network;
- International Network for Bamboo and Rattan; and
- Managing Natural Resources (in Africa and the Middle East; Asia; and Latin America and the Caribbean).
- 

### 3.4 Canadian Scientific Knowledge and Applications

Canada's scientific community offers a considerable array of knowledge, talent and experience that can be applied to the needs and concerns of the developing world. The expertise lies within federal and provincial government agencies, universities and colleges, privately – funded research and technology organizations, and within the research and development units of private corporations. Canadian science has played a key role in the past two decades in informing some of the international decisions and conclusions regarding global climate change. Canada's contribution to climate science has included the development and running of climate models to determine future climate changes, and the observation and tracking of climate trends and variations in Canada. Forecasting tools for extreme climatic events and for longer-term processes such as the El Niño cycles are a particular strength of Canada's climate science network. Canadian scientists have made significant international contributions to the work of the IPCC in areas of climate science and climate change impact assessment and are well placed and experienced to continue these studies on global or regional scales as required.

Appropriate resources and individuals are present in Canada to support the continuation of this contribution to climate science, and to improve understanding the causes and effects of climate change. The federal government allocated \$60 million to the Canadian Foundation for Climate and Atmospheric Sciences to build scientific capacity and to foster collaborative research with universities across Canada. The foundation has a six-year mandate to provide research grants for Canadian scientists to strengthen and maintain Canada's research capacity in climate-related fields and in the areas of air quality and severe weather.

Climate science is critical to the understanding of the process and impacts of climate change but other scientific and technical niches need to be drawn upon to evaluate adaptive capacities and to undertake adaptation planning and management. Wheaton and Maciver (1999) listed the following key questions for adaptation science, which illustrate the wide range of expertise and information that is needed:

1. What do we understand about the adaptation of human and natural systems to past, present and anticipated future climate variability and change?
2. How is the adaptation process similar or different in human and natural systems?
3. What is the ability of the scientific community to accurately represent adaptation processes in impact models and assessments? What are the best ways of modeling adaptation?



4. How do people monitor and gather information that indicates they need to adapt? How do they know that a system or activity is adapted or maladapted? What feedback or warnings are needed?
5. How are the risks of climate variability and change perceived by decision makers, by managers, by those responsible for adaptation management?
6. The use of adaptation options is part of a broader process of the adoption of innovation, which is a component of social change. What is our understanding of the process of social change and of the adoption of innovation?
7. What options exist or are needed for developing regional or sectoral monitoring systems to determine how well activities or systems are adapted?

Canada's physical, biological and social science infrastructure is capable of satisfying the demands of these questions and issues. For example, Canada's earth scientists (in the Geological Survey of Canada and in provincial departments and university research institutions) have published extensively on climate change impacts such as sea level changes and the retreat of alpine glaciers (Ryder, 1998). The capabilities are there but the difficulty will be in drawing scientists and other specialists from their traditional niches and interests, to apply their knowledge and expertise to the new questions of adaptation. Just as great efforts have been taken by governments and other stakeholders to raise the level of public education and awareness of climate change as an environmental and social issue, similar efforts need to be made to attract scientists from a variety of disciplines to the multidisciplinary field of adaptation. Canada's extensive networks of physical scientists, life scientists, earth scientists and social scientists could be called upon to develop new and innovative approaches to adaptation management and they are an important resource that Canada can offer to the international community.

### 3.5 Canadian Technologies

Canada has strengths and emerging strengths in technologies that offer promise to climate change mitigation and adaptation actions in Canada and abroad.

Technology plays a pervasive role in modern society and the availability of cost-effective technologies with improved environmental performance is vital to a sustainable future. Largely because of these factors, and the promises offered by Canadian technologies, technology development is a key element of the *National Implementation Strategy on Climate Change*. The NIS recognizes that ensuring Canadian companies can provide appropriate technologies in both domestic and international markets will yield significant economic benefits for Canada. Consequently, the NIS and First National Business Plan recommend serious and sustained efforts by all Canadian jurisdictions to support and stimulate the availability of technology and to facilitate its commercialization, market access and deployment by Canadian companies.

The Technology Issues Table of the National Climate Change Process undertook an extensive survey of Canadian technological capabilities and produced a list of over 1,300 existing, emerging and future technologies in Canada that are suitable for actions to address the global issue of climate change (National Climate Change Process, 1999). For adaptation management, and particularly in low technology areas of the developing world, the need is more for the application of existing technologies than for intensive research and development and the creation of new products and systems. The UNFCCC has developed reports and papers on adaptation technologies (1997 & 2000),



and notes that no comprehensive catalogue of adaptation technologies exists. The UNFCCC has attempted to catalogue decision tools for the evaluation of alternative adaptation strategies (2000) and has identified adaptation opportunities in five sectors: human health, agriculture, coastal zones, urban areas and freshwater resources (1997). The UNFCCC notes that effective and timely implementation of adaptation options and measures can be complemented by the development of soft technologies (e.g., capacity building, education, simulation tools).

Climate change impacts are expected to include drought, desertification, flooding due to sea level rises as well as concerns over food production and water supply. Consequently, technical expertise will be needed in areas such as irrigation systems, flood management, hydrology and groundwater extraction technologies, agricultural and forest management systems. There will also be demands for help with the policies, planning and institutional management of technologies and technical infrastructure systems. Canada has significant human and technical resources and an extensive history of relevant domestic experience in these areas and has already developed new and innovative systems that will contribute to these international demands.

### 3.6 Canadian Capacity Building

Canada's approach to the issue of climate change has been unique in bringing a broad range of stakeholders and public attention into the process. The focus has been on building a capacity for interest and a capacity for action, which are qualities that can be useful in providing assistance to the developing world for adaptation management. The Issues Table component of the National Climate Change Process included over 450 stakeholders from all levels of government, industry, academia and non-governmental organizations. In a second tier of involvement there were probably several thousand additional participants in the process. Also, an important theme of the national process was to enhance public understanding and awareness of climate change and to develop public acceptance for the measures and impacts that could be expected in the future.

Essentially, the National Climate Change Process was a massive capacity building exercise, which has provided Canada with a model and the tools that could be used in the international arena. Products of the process are that virtually all jurisdictions in Canada have developed or are developing their own regional climate change strategies with input from their local citizens and industries. The Federation of Canadian Municipalities (FCM) has been active in the national process and individual cities (Toronto is a prominent example) are reaching to their general public and promulgating action plans that make practical sense for their communities. Representatives of industrial sectors and individual firms are working beside members of environmental interest groups to identify sustainable development measures, such as technology improvements, that will both contribute to climate change efforts and provide economic benefits.

In large part due to impetus from the Environmental Adaptation Research Group of Environment Canada, some areas of the country (e.g. northern rivers, prairies, Great Lakes) have made significant progress towards an integrated approach to climate change science, impacts and adaptation (Cohen, 1997; Mills and Craig, 1999). *The Canada Country Study* (Environment Canada, 1997) has given Canada not only a comprehensive appraisal of climate change impacts and suggested adaptation responses, but also a model process that could have far-ranging application in other geographic regions.



The Canadian public sector has a long and internationally respected tradition of high quality service and has already made significant contributions to many global issues. As noted earlier, the environment is a shared responsibility among the federal, provincial and territorial governments and requires consensus and collaboration among all parties. Despite political and ideological differences, the senior levels of government have had to learn to work together on national environmental concerns and have developed processes, such as the CCME and the National Air Issues Coordinating Mechanism (NAICM), to facilitate such cooperation.

Application of these models, processes and mechanisms to institutional strengthening and adaptive capacity-building in the developing world can be a major contribution by Canadian governments and their private sector partners.

### 3.7 Canada's Developing Country Experience

Canada has an extensive and respected record of experience with aid and assistance programs in the developing world. Details can be accessed on the web sites listed in **Annex 1**. Work with developing countries is undertaken through CIDA and its ODA programs, through other federal government agencies, through provincial government agencies (e.g. Ontario's Ministry of Environment has advised and trained enforcement officers in Mexico; Ontario's Ministry of Natural Resources has coordinated forestry management projects in southern Africa; Alberta's Department of Resource Development is engaged in CDM related projects in China), through Canada's multinational corporations and international consulting firms, and through non-governmental organizations. Canadian agencies and companies are linked to projects in the developing world through international financial institutions such as the World Bank and the Asian Development Bank.

The work encompassed by these international activities covers a wide spectrum of needs, subjects and disciplines. As well as environmental, resource management and technology development activities, the Canadian experiences also extend to economic and social issues such as human health and disease, malnutrition, poverty alleviation, financial systems management, and urban and regional planning. A comprehensive treatment of adaptation to the impacts of climate change, including climate variability and extreme weather events, potentially can call for attention to all of these areas. With their demonstrated experience in these areas in the developing world, Canadian agencies have the knowledge, expertise and credibility to make a significant and valuable contribution to adaptation management in the developing world.

## 4.0 Adaptation Policy Framework

### 4.1 Policy Needs

Adaptation has been mainly a technical issue as scientists have worked to understand climatic change, the likely physical impacts of climate change, the sensitivity and vulnerability of natural systems to the impacts, and the manner and extent to which these systems can adapt to the changing conditions and impacts. The work on natural systems is being supplemented increasingly by attention to social and economic systems. Integration of the environmental and economic concerns is being done in the context of sustainable development. Linkages with other major environmental problems (e.g., air and water quality, biodiversity, desertification) and social issues (e.g., population pressures, human health, food production, poverty) are being explored more intensely. Adaptation encompasses a great breadth of issues, subjects and disciplines that inject considerable complexity into any decision-making process.



Thus, a policy framework is needed to provide a rationale and order to the formulation, assessment and adoption of specific adaptation measures, projects and programs. This policy development process is underway. A decision taken at COP 3 in Kyoto requested the UNFCCC SBI to launch a process to identify actions to meet the needs of developing countries arising from the adverse impacts of climate change. Also involved in this exercise is the SBSTA which has been commissioning studies and hosting international workshops on the subject. In 1998, the IPCC convened a *Workshop on Adaptation to Climate Variability and Change* that included substantial policy elements (Klein and Maciver, 1999). More recently (June, 2001), Environment Canada facilitated a *UNFCCC Workshop on Methodologies on Climate Change Impact and Adaptation* held back-to-back with a *UNDP-GEF Workshop on an Adaptation Policy Framework*. The principal focus of the discussions was on improvement to the tools and methodologies for undertaking impact assessments, developing adaptation strategies and building the adaptation policy framework as opposed to the content of the policy.

From CIDA's perspective, there is a need to integrate climate change adaptation policies with other environmental and socio-economic policies and with the decision-making apparatus of the development assistance programs. The following discussion outlines an adaptation policy framework. The components of this framework represent the areas of concern for developing countries regarding adaptation to climate change. Evaluating initiatives in the context of this framework allows the value and priority of the initiative to be determined in a systematic fashion. This **Adaptation Policy Framework** is built around four main components: **Baseline Conditions, Assessment of Impacts and Vulnerabilities, Response Options, and Adaptation Management.**

## 4.2 Baseline Conditions

An adaptation policy framework begins with the fundamental premise that climate change will occur. Debate continues over the degree of scientific certainty about the causes and effects of global warming and other characteristics of climate change. However, in the considered opinion of the IPCC, there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems and that global temperatures and sea levels are expected to rise over the next century.

Before assessing the risks and impacts inherent in these projected trends, the baseline conditions upon which the climate changes will be imposed must be clearly and comprehensively described. Elements of this description could include, but not be limited to:

- physiographic description of the country or region, including all dimensions and physical characteristics;
- biogeographic description focusing on the types and distribution of ecosystems;
- inventory of natural resources;
- demographic assessment of population distribution, growth and trends; health, education and literacy levels;
- characterization of economic conditions including key economic indicators, primary resource base, industrial base, trade parameters;
- assessment of current environmental problems and risks;



- assessment of current socio-economic issues and risks;
- current governance systems (political, institutional);
- description of in-place infrastructure quality, and renewal or expansion projections; and
- perception levels of the risks from climate change impacts by decision-makers, managers, and general populace.

The intent of this process is to establish a starting point for evaluation of the changes to the physical, biological and human systems caused by climate change and for the adjustments that may take place in a natural or directed manner in response to these changes. Quantification of the parameters may also allow monetary values to be applied, thus assisting with later cost-benefit analysis of adaptation options.

Inclusion of social and economic parameters as well as physical and biological characteristics of the country or region is important to ensure that a broad strategic approach is taken, which integrates consideration of climate change adaptation with other development priorities, such as poverty alleviation.

### 4.3 Assessment Of Impacts And Vulnerabilities

An extensive body of knowledge, expertise and guidance is being generated to assess climate change impacts and the vulnerability of systems to these impacts. Much of this effort has been focused on the sensitivities of natural systems - physical and biological - to heating and cooling trends, alterations to precipitation patterns, droughts and floods, sea level rises and other changes due to climatic effects. Less attention has been given to social and economic systems but their importance is being recognized more widely and the results of such socio-economic appraisals are being accepted as important tools in defining the adaptive capacity of a country, region or population.

The *UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies* (Feenstra et al, 1998) lists a series of questions that need to be addressed. The key questions relevant to impact and vulnerability assessment are:

- *How is the problem to be defined?*

The definition of the problem should provide the direction suggested by current knowledge.

- *What are the goals of the assessment?*

Is the assessment to serve the policy interests of the national or regional government or contribute to a larger international exercise?

- *What is the scope of the assessment?*

Geographically and temporally?

- *What sectors and systems are to be included?*

Although a wide scope is usually preferred, the content of an assessment may be constrained by the availability of financial and other resources. Usually, both science and policy requirements call for studies designed to provide a broad overview rather than precise answers to specific questions. However, if a country's efforts in this area are sufficiently matured to be at the stage of specific questions or if the effects on a particular sector or system are of critical significance (e.g. sea level rise and a small island state), then a narrow scope to the assessment can be useful.



- *How can comparability be ensured?*

Climate change is a global issue with complex interactions between and among regions. Therefore, consistency of approach to different sectors and systems or to different regions is necessary to allow for equitable and balanced choices at strategic policy or program decision points.

- *How can the project be sufficiently integrated?*

Integration is different from comparability and involves a closer examination of the interaction between and among systems. Integrated impact assessment is intended to enable policy makers to place climate change impacts in a broader context of natural resource management, ecosystem sustainability or economic development and be in a position to consider the broader questions.

- *What plans should be made for the communication and use of results?*

Addressing this question at an early stage allows consideration of the wider context of the assessment. For example, what outputs will be most useful to policy makers? How will the assessment be related to national economic and social development goals? How will the results be communicated to a wider audience, especially those most at risk?

- *What methods or tools should be used?*

This is more of an operational question than a policy question. However, because some sectors and systems are quite different in their sensitivity to different kinds of analysis, the choice of methods can have a strong influence on the quality of the final conclusions. There is a considerable body of literature available on this subject which is well referenced in the UNEP Handbook and other recent publications (Benioff et al, 1996; Parry and Carter, 1998; Smit et al, 1999; Stratus Consulting Inc., 1999).

Impact and vulnerability assessment is clearly a critical component of the adaptation policy framework. Without adequate attention to this area, the fundamental questions of adaptation policy – What will adapt? What can adapt? What can be adapted? – cannot be addressed with confidence.

#### 4.4 Response Options

The ideal purpose of a planned response option is to reduce the vulnerability of a system to the predicted adverse impacts of climate change. If that is not possible or feasible, the response option should then aim to ameliorate the adverse nature of the impacts by moving, adjusting or supporting the system under pressure. If the impact has actually produced beneficial effects or if a natural adaptation has produced beneficial results then the response option may be directed to enhance the opportunities.

*Options Assessments.* A vast number of natural and human systems and subsystems are potentially vulnerable to the impacts of climate change to some degree or another. Consequently, response options of many types and scales can be devised to address this complexity of impacts. With such a possible range of options, consistent and fair comparative assessment will be difficult to achieve. Efforts will need to be made to develop a classification and criteria that will allow decision-makers to separate those options with broad policy implications from those of more limited scope (but not necessarily less value).

*Performance Indicators.* As noted above, the primary goals of response options should be to reduce vulnerabilities,



ameliorate impacts, or enhance opportunities. A response option must be explicit as to the system adjustments or system improvements that are expected and how these will be measured. Because of the long-term nature of many climate change-related processes, achievements or successes expected from the response option may be difficult to identify. Interim targets for progress towards a final goal will need to be defined. In some cases there may not be a final result per se, rather the achievement could be a process of continuous improvement. When the science of climate change itself is still a work in progress, considerable effort and innovative thinking is required to develop an appropriate performance indicator system.

*Policy Development and Integration.* The primary clients for response options are the decision-makers responsible for policy analysis associated with global agreements or conventions, national strategies, or implementation plans. The international and national instruments are complex policy constructions, covering a range of environmental, economic and social issues, and there is a clear need for consistency and comparability among the response options that will form the basis for the policies. There is also a need to integrate competing or overlapping concerns, such as climate change and desertification or climate change and food production, which again calls for consistency in the format of response options on separate but related issues.

*Operational Challenges.* These include training of staff to formulate, assess and implement the response options, ensuring sufficient technical or scientific capacity to support the response options, and developing communications and outreach strategies.

Taken together, the challenges for an effective response option system are formidable but so too is the environmental and economic challenge of climate change. The urgency is such that the prudent course of action is to proceed with the development of adaptation response options even as the policies for their management are still being fashioned. Some errors of judgment or financial allocation may be made in the early stages but, in aggregate, the two processes should be mutually supportive and ultimately beneficial to the parties involved.

## 4.5 Adaptation Management

The sequential process outlined in this policy framework comes to the point where decisions have to be made, choices have to be taken and implementation of adaptation measures begins. Stratus (1999) has assembled an extensive compendium of decision tools to evaluate alternate adaptation strategies and the following discussion of adaptation management decision tools is drawn partly from that compilation (see [www.unfccc.de/sessions/workshop/010611/index.html](http://www.unfccc.de/sessions/workshop/010611/index.html) for a direct link to this report).

Given that baseline conditions have been defined, that impacts and vulnerabilities have been assessed, and that alternative response options have been proposed, this stage of the process should normally begin with a screening of the available options against pre-selected criteria, such as:

- Will the measure target a high priority area?
- Will the measure address targets of opportunity?
- Is the measure appropriately scheduled and timely?
- Is the action likely to be effective?
- Will the action generate other benefits?



- Is the measure expensive or inexpensive?
- Is the measure feasible according to the prevailing conditions?

(These are very generic criteria and CIDA and other external management or funding bodies will wish to use additional criteria specific to their particular purposes or priorities.)

The screening leads to a ranking of the options according to how well they meet policy objectives. Another key input at this stage is the estimated costs of the alternative adaptation measures. Thus, the key output at this stage is the relative cost-effectiveness of the alternate adaptation measures that satisfy the policy objectives.

Externalities now begin to exert influence on the process. These include existing institutional or bureaucratic arrangements, training levels and quality of available staff, and access to financial capital. Management actions additional to the proposed actions or measures in the adaptation response option may be necessary to reduce these potential barriers.

Consideration must also be given to the style of adaptation management that is most desirable or that best applies to the circumstances of the situation. This will be dependent on the type of measure that has been proposed or recommended and on the conditions within which it is to be implemented. Adaptation management styles could be legal or legislative, institutional or administrative or organizational, regulatory, educational, financial, incentives or subsidies driven, research and development, taxes or tariffs or fee driven, market driven, behavioral, or technological.

Adaptation management is not the end of the process and should more properly be viewed as a stage in a larger adaptation cycle. The actions and measures undertaken to invoke or encourage adaptation to the impacts of climate change will have altered or adjusted the fundamental conditions of the system or systems in question and these conditions may already have been modified by climate change itself. The impacts due to climate change will continue because climate change is a long-term continual process. Consequently, the adaptation characteristics of a system must be revisited and reassessed.

## 5.0 Adaptation Project Management

### 5.1 Project Design Parameters

Adaptation project management, whether it is direct supervision of the project itself or management of the funding process that facilitates the project, requires attention to several fundamental questions:

- Where in the Adaptation Policy Framework does the proposed project fit?
- Is the proposed project consistent with internationally accepted policies/priorities in the area?
- Is the content of the proposed project consistent with internationally accepted guidelines for this particular type of activity?
- Does the proposed project demonstrate recognition of, or integration with, other major environmental or socio-economic concerns of the developing world?



The following more specific points, questions and suggestions are arranged in a sequential order that reflects an initial assessment of a proposed adaptation project. The issues addressed in this sequence are generic in character as it is not possible to anticipate the large range of permutations and combinations of possible specific demands on the physical, biological and socio-economic systems in developing countries caused by the impacts of climate change. Some particularly unusual issues or currently unforeseen impacts may require future additions to the list of key parameters. However, the current list provides a practical guide to project assessment. It is a guide and not a fixed prescription and should be used in a flexible manner.

Where in the adaptation policy framework does the project lie? For example, does the project aim to achieve:

- Delineation of the baseline conditions of a particular system or region?
- Determination of sensitivities and vulnerabilities of the system or region?
- Assessment of probable impacts on the system or region due to climate change?
- Formulation of a preferred adaptation response or a set of alternate responses to projected impacts?
- Enhanced adaptive capacity to projected impacts?
- Organizational or management structure to implement proposed adaptation responses?
  - i. Problem definition*
  - ii. Project goals*
  - iii. Geographic and sectoral boundaries of the activity*
  - iv. Time frame of the issue of concern and of the adaptation adjustments that are required*
  - v. Methodologies and tools to be applied and time schedule for the project*
  - vi. Monitoring the operational progress of the work*
  - vii. Tracking the sustainability of the results following completion of a discrete project or tracking the ongoing changes being achieved by a continuous improvement project*
  - viii. Evaluating results and achievements*
  - ix. Communications plans to:*
    - Raise awareness of decision-makers, managers, and organizations or individuals expected to be effected by the climate change impact and/or the results of the adaptation adjustment;
    - Achieve acceptance of recommended changes;
    - Broadcast instructions for necessary changes; and
    - Distribute results to wider audience.

## 5.2 Linkage with Other Issues and Initiatives

Climate change cannot be addressed in isolation of other major environmental, social and economic concerns. The CCCDF is committed to programs associated directly with climate change but it continues to compete for fiscal and



other resources and must be balanced against other Canadian development assistance priorities. Among the program areas of the CCCDF, adaptation is competing against the needs of mitigation and other core capacity building initiatives. The proponents of climate change adaptation projects in the developing world are also competing for attention and resources in their own organizations and jurisdictions. In addition, adaptation measures may provide collateral benefits in other endeavors related to climate change, other environmental areas and in socio-economic fields – and vice versa. Consequently, a proposed adaptation response option must satisfy two further conditions:

a. *Does the proposal recognize a relationship between itself and other issues, for example:*

- Other major international environmental initiatives such as the UN Biodiversity or Desertification conventions;
- Regional air quality strategies;
- Regional water quality, supply and treatment plans;
- Watershed management plans;
- Infrastructure enhancement and development;
- Urban population pressures;
- Other social issues such as human health, poverty, malnutrition, and discrimination on the basis of race, gender, class and other factors;
- Economic indicators and the ability of countries to be able to afford proposed measures and actions; and
- Depletion of natural resources of a region due to unsustainable practices.

b. *Does the proposal make an attempt, and how legitimate and feasible is the intent, to integrate with other relevant or associated issues?*

### 5.3 Decision Tools

The UNFCCC, UNEP and other international organizations have commissioned a number of studies and convened workshops of policy and technical specialists with the express purpose of building a set of tools that provide a consistent and effective approach to adaptation project design and implementation. The aim is to produce aids for the proponents of adaptation response options as well as for the evaluators of these projects within national and international funding bodies. Examples include:

- *IPCC Technical Guidelines for Impacts and Adaptation Assessments* (Carter et al, 1994);
- *U.S. Country Studies Program Guidebook on Vulnerability and Adaptation Assessments* (Benioff et al, 1996);
- *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies* (Feenstra et al, 1998); and
- *Compendium of Decision Tools to Evaluate Strategies for Adaptation to Climate Change* (Stratus, 1999).

Although these methodologies and tools have broad application, they are principally for the assistance of those organizations that are developing an adaptation strategy or formulating adaptation response options. For officers of CIDA, a further set of evaluation questions is needed (which incorporates some of the recommendations from the aids listed above):



- Has the project proponent used internationally accepted methodologies or tools in the decision-making leading to, and as part of, the formulation of the adaptation response option? If a new or more innovative approach has been employed, has sufficient explanation or justification been provided to support the different methodology? Should the approach be reviewed by an independent body?
- What are the broader CIDA criteria for project acceptance?
  - Regional priority;
  - Funding limits;
  - Timing;
  - Partners
- What environmental, economic, social or other technical or policy indicators are apparent in the proposal that point to the project making a substantial contribution to preventing or ameliorating a climate change impact, or enhancing the effect of the impact if it is a beneficial change?
- What indicators has the proponent provided that will help to demonstrate progress of the project and/or achievement of the desired outcome?
- Has the proponent provided options for undertaking the adaptation response or, if not, has the proponent shown that alternatives were considered?

## 5.4 Support Systems

An important component of an adaptation response option will be the support systems that will be an integral part of the project or supplementary but readily available to it. A project reviewer should ensure that the following support systems are built into the project design or that access to the systems is included in the design.

### 5.4.1 Education

Participants in the project, who may be the implementers of actions or those who are expected to respond to the actions, should be knowledgeable of the goals and objectives of the project and the background rationale for the undertaking. Without full awareness of the issue and/or without acceptance of the potential impacts, burdens and costs (if any), successful achievement of project targets could be difficult to reach.

If broad social change is expected to be an outcome of either the climate change impact or the adaptation response, then there will have to be a public education component that raises the level of public awareness of the issue and creates strong public acceptance of the proposed measures.

### 5.4.2 Training

Many adaptation response options will involve changes to existing practices, the introduction of new practices or the introduction of new technologies. The changes could take place within a narrow range of activity involving only specialists or technicians in that area or the change could be one of broad public behavior or wide public usage of a particular technology. In any case, narrow or broad, familiarizing participants with the new practices or technologies will be important to the efficiency and effectiveness of the adaptation measure. Therefore, training



programs or activities should be built into the proposed project. These could be directly incorporated in the project or could be set up as satellite activities by other partner organizations. The project reviewer should determine whether this issue has been properly recognized and reported in the project proposal.

### 5.4.3 Performance Measurement

The project design parameters should include monitoring, tracking and evaluation components, including indicators that are focused on reaching or sustaining the objectives and targets of the adaptation measure. It will also be important, not only to the immediate project, but also to future projects that may wish to employ similar assumptions, policies, methodologies and tools, that the efficacy or performance of these elements of the adaptation response are appropriately assessed. It may be preferable to use independent auditors for all aspects of this performance measurement.

### 5.4.4 Communications

The project design parameters should call for communications plans to raise awareness of decision-makers, managers, organizations and individuals; achieve acceptance of recommended changes; broadcast instructions for necessary changes; and distribute results to a wider audience. These activities could be carried out as an integral part of the project or by a partner organization. A further level of communications is, perhaps, more accurately characterized as public relations – the marketing of the project, or the country’s needs in respect of the project. A further extension of the communications component could encompass activities in the area of intergovernmental relations, especially if the proposed adaptation measure were to involve transborder or international elements.

The above comments and suggestions apply to the proposed adaptation response option or to the proponent of that option. If adaptation response projects are to be successfully evaluated, supported and facilitated, then the managers will need to be knowledgeable of the background to the issues and of the policy and technical components of the proposed activities. If necessary, appropriate education and training programs should be instituted. Finally, communications will be an important exercise to maintain future support and political commitment.

## 6.0 Building and Enhancing the Capacity to Adapt to Climate Change

### 6.1 Challenges and Opportunities

One of the challenges facing developing countries is that there is little that they can do to fundamentally alter the human activities that are the primary drivers of global atmospheric change and subsequent changes in temperature, evaporation and precipitation regimes. With the exception of a very few large developing countries the contributions of individual developing nations to reducing the emission of greenhouse gases will be small and indeed almost inconsequential relative to those of most developed countries. While the cumulative impact of actions taken by developing countries will be important, the capacity of most developing countries to significantly alter the overall global emission of greenhouse gases and other climate-altering substances is very limited.

Developing countries can, however, take many positive and practical steps to enhance their national and local capacities to adapt to both anticipated and unforeseen changes in their environment and natural resources. In many instances these steps are simply good practices that would make sense regardless of the extent to which these changes are attributable to man-induced climate change. While extreme weather-related events are likely to



increase in frequency and magnitude there is a reservoir of experience for dealing with such events that have occurred historically. Long-term gradual changes in the local climates that are envisaged as occurring over centuries are less easy to predict and relate to human experience. For some communities these long-term changes induced at least partly by climate change could be very disruptive to local economies. An obvious example is coastal communities where increased flooding, more severe storm surges and destruction of coral reefs and other coastal resources would be particularly devastating.

CIDA and other international aid agencies have an opportunity to assist developing countries in planning and implementing steps to help prepare recipient countries for a future that is likely to be significantly influenced by climate change. A challenge will be to focus climate change 'adaptation' programming to enhance the capacity of developing countries and regions to prepare for, and adapt to, both the long-term gradual changes in climate that are anticipated as well as probable increases in the frequency and magnitude of extreme weather-related events. Both categories of climate-related natural changes occur when they result in harm to people, communities and ecosystems. Human decisions and actions, especially their land use practices, often have a major influence on the extent to which they and others are exposed to the negative aspects of climate change. Thus, adaptation programming can focus on these intervening environmental and human factors to mitigate the harmful and negative impacts of these changes while at the same time identifying opportunities to take advantage of these changes.

In some instances this might mean that the most appropriate course of action is to assist in the development of infrastructure to address today's needs while at the same time building a capacity to better adapt to an uncertain and different future. Improved water delivery and water conservation programs are clearly needed in many regions and, as expressed in the constitution of South Africa, "Some water, for all, forever" is a fundamental component of human security. In other instances the most appropriate focus may be planning and preparing for the extreme weather-related events that could have immediate and devastating impacts on regions and local communities.

CIDA is well positioned to address the adaptation challenge through specific projects, such as those approved under the Adaptation Program of the Canada Climate Change Development Fund (CCCDF). This program seeks to help developing countries reduce their vulnerability to climate change while adapting to its adverse impacts. In designing and developing adaptation projects an appropriate primary focus, at least initially, is on the current human land-use practices that would be vulnerable to long-term shifts in temperature and precipitation and the land use patterns are likely to increase the negative impacts of climate change and increased climate variability on ecosystems and communities.

International aid agencies can also help ensure that all their policies, programs and projects take the potential for climate change into account through a screening and assessment process and, where additional action is warranted, make appropriate changes. Such a process encourages consideration of the sensitivity and susceptibility of local systems to long-term trends associated with climate change as well as to extreme weather-related events, and provides opportunities to actively promote a range of preventative and adaptive measures to reduce the negative impacts of these changes on people, communities and ecosystems.

The ultimate goal of both a) designing and developing adaptation projects to address climate change and b) including an adaptation assessment process within a strategic environmental assessment to be applied to new and existing CIDA policies and programs is the same. In simple terms, it is to support actions and measures that will



improve the adaptive capacity of a country or region to prepare for and respond to the impacts of climate change. Building on the adaptation policy framework and tools and methods of adaptation management outlined earlier, the following sections describe specific operational processes recommended for the use of CIDA officers.

## **6.2 Planning for Change and Uncertainty: A Rationale for Enhancing Community Preparedness and Resilience.**

Adaptation projects and programs can cover a multiplicity of options, ranging from short-term projects, such as planting drought-resistant crop varieties and improved weather forecasting, to long-term initiatives, such as reforestation projects, water storage, delivery and conservation projects, and increasing the institutional and policy capacity to prepare for and manage natural disasters. It is suggested that adaptation programming concentrate on influencing the human practices and preparedness that influence the capacity of ecosystems and human communities to withstand and adapt to the impacts of climate change – that is, to lessen the negative aspects of these impacts on populations and ecosystems at risk and to take advantage of opportunities that these changes could present. The rationale for this recommendation is discussed below under four headings: temporal and spatial concerns; political and public constituencies; practicality issues regarding project design and implementation; and the relevance challenge.

### **6.2.1 Temporal and Spatial Concerns**

As reflected in Figure 1, both long-term gradual changes in average conditions and weather-related extreme events can singly and in combination result in harm to people, communities and ecosystems. This model will be used to help explain why RFI believes that adaptation programming should focus on increasing national and local capacities to anticipate, recognize and respond to and reduce the negative effects of climate change. In Part 1 of Figure 1, climate change creates ecosystem transformations; this relationship, which can be both negative and positive, is characterized by complexity and uncertainty.

Climate change is a long-term, large-scale phenomenon that can be difficult to appreciate accurately on a human scale. Although broad global and continental projections have been developed, the impacts of climate change are largely unpredictable, at least at local and regional level. Unanticipated events can create uncertainty in the efforts of international aid agencies to design and implement programs when the pay-off for these efforts is likely to be well beyond the timeframe used for planning and assessing most activities. As indicated in Part 2 of the figure, the time horizons of climate change effects and events are often measured in the hundreds of years. For such gradual and long-term processes there is little accumulated human experience to gauge appropriate response actions. The long-term gradual time horizon attributed to climate change is not amenable to traditional planning horizons.

On the other hand the incidence and severity of weather-related extreme events is generally expected to increase with climate warming and in recent decades such extreme events have been increasingly devastating in terms of economic costs and, in developing countries, in the loss of human life. Part 3 of Figure 1 illustrates that extreme weather conditions have a high probability of generating negative effects on communities on a human time scale. These effects can be reduced, but rarely eliminated regardless of the level of preparation or prevention that has been employed. Typically, these extreme conditions and the resulting harm have disproportionately negative effects on the poor, which corresponds to CIDA's development focus on poverty alleviation.



Weather-related extreme events (Part 4 of Figure 1) are associated with real, measurable events that take place at particular times and places because of human exposure to, and vulnerability to, these events. They are relevant to governments, industry and individuals, and can be at least partially mitigated through appropriate planning and adaptive responses related to ecosystem health and human land use patterns and the locations and types of human settlements.

The decisions and actions taken by people and communities can have a major influence on their ability to withstand and adapt to extreme events. Development programs and projects can increase the ability of communities and societies to anticipate and prepare for such events within realistic temporal and spatial scales, and have a real impact on the lives of people and their communities.

RFI believes that the primary focus when planning activities for programs and actions to reduce the vulnerability to climate change should be on the intervening environmental and human factors (Part 5 of Figure 1). These include human land use practices and other management options that interact with the climate, weather and environmental conditions to improve the capacity of local communities to recognize and respond to climactic changes.

## 6.2.2 Political and Public Constituencies

CIDA and many other international aid agencies pursue a development mandate with an overarching goal of reducing poverty. Emergency assistance is an important part of Canada's aid program, particularly with respect to natural disasters – “disasters which in the developing world cost on average 20 times more as a share of GDP than those in the industrialized world.”<sup>1</sup> CIDA has identified the need to invest in disaster-preparedness to mitigate the impact of extreme events. An adaptation focus on the human activities and land-use practices that are likely to influence the nature, extent and significance of the ecosystem and community impacts seems appropriate for addressing both long-term gradual changes in average conditions and the more immediate extreme weather-related events. A balanced approach will involve investing in preparedness for change, surprise and in the capacity to respond to disasters after they occur. Adaptation projects can be viewed as preparedness projects, allowing climate change funding to impact on a priority programming area that is strongly supported by the Canadian public.

In the developing country or region, reducing climate change considerations to matters of human scale and to events with manageable time frames will help to raise the level of public and political acceptance for the actions and measures that will be required. Increased awareness of the short-term benefits and impacts of climate change programming in the area of adaptation can help to increase public acceptance of the goals of the UNFCCC.

Climate change programming focused on preparedness for extreme climate and weather conditions allows for the participation of private sector firms and public sector agencies in key areas of the developing world. Adaptation measures include practices, technologies and institutional capabilities that are well represented in Canada's public and private sectors. They provide the opportunity for Canada to meet its commitments in the developing world as well as offering considerable potential for economic development through the provision of Canadian technologies, products and services to international markets.

---

<sup>1</sup> CIDA. 2001. *Strengthening Aid Effectiveness: New Approaches to Canada's International Assistance Program*. p.26,



### 6.2.3 Practicality Issues Regarding Project Identification and Design

---

A broad range of proven preventative and adaptive strategies to reduce vulnerability to extreme weather conditions and events exist, but many of these strategies are not likely to be economically, technically or socially feasible for many developing countries. Many developing countries have limited financial and human resources, which restricts their ability to institute a wide range of adaptive activities. In some instances, poverty and urban population growth may severely limit a country's ability to plan and implement measures to reduce the incidence and severity of weather-related extreme events and to increase its capacity to cope with long-term changes in climate, weather and environmental conditions. In other instances, cultural factors and traditional practices may be very difficult to modify even when cost-effective alternatives seem feasible.

In some instances long-term educational programs and awareness raising might be the most effective way to begin a sustained program to enhance a country's capacity to adapt to both anticipated and unforeseen conditions and events. An important component of a comprehensive awareness raising programme could, for example, be to directly involve local communities in the long-term monitoring of key environmental and natural resource variables that are: a) likely to be important to the long-term sustainability of the community as well as being relevant in the short term and b) linked directly or indirectly to climate change and climate variability.

However, we expect that developing countries will be prepared to focus on potential changes to the climate, weather and environmental conditions that have been vital to their communities. The provision of adequate supplies of freshwater to meet basic needs and current agricultural practices, as well as opportunities to alter and adapt these practices through different irrigation practices and crops (such as drought resistant varieties) are likely to generate interest. Extreme weather-related events are readily related to real-life experiences and time frames and, often there is community experience with these events.

### 6.2.4 The Relevance Challenge

---

A major challenge is to package the planning and programming of adaptation initiatives so that it is clearly relevant to current needs and perceived to be consistent with the experiences and time frames of current inhabitants. It is also important for both donor agencies and for recipient countries and communities to be able to recognize, or at least, anticipate positive outcomes in the near- and medium term. Developing countries, especially those with limited budgets, have a host of immediate survival challenges without having to deal with the added burdens likely to be imposed by climate change. Climate change is unlikely to receive much attention if it is perceived as occurring in the distant future, and packaged as a separate and distinct priority.

RFI expects climate change to result in significant long-term changes in precipitation patterns and the future availability of freshwater, although the precise nature of these changes are difficult to predict accurately, especially at the local and regional level. At the same time, RFI is aware that many developing countries are concerned about continued access to adequate supplies of freshwater for local needs, and that a host of considerations related to the use, abuse, conservation and access to freshwater will be an ongoing concern with immediate relevance.



In many instances international aid agencies will find it advisable to support and influence the development of water management infrastructure. This is an effective means of increasing the capacity of a developing country to manage their freshwater resources under current conditions, while at the same time beginning to equip them to deal with more extreme conditions in the future. An improved capacity to manage the use and conservation of freshwater and freshwater resources can be justified primarily on the basis of immediate needs and more likely to appeal to countries and communities preoccupied with addressing immediate needs.

A primary reason for encouraging consideration of extreme weather-related conditions and events as a focus for attention is because countries and communities have experienced, or are aware of, the devastation caused by these events. While extreme weather-related events are linked to climate change, there are often more direct, more immediate and easier to justify reasons for improving the capacity of countries and communities to prepare for and respond to such events. Increasing the capacity of countries and communities to reduce their vulnerability to climate change and climate variability can be addressed through the “intervening environmental factors” and the human activities and land use practices that influence the exposure to and vulnerability of these countries and communities. The categories of human activities and land use practices summarized briefly in section 6.3, while all relevant to the challenge of adapting to climate change, can also be justified on the basis of other considerations, including meeting short-term needs and contributing to the long-term sustainability of ecosystems and communities. The financing made available by multilateral and bilateral funding agencies can alert developing countries to the need to develop a greater capacity to adapt to an uncertain future influenced by climate change. This monetary stimulus will be needed to catalyze and, to a significant degree, to sustain initiatives that will enhance the adaptive capacity of countries and communities. In many instances “new and additional” resources will be needed.

### 6.3 Adaptation Project Identification

Figure 1 reflects a focus on the human activities that influence the vulnerability of ecosystems and communities to climate change and climate variability (Part 5 of Figure 1). It is based on the recognition that the severity of negative impacts on the natural environment and human life and welfare are often strongly conditioned by certain intervening human factors that are amenable to adaptation planning. The exposure and vulnerability to climate change and extreme weather events can be influenced dramatically by decisions and actions taken before, during and after the changes and events occur. In some instances the most practical and cost-effective approach may be taking steps to reduce the scale and magnitude of environmental disruptions. In other instances, the highest priority may be to enhance the capacity of exposed communities to cope with and adapt to environmental extremes.

CIDA has identified target countries and regions for adaptation programming within the *CCCDF Management Framework and Business Plan*. These include Small Island Developing States, Sub-Saharan Africa, Bangladesh and Central America. To determine appropriate areas for adaptation programming within these identified areas, CIDA officers will need to determine vulnerable communities – the populations and ecosystems most at risk. The exposure of communities to the impacts of long-term shifts in climate, as well as anticipated increases in the frequency and magnitude of extreme weather-related events, will be conditioned by many site specific factors. Nevertheless, there are a number of generic overarching categories of human practices that contribute directly to the overall exposure and vulnerability of ecosystems and humans to climate and weather extremes. Seven general categories amenable to adaptation planning are:



- Programmes and Practices for the Use and Conservation of Freshwater Ecosystems,
- Forests and Agriculture Practices,
- Coastal Zone Management,
- Awareness Raising,
- Land Use Planning for Hazardous Areas,
- Codes, Guidelines and Incentives, and
- Institutional and Policy Capacity Building.

The priority programming areas, identified in Part 5 of Figure 1 as intervening environmental and human factors are in line with CIDA’s development priorities and will be acceptable to most developing country governments. The focus on initiatives that are likely to lead to short-term, relatively low cost, results-driven adaptation programming is likely to be most appropriate. The identification of priority adaptation intervention areas will allow CIDA officers to identify and design adaptation projects of a manageable scale and time frame that will generate a high level of acceptability and significant probability of implementation.

### **6.3.1 Programmes and Practices for the Use and Conservation of Freshwater Ecosystems**

---

Much of the world is faced with severe current and predicted shortages of freshwater. In many instances these shortfalls could turn out to be extremely damaging. The potential impacts of climate change, including higher surface temperatures, greater evaporation and significant changes in precipitation increase the likelihood of even more severe droughts and water shortages in many regions. The challenge of providing “Some water, for all, forever” is a daunting task. Programmes and policies to increase the capacity of countries and communities to increase their supplies of freshwater and, especially, to conserve and protect existing supplies is clearly needed as are measures to make more efficient use of freshwater resources.

The range of possibilities is very large and priorities will vary widely depending on the capacities and challenges faced by individual countries and communities. Programmes will clearly need to be tailored to specific needs. In some instances changing irrigation practices and shifting to more drought and heat tolerant crops may be warranted. New varieties developed through both traditional plant breeding and genetically modified organisms developed through the use of modern biotechnology may be useful. In other instances there may be viable opportunities to increase surface supplies of freshwater or to make greater use of groundwater reserves. Often there will be a clear need to develop institutions and infrastructure to better manage freshwater ecosystems.

Climate change and adaptation to these changes is simply one of many reasons why freshwater ecosystems need attention. However from the standpoint of recipient countries, especially those which are already suffering from severe water shortages, a climate change argument is not likely to be nearly as compelling as arguments based on a need to alleviate poverty or specific actions aimed at increasing the capacity to cope with the current situation.

### **6.3.2 Forest and Agriculture Practices**

---

Forest and agriculture practices have a major impact on watershed runoff patterns, evaporation rates and can under some circumstances contribute substantially to the conservation of biodiversity and the sustainability of ecosystems and communities. Forest cover helps to stabilize slopes and coastlines and significantly reduces erosion and the frequency and severity of mudslides. Forest cover also reduces surface runoff and inland flooding



by retaining soil water and, in cold areas, slowing the melting of snow packs. Extreme weather events such as hurricanes, heavy rains and snowfall and the rapid melting of snow and ice packs can lead to disastrous flooding and erosion along rivers and coastlines, and trigger land and mud slides on unstable slopes.

Population pressures and the growing global market for agricultural goods and services and forest products are likely to continue to put additional pressure on food production systems and forests. Without compensating pressures and incentives, it is very likely that rates of deforestation in the developing world will accelerate to meet immediate needs and the short-term demands of the global market place.

At another scale, forestry and agricultural practices can serve as a sink for carbon dioxide and have a major influence on biological diversity, the maintenance of soil fertility and can slow or reverse the process of desertification. The UNFCCC and the recent Bonn Agreement may provide opportunities for some developing countries to reap additional economic benefits from the conservation and sustainable use of forested lands. Similarly the Convention on Biological Diversity may provide additional incentives for developing countries to conserve and protect their forested lands. These international agreements are illustrative of other long-term and sustainable benefits of forest management practices that will in most instances also reduce vulnerability to extreme weather events.

### 6.3.3 Coastal Zone Management

---

Coastal zones are particularly susceptible to both short and long term changes in sea level and to increases in the frequency and strength of storm events. The potential for serious consequences for coastal developments and ecosystems is very large. Tropical and subtropical countries often have major coastal mangrove swamps and/or coral reefs in their coastal regions. These major ecosystems are extremely important as centres of marine biodiversity. They also provide important natural barriers that reduce shoreline wave action, shoreline erosion and coastal zone flooding. While much attention has focused on the impact of increased water levels on coastal regions, especially those of Small Island States, there are other major stresses on mangrove and coral reef ecosystems.

Temperature elevation and increased exposure to Ultraviolet B radiation have both been associated with large-scale degradation of coral reef habitat, and pollution and siltation from land-based activities threaten both coral reef and mangrove ecosystems. However, as in inland regions, a major factor is the conflict between the long-term integrity of natural systems and the need/opportunity to produce commodities for local sustenance and to meet global market demand for farmed marine species. The extremely rapid growth of marine aquaculture for the production of fish, and especially for invertebrates such as shrimp, is clearly having a major impact on coastal mangrove swamps. Similarly the unsustainable “mining” of coral reef ecosystems to meet international demand for building materials, corals and other vertebrate and invertebrate coral reef species for the international aquarium trade are putting great pressure on coral reef ecosystems.

### 6.3.4 Awareness Raising

---

Understanding and communicating the many factors, both natural and human influenced, associated with the extreme climatic conditions and weather events is an important aspect of increasing the capacity to anticipate, recognize and respond to climate change. This can build public and community support for measures to reduce the exposure and vulnerability to extreme weather-related events. The challenge of adapting to extreme weather events provides an opportunity to draw upon both expert and local knowledge. Experts familiar with the general relationships between extreme weather-related events and the human attitudes and practices that influence the



severity of ensuing natural disasters can help provide a framework for understanding specific situations. As a complement, local traditional knowledge will draw upon generations of experience with extreme weather events and provide insights as to how local communities have adapted to extreme weather-related events that have occurred in the past.

In some situations an effective and appropriate means of increasing this awareness might well be to involve local communities, perhaps through their schools, in programmes to monitor key local environmental and natural resource variables. These key variables selected because of their relevance to the community as well as their relationship to climate and weather would be a means of developing a greater local appreciation of climate change and the challenges and opportunities involved in adapting to these changes.

### **6.3.5 Land Use Planning for Hazardous Areas**

---

Land use planning, designed to limit land use activities in disaster prone areas to activities that are less vulnerable to extreme weather-related events, can be very effective at reducing exposure to and damage from such events. Clearly, if people avoid living in flood-prone and slide-prone areas they are less vulnerable to extreme weather-related events. In reality, people, by choice or necessity, do live in such areas even when there are clear risks. A wealthy individual with state-subsidized flood insurance may choose to live in a flood plain or along a flood and erosion prone coastline because of the view or the environment. On the other hand, poor migrants to urban areas in developing countries often have very little choice other than to settle in urban shantytowns that are located in flood plains or on the side of deforested slide-prone mountains.

### **6.3.6 Codes, Guidelines and Incentives**

---

Countries are well advised to develop codes, guidelines and incentives to help guide their citizens and industries to limit their exposure to extreme weather-related events. Avoiding unwise land-use practices in disaster-prone areas is one aspect. Emergency and contingency planning and response can also limit damages as can targeted public information programs and early warning programs to increase public awareness and readiness.

### **6.3.7 Institutional and Policy Capacity Building**

---

Developing countries are unlikely to be well equipped to deal with the long-term dimensions of climate change. Their institutional and policy capacity to deal with the more immediate natural disasters is also likely to be quite limited although they will almost certainly have some appreciation of how previous weather-related extreme events have resulted in natural disasters. The expectation that climate change will also include an increase in the frequency and severity of extreme weather-related events is an incentive to develop capacities in these areas. Another added advantage is that increased institutional and policy capacity to address weather-related natural disasters will have relevance to both the long-term and more immediate dimensions of climate change. In addition, they will often also be valuable as a means of planning for and adapting to other types of natural disasters such as those resulting from earthquakes and volcanoes.



## 6.4 Adaptation and Strategic Environmental Assessment

International aid agencies are to be encouraged to include climate change considerations when assessing their ongoing and new policies and programs. In Canada, the 1999 *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals* requires CIDA to undertake environmental assessments of policies, programs and plans, and their alternatives. The explicit inclusion of climate change in this process would encourage planners to consider the sensitivity of local systems to weather-related and other natural disasters, assess the adaptive capacity of the country or region, and promote a range of adaptive or preventive measures to reduce the negative impacts of natural disasters. This approach will also capture events that are not directly correlative with climate change or that cannot be attributed to the impacts of climate change, but may cause severe damage to natural or human systems.

CIDA officers already carry out many of the steps required by this assessment as part of standard policy and program development. The adaptation assessment will be most valuable when carried out in the early stages of policy or program development, but the process can also be applied usefully to existing policies and programs.

RFI developed the Strategic Environmental Assessment (SEA) Handbook for the CIDA Policy Branch. Adaptation considerations could be incorporated in the SEA in Section 4.1, “What is the nature of the various options’ environmental effects?” The adaptation effects could be considered for each identified programming option by answering a series of specific questions, or reviewing a check-list of items, in eight main steps. The adaptation questions, outlined below, are consistent with the process set out in the Handbook on SEA. Annex I of this report provides a sample form for documenting the results of an adaptation assessment.

This inclusion of an adaptation assessment within a strategic environmental assessment will sensitize practitioners to a country’s or region’s exposure and sensitivity to extreme weather related events. It will also help ensure that the adaptive capacity of a region or country to climate change is taken into account when designing and implementing CIDA policies and programs. Consistent with the recommended focus for CIDA programming in adaptation, this assessment focuses on the short-term effects of climate change generated by extreme weather events.

### *Step 1: Is consideration of adaptation planning appropriate?*

- Does the proposed policy or program involve management of natural systems? yes/no  
Does the proposed policy or program involve natural resource development or exploitation? yes/no
- Does the proposed policy or program involve adjustments to socio-economic systems that could be affected by changes in the natural world? yes/no
- Does the proposed policy or program involve major capital construction? yes/no

A “yes” response to any of the above questions suggests the need to at least initiate consideration of the potential for natural disasters and move to the next step in the process. Although assessments at this level will largely be qualitative, the following steps should be carried out using the best available knowledge of local country conditions, supplemented with additional information as required.



*Step 2: Is the geographic region of interest subject to extreme weather conditions (or other physical or biological extremes)?*

For example:

- Wide seasonal fluctuations
- Temperature extremes
- Precipitation extremes
- Prolonged dry periods
- Intense wet periods
- Geological instability
- Ecosystem sensitivity
- Others

If one or more items are selected from this checklist, further assessment of the potential for natural disasters in the region is called for.

*Step 3: What extreme events may be anticipated in the geographic region as a result of these weather or other conditions?*

For example:

- Storms and associated events
- Drought
- Flood
- Fire
- Earthquake
- Volcanic eruption
- Landslides
- Geological plagues
- Mass die-offs or extinctions
- Others

If one or more items are selected from this checklist, the remainder of the assessment process should be completed for all relevant project proposals in the region of interest.

*Step 4: What is the scope of the anticipated extreme events?*

- Geographic range:** What is the total area in which the anticipated event is likely to occur? Is the event characterized as *local*, *regional* or *widespread*?



- **Systems:** Which systems (natural, physical, human, socio-economic etc) are likely to be effected by the event?
- **Magnitude:** In qualitative terms, how large an effect will the event produce?
- **Temporal characteristics:** Is the event expected to be long, short, repeated or intermittent in nature? Based on the best technical knowledge and previous experience available, what are the lengths of the time periods involved?
- **Likelihood:** Based on the local or regional conditions and historical records, what are the probabilities that the event will occur? Can the probabilities of occurrence be linked to a future time frame?
- **Seasonality:** Can the anticipated event be linked to a specific time period or season which could result in particularly adverse impacts on the operation of natural cycles, agricultural production systems, etc.
- **Reversibility:** What is the likelihood that effects of the event can be reversed and the environment and other systems returned to their previous state? How easily can the effects be undone?

#### *Step 5: What is the anticipated impact of the extreme event?*

Post-event evaluations of extreme events often focus on the quantitative results of the event such as number of deaths, number of homeless, monetary value of damage and other social and economic parameters. Predictions of these events can estimate the scope and magnitude of the potential event but can only provide qualitative projections of the expected impacts. However, in assessing the need for response options, it is important to identify the categories of impacts that might be expected. This information becomes critical to the conclusions reached in the next two steps in the assessment process.

The likely areas of impact may include:

- Natural ecosystem damage
- Physical destruction (urban, rural and industrial infrastructure)
- Human health (e.g. loss of life, disease, epidemics, sanitation)
- Social system dislocation (e.g. homelessness, pressures on medical infrastructure, transportation disruptions, energy production and supply, banking and insurance industries)
- Disruption of food and water supply systems
- Loss or degradation of land usage
- Others

#### *Step 6: What is the state of preparedness of the country or region?*

Assessing a country's capacity to respond to potential extreme events centers on two areas, *preparedness* and *public concern*.



On *preparedness*, the following questions should be addressed:

- Are processes or protocols in place to allow governments, organizations and institutions to respond effectively to the impacts of anticipated impacts in the region?
- If such response structures and procedures are in place, can they be expanded to provide early warning of potential extreme events?
- Can the preparedness procedures be extended or adjusted further to include adaptive measures to prevent or reduce the impacts of extreme events?
- If preparedness procedures are not in place, does the region have the institutional capacity to develop such tools?

Understanding *public concern* regarding potential extreme events not only provides new information, but also ensures that the opinions, values, experiences and special knowledge held by those who may be affected by the event are considered. Their involvement can also flag potentially costly problems, and help to build consensus on the objectives of adaptive policies or programs. In many cases, public concerns revolve around issues related to resource use, social structure, security, locally held traditions and values.

CIDA officers can assess public concern on two levels:

- **Recipient Country Public Concern:** Assessing a recipient country's concern requires knowledge of the environmental and economic conditions of the country or region and the values held by its people. A survey may be required to assess this. Other methods include reviewing local newspapers, historical experience, and examining local customs.
- **Canadian Public Concern:** There is also the need to consider Canadians' concerns for the region and the desire to help. Consulting NGO groups can be a useful approach for accomplishing this.

#### *Step 7: What adaptation measures can be taken to avoid or mitigate the negative impacts?*

Selection of appropriate actions or measures will be dependent on the scan of baseline conditions and potential effects outlined in Steps 2 to 5. Initial areas of focus might include:

- Adapting forest management practices to reduce the incidence and magnitude of mud and landslides associated with extreme wind and precipitation events.
- Encouraging agricultural practices that maintain soil quality and reduce soil erosion.
- Adapting coastal zone management practices, including the management of coastal vegetation, to reduce the frequency and magnitude of coastal flooding and erosion.
- Developing effective communication strategies to help developing countries understand and access their exposure to, and vulnerability to, extreme weather-related events and to provide guidance as to the adaptation options and opportunities that are likely to be practical and effective.
- Discouraging the use of flood-prone and slide-prone lands for human settlement.
- Encouraging the development of codes, guidelines and incentives to promote building practices that are sensitive to the more probable extreme weather-related events in the locality.



- Increasing the capacity of banking and insurance industries to provide practical, cost-effective services to support or compensate those harmed by natural disasters.  
Building the capacity, and confidence of developing countries and communities to plan and implement actions that will make them less vulnerable to extreme weather-related events.

#### *Step 8: What actions should be taken in post-assessment follow-up?*

Post-assessment is important to ensure that potential impacts that may have been overlooked are managed, and that adaptation and prevention measures have been implemented and are effective.

The reviewer should consider the following questions:

- How valid were the vulnerability and impact predictions?
- Were the proposed adaptive and preventive measures carried out?
- What was the general level of effectiveness of these measures?
- What further changes are needed to ensure adequate preparedness?
- Is there a need for further adaptation assessment at the project, program or policy level?

## **6.5 Conclusion**

The ultimate goal of both a) designing and implementing adaptation projects to address climate change and b) including an adaptation assessment process within a strategic environmental assessment to be applied to new and existing CIDA policies and programs is to identify actions and measures that will improve the adaptive capacity of a country or region to respond to the impacts of climate change – and to be prepared for, and respond effectively to, extreme weather events that may result from these impacts. These programming tools are directed primarily at CIDA officers who often work within severe time constraints, with limited budgets and with imperfect information.

The recommended focus for adaptation programming is to increase the capacity of developing countries and communities to anticipate and adapt to climate and weather related changes that are likely to occur. In most instances a primary emphasis will be on influencing the human activities and practices that are likely to be harmed as a result of climate change, or which will exacerbate the negative impacts of climate change. This focus leads to the identification of priority areas for intervention: forest and agricultural practices; coastal zone management; awareness raising; land use planning for hazardous areas; codes, guidelines and incentive; and institutional and policy capacity building. As well, the inclusion of adaptation considerations in the SEA process will ensure that all CIDA policies and programs account for extreme weather events and resultant natural disasters at the design stage.

This adaptation focus on natural disasters will enhance CIDA's ability to achieve its development mandate by focusing on the poor (extreme conditions and the disasters that result have disproportionately negative effects on the poor), and assist the Government of Canada in meeting its obligations under the UNFCCC. It is intended to provide direction for CIDA officers in the identification and development of adaptation programs and projects, and,



through a modified strategic environmental assessment process, enable officers to assess adaptation considerations at the design stage.

An important dimension of adapting to climate change is the globalization phenomenon. The move toward a global free market in goods and services brings both opportunities and risks for developing countries. For some countries the pressures to convert their forests to forest products and change agricultural practices in response to international markets for food products will be overwhelming. These responses to the market are likely to benefit inhabitants in the short-term. Developing countries that experience, or are threatened with, food shortages have the potential to import food from other regions. At the same time, initiatives to increase the levels of self-sufficiency in terms of food production may be equally or more appropriate. Clearly one of the major challenges for aid agencies will be to design programs that are cognizant of global realities, while being sensitive to local needs and wants.

Climate change is complex and unpredictable, creating uncertainty in development planning. However, a focus on the intervening environmental and human factors that can lessen the negative impact of extreme climate and weather conditions provides an opportunity to develop initiatives that address the needs of the poor, delivers results that are relevant in the short term and at the same time increases the capacity to adapt to changes over the long term.



## References

- Benioff, R., Guill, S. and J. Lee, editors, 1996. *Vulnerability and Adaptation Assessments: An International Guidebook*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Burton, I., 1992. *Adapt and Thrive*. Canadian Climate Centre, Downsview, Ontario, unpublished manuscript.
- Carter, T.R., Parry, M.L., Harasawa, H. and S. Nishioka, editors, 1994. *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations*. Department of Geography, University College, London.
- Cohen, S.J., editor, 1997. *Mackenzie Basin Impact Study (MBIS): Final Report*. Environment Canada, Downsview, Ontario.
- Environment Canada, 1997. *The Canada Country Study: Climate Impacts and Adaptation, National Summary for Policymakers*. Ottawa, Environment Canada.
- Feenstra, J., Burton, I., Smith, J. and R.Tol, editors, 1998. *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. UNEP, Nairobi and Institute for Environmental Studies, Vrije Universiteit, Amsterdam.
- IPCC, 2001a. *Summary for policymakers*. Report of Working Group I of the Intergovernmental Panel on Climate Change, January 2001, 20pp.
- IPCC, 2001b. *Summary for policymakers – Climate Change 2001: Impacts, Adaptation and Vulnerability*. Report of Working Group II of the Intergovernmental Panel on Climate Change, February 2001, 18pp.
- Kates, R.W., 1997. Climate change 1995 – impacts, adaptation and mitigation. *Environment*, 39 (9), p. 29-33.
- Klein, R.J.T. and D.C. Maciver, 1999. Adaptation to climate variability and change. *Mitigation and Adaptation Strategies for Global Change*, 4 (3/4), p. 189-198.
- Mills, B. and L. Craig, editors, 1999. *Atmospheric Change in the Toronto-Niagara Region*. Environmental Adaptation Research Group, Environment Canada.
- National Climate Change Process, 1999. *Technology Issues Table – Enhancing Technology Innovation for Mitigating Greenhouse Gas Emissions*. National Climate Change Secretariat, Ottawa, 64pp. plus appendices.
- National Climate Change Process, 2000a. *A Compendium of Canadian Initiatives – Taking Action on Climate Change*. National Climate Change Secretariat, Ottawa, 84pp.
- National Climate Change Process, 2000b. *Canada’s First National Climate Change Business Plan*. National Climate Change Secretariat, Ottawa, 100pp.
- National Climate Change Process, 2000c. *Canada’s National Implementation Strategy on Climate Change*. National Climate Change Secretariat, Ottawa, 13pp plus annexes.
- Parry, M. and T. Carter, 1998. *Climate Impact and Adaptation Assessment: A Guide to the IPCC Approach*. Earthscan Publications Limited, London.
- Ryder, J.M., 1998. Geomorphological processes in the alpine areas of Canada – the effects of climate change and their impacts on human activities. Geological Survey of Canada, *Bulletin* 524, 44pp.
- Smit, B., editor, 1993. *Adaptation to Climate Variability and Change*. Environment Canada, Guelph, Ontario.



- Smit, B., Burton, I., Klein, R.J.T. and R. Street, 1999. The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, 4 (3/4), p. 199-213.
- Smith, J.B., Ragland, S.E. and G.J. Pitts, 1996. A process for evaluating anticipatory adaptation measures for climate change. *Water, Air and Soil Pollution*, 92, p. 229-238.
- Stakhiv, E., 1993. *Evaluation of IPCC adaptation strategies*. Institute for Water Resources, US Army Corps of Engineers, draft report.
- Stratus Consulting Inc., 1999. *Compendium of Decision Tools to Evaluate Strategies for Adaptation to Climate Change*. UNFCCC Secretariat, Bonn, Germany.
- United Nations Framework Convention on Climate Change (UNFCCC), 1997. *Technological Issues: Adaptation Technologies*. Technical Paper. FCCC/TP/1997/3. 8 October.
- United Nations Framework Convention on Climate Change (UNFCCC), 2000. *Methodological Issues: Methods and Tools to Evaluate Impacts and Adaptation*. Progress Report. FCCC/SBSTA/2000/INF.4. 19 April.
- Watson, R.T., Zinyowera, M.C. and R.H.Moss, 1996. *Climate change 1995: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge.
- Watson, R.T., Zinyowera, M.C. and R.H. Moss, editors, 1997. *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. Special Report of Working Group II to the Intergovernmental Panel on Climate Change.
- Wheaton, E.E. and D.C. Maciver, 1999. A framework and key questions for adapting to climate variability and change. *Mitigation and Adaptation Strategies for Global Change*, 4 (3/4), p. 215-225.



**Annex 1:  
The Adaptation Assessment Form**

The “Adaptation Assessment Form” presented below is designed to capture the outputs of each of the eight steps described in Section 6. This form will allow for the documentation of the factors considered in an adaptation assessment and the conclusions drawn. Any adjustments made to the initiative as a result of the assessment, prior to implementation or in the course of periodic review and evaluation, should be documented by updating the form.

**A. General Information**

<b>Title of Project or Program</b>	
<b>Branch</b>	
<b>Name of Officer</b>	
<b>Telephone</b>	
<b>Email</b>	

**B. Results of the Adaptation Assessment**

<b>Step 1: Is consideration of adaptation planning appropriate?</b>	<b>Yes</b>	<b>No</b>	<b>Unknown</b>
Does the proposed project or activity involve management of natural systems?			
Does the proposed project or activity involve natural resource development or exploitation?			
Does the proposed project or activity involve adjustments to socio-economic systems that could be affected by changes in the natural world?			
Does the proposed project or activity involve major capital construction?			
<b>Step 2: Is the geographic region of interest subject to extreme weather conditions (or other physical or biological extremes)?</b>	<b>Yes</b>	<b>No</b>	<b>Unknown</b>
Wide seasonal fluctuations			
Temperature extremes			
Precipitation extremes			



Prolonged dry periods			
Intense wet periods			
Geological instability			
Ecosystem sensitivity			
Others			
<b>Step 3: What extreme events may be anticipated in the geographic region as a result of these weather or other conditions?</b>	<b>Yes</b>	<b>No</b>	<b>Unknown</b>
Storms and associated events			
Drought			
Flood			
Fire			
Earthquake			
Volcanic eruption			
Landslides			
Biological plagues			
Mass die-offs or extinctions			
Others			
<b>Step 4: What is the scope of anticipated extreme events?</b>	<b>Extreme Event 1</b>	<b>Extreme Event 2</b>	<b>Extreme Event 3</b>
Geographic Range: What is the total area in which the anticipated event likely to occur? Local, regional or widespread?			
Systems: What systems (natural, physical, human, socio-economic, etc.) are likely to be affected by the event?			
Magnitude: In qualitative terms, how large an effect will the event produce?			
Temporal Characteristics: Is the event expected to be long, short, repeated or intermittent in nature?			
Likelihood: What are the probabilities that the event will occur?			
Seasonality: When in the year is the effect likely to occur (rainy season, dry season, winter, ice break-up)? Will this			



season result in particularly adverse impacts on natural cycles or agricultural production?

Reversibility: Can the event be reversed and systems returned to their previous state?

What is the likelihood that the effect will actually occur (high, medium, low)?

What is the potential for cumulative effects to occur (high, medium or low)?

If they occur how can they be characterized?

- Short-term or long-term,
- Permanent or temporary
- Direct or indirect

**Step 5: What is the anticipated impact of the extreme event?**

**Extreme Event 1    Extreme Event 2    Extreme Event 3**

The likely areas of impact may include:

- Natural ecosystem damage
- Physical destruction (urban, rural, industrial infrastructure)
- Human health (e.g. loss of life, disease, epidemics, sanitation)
- Social system dislocation (e.g. homelessness, medical infrastructure, transportation, energy production and supply)
- Disruption of food and waster supply systems
- Loss or degradation of land usage
- Other

**Step 6: What is the state of preparedness of the country or region for extreme events?**

**6.1: Preparedness**

**Yes    No    Unknown**

Are processes or protocols in place to allow governments, organizations and institutions to respond effectively to the impacts of anticipated natural disasters in the region?

If such response structures and procedures are in place, can they be expanded to provide early warning of potential extreme events?

Can the preparedness procedures be extended or adjusted further to include adaptive measures to prevent or reduce the impacts of natural disasters?



If preparedness procedures are not in place, does the region have the institutional capacity to develop such tools?

<b>6.2: Public Concern</b>	<b>Yes</b>	<b>No</b>	<b>Unknown</b>
Is there recipient country public concern for action?			
Is there Canadian public concern for action?			
<b>Step 7: What adaptation measures could help to avoid or mitigate the negative impacts?</b>	<b>Extreme Event 1</b>	<b>Extreme Event 2</b>	<b>Extreme Event 3</b>
Initial areas of focus may include: <ul style="list-style-type: none"> <li>- Forest management practices</li> <li>- Sustainable agricultural practices</li> <li>- Coastal zone management</li> <li>- Awareness raising</li> <li>- Land use planning for hazardous areas</li> <li>- Codes, guidelines and incentives</li> <li>- Institutional and policy capacity building</li> </ul>			
<b>Step 8: What actions should be taken in post-assessment follow-up?</b>	<b>Adaptation Measure 1</b>	<b>Adaptation Measure 2</b>	<b>Adaptation Measure 3</b>
<b>Questions</b>			
How valid were the vulnerability and impact predictions?			
Were the proposed adaptive and preventative measures carried out?			
How effective were these measures?			
What was the general level of effectiveness of these measures?			
What further changes are needed to ensure adequate preparedness?			



## ANNEX II Sources for Further Information

---

The reader is therefore referred to the following sites for data and information to supplement the policy summary provided in this report.

Canada's National Climate Change Process. This site is maintained by the National Climate Change Secretariat in Ottawa and contains a very comprehensive set of links to other federal government sites as well as provincial, U.S. and other international government bodies, international organizations, nongovernmental organizations, academia and the research community. It is an excellent starting point for climate change information searches. **All organizations listed below and referenced in the preceding text are linked through this site.**

[www.nccp.ca](http://www.nccp.ca)

Global Environment Facility [www.gefweb.org](http://www.gefweb.org)

Government of Ontario (for Ministries of Environment, Natural Resources and others) [www.gov.on.ca](http://www.gov.on.ca)

Intergovernmental Panel on Climate Change (IPCC) [www.ipcc.ch](http://www.ipcc.ch)

International Institute for Sustainable Development <http://iisd.ca>

Natural Resources Canada. This particular site within the Natural Resources Canada system leads directly to information on greenhouse gas emission projections [www.nrcan.gc.ca/es/ceo/update.htm](http://www.nrcan.gc.ca/es/ceo/update.htm)

United Nations Framework Convention on Climate Change (UNFCCC) [www.unfccc.de](http://www.unfccc.de)

For the June 2001 UNFCCC workshop on adaptation methodologies and adaptation policy framework see [www.unfccc.de/sessions/workshop/010611/index.html](http://www.unfccc.de/sessions/workshop/010611/index.html)

United Nations Environment Program (UNEP) [www.unep.ch](http://www.unep.ch)

United States Environmental Protection Agency [www.epa.gov/globalwarming](http://www.epa.gov/globalwarming)

United States Global Change Research Program [www.usgcrp.gov](http://www.usgcrp.gov)

World Bank [www.worldbank.org](http://www.worldbank.org)

*Mitigation and Adaptation Strategies for Global Change* – an international journal devoted to scientific, engineering, socio-economic and policy responses to environmental change. Full contents of the journal can be accessed on the site. Volume 4, issue ¾ (1999) is devoted entirely and usefully to the subject of adaptation.

<http://kapis.www.wkap.nl/journalhome.htm/1381-2386>

*Climatic Change* – an interdisciplinary journal devoted to the description, causes and implications of climate change. <http://kapis.www.wkap.nl/journalhome.htm/0165-0009>



## ANNEX III

### Definitions and Terminology

---

**Adaptive capacity** is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

**Adaptability** is the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate; adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions (Watson et al., 1996).

**Annex 1 Countries** refers to the members of the Organization of Economic Cooperation and Development (OECD), plus countries with economies in transition, Central and Eastern Europe (excluding the former Yugoslavia and Albania). By default the other countries are referred to as Non-Annex I countries.

**Climate change**, in current IPCC usage, refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change where climate change refers to a change of climate attributable directly or indirectly to human activity that alters the composition of the global atmosphere and that is additional to natural variability observed over comparable time periods.

**Extreme Weather Events** are rare or unusual weather events that are often associated with substantial harm to ecosystems and communities. Hurricanes, tornados, heat waves and prolonged drought are examples. Extreme weather events have always occurred, but there is some evidence that the frequency and severity of such events are increasing, at least partly as a result of atmospheric changes that are occurring. The extent to which extreme weather events can be attributed to anthropogenic climate change is not clear. Additional data and improved climate models will narrow, but not eliminate this uncertainty

**Greenhouse gases** (GHGs) are part of the mixture of gases in the Earth's atmosphere that absorb the sun's heat and radiate it back to the Earth's surface, trapping it like a greenhouse. The Kyoto Protocol addresses the six main types of GHGs – carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride. Three of these are of particular concern:

- Carbon dioxide – the most significant GHG released by human activities, especially through the burning of fossil fuels;
- Methane – produced when vegetation is digested or rotted without the presence of oxygen; much more potent a GHG than carbon dioxide but produced in less volume; and
- Nitrous oxide – released when chemical fertilizers and manure are used in agriculture.

**Impacts** of climate change are a function of the magnitude and rate of global and regional changes in mean climate, climate variability and extreme climate phenomena, physical and biological settings, social and economic conditions, and adaptation.



**Impact assessment** refers to research and investigations designed to find out what effect future changes could have on human activities and the natural world. Impacts can be adverse or beneficial.

**Kyoto Protocol** was established in December 1997 at the COP3 to the UNFCCC in Kyoto, Japan. As part of this agreement, industrialized countries undertook to reduce their collective emissions of greenhouse gases by 5.2 percent below 1990 levels by the period 2008-2012. The Government of Canada agreed to a target of 6 percent below 1990 levels. Provisions of the Protocol stipulate that 55 Parties representing 55 percent of 1990 Annex I carbon dioxide emissions must ratify the Protocol before it comes into effect.

**Maladaptation** refers to those actions that tend to increase vulnerability to climate change (e.g. development or investment decisions neglecting consideration of climate or climate change).

**Sensitivity** is the degree to which a system will respond to a change in climatic conditions (e.g. the extent of change in ecosystem composition, structure, and functioning, including primary productivity, resulting from a given change in temperature or precipitation) (Wheaton and Maciver, 1999).

**Social vulnerability** refers to the susceptibility of groups or individuals to stress as a result of social and environmental change. Important elements of social vulnerability include food security, resource dependency, risks to human health, migration and economic factors (Klein and Maciver, 1999).

**United Nations Framework Convention on Climate Change (UNFCCC)** was a milestone in a process that began in the 1980s when scientific evidence suggested a link between anthropogenic greenhouse gas emissions and the risk of global climate change. The Convention was opened for signature at the Rio de Janeiro Earth Summit in June 1992, was subsequently signed by 154 nations and came into force on March 21, 1994. Article 2 of the UNFCCC states that “the ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.”

**Vulnerability** is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Vulnerability is a function of the sensitivity of a system to changes in climate (the degree to which a system will respond to a given change in climate, including both beneficial and harmful effects) and the adaptability of the system to changes in climate (the degree to which adjustments in practices, processes or structures can moderate or offset the potential for damage or take advantage of opportunities created, due to a given change in climate). Under this framework, a highly vulnerable system would be one that is highly sensitive to modest changes in climate, where the sensitivity includes the potential for substantial harmful effects, and one for which the ability to adapt is severely constrained (Watson et al., 1997).



## ANNEX IV Assessment of Regional Vulnerability

---

All regions of the Earth's land surface will be affected to some degree by the impacts of climate change and climate variability. However, wide variation in the vulnerability of similar sectors or systems is to be expected across regions, as a consequence of differences in local environmental conditions, pre-existing stresses to ecosystems, current resource use patterns, and decision making factors such as government policies, prices, societal preferences and community values. Article 2 of the UNFCCC acknowledges the importance of natural ecosystems, food production and sustainable economic development. Therefore, the following summary of regional vulnerabilities, which is drawn largely from the IPCC Special Report on the Regional Impacts of Climate Change (Watson et al., 1997), focuses on five sectors - ecosystems, hydrology and water resources, food and fibre production, coastal systems, and human health.

The description of regional vulnerabilities is selective and, consistent with the goals of the Canada Climate Change Development Fund, places emphasis on the developing world that is expected to suffer disproportionately from the impacts of climate change.

### **Ecosystems**

Ecosystems are of fundamental importance to environmental function and to sustainability, and they provide many goods and services critical to individuals and societies. These goods and services include: (i) providing food, fibre, fodder, shelter, medicines and energy; (ii) processing and storing carbon and nutrients; (iii) assimilating wastes; (iv) purifying water, regulating water runoff and moderating floods; (v) building soils and reducing soil degradation; (vi) providing opportunities for recreation and tourism; and (vii) housing the Earth's entire reservoir of genetic and species diversity. In addition, natural ecosystems have cultural, religious, aesthetic and intrinsic existence values. Changes in climate have the potential to affect the geographic location of ecological systems, the mix of species that they contain, and their ability to provide the wide range of benefits on which societies rely for their continued existence. Climate change influenced by anthropogenic factors is expected to occur at a rapid rate relative to the speed at which ecosystems can adapt and reestablish themselves.

In Africa today, tropical forests and rangelands are under threat from population pressures and systems of land use. Generally apparent effects of these threats include loss of biodiversity, rapid deterioration in land cover and depletion of water availability through destruction of catchments and aquifers. Climate change will interact with these underlying changes in the environment, adding further stresses to a deteriorating situation. Were rainfall to increase in the highlands of east Africa and equatorial central Africa, as some models have predicted, marginal lands would become more productive than they are now. These effects are likely to be negated, however, by population pressure on marginal forests and rangelands. Adaptive options include control of deforestation, improved rangeland management, expansion of protected areas and sustainable management of forests.

In most arid or desert vegetation types, in Africa and other parts of the world, climate change projections suggest little change, that is most lands that are deserts are expected to remain deserts. Greater change is anticipated in the composition and distribution of vegetation types of semi-arid areas such as grasslands.



Large forest and rangeland areas in Latin America and Southeast Asia are expected to be affected by climate changes, with mountain ecosystems and transitional zones between vegetation types extremely vulnerable. Climate change could add an additional stress to the adverse effects of continued deforestation in, for example, the Amazon rainforest. This impact could lead to biodiversity losses, reduced rainfall and runoff within and beyond the Amazon basin which could affect the global carbon cycle. Changes in the distribution and health of rainforest and drier monsoon forest in tropical Asia will be complex. In Thailand, for instance, the area of tropical forest could increase from 45 per cent to 80 per cent of total forest cover, whereas in Sri Lanka, a significant increase in dry forest and a decrease in wet forest could occur.

Some critical marine ecosystems, such as coral reefs, are very sensitive to temperature changes. Although some reefs have the ability to keep pace with the projected rate of sea-level rise, in many parts of the tropics (e.g. Caribbean Sea, eastern and southwestern Pacific Ocean) some species of corals live near their limits of temperature tolerance. The adaptive capacity of mangroves to climate change is expected to vary by species, as well as according to local conditions. For example, landward migration of mangroves and tidal wetlands in response to changing natural conditions will be constrained by human infrastructure and human activities.

## Hydrology and Water

Water availability is an essential component of social welfare and productivity. Currently, 1.3 billion people do not have access to adequate supplies of safe water, and 2 billion people do not have access to adequate sanitation. Some 19 countries, primarily in the Middle East and north and southern Africa, face such severe shortfalls that they are classified as either water-scarce or water-stressed. The number is expected to double by 2025, largely because of increases in demand resulting from economic and population growth. Changes in climate could exacerbate periodic and chronic shortfalls of water, particularly in arid and semi-arid regions. Developing countries are highly vulnerable to climate change because many are located in these regions, and most derive their water resources from single-point systems such as bore holes or isolated reservoirs. These systems, by their nature, are vulnerable because there is no designed contingency in the system to provide resources, should the primary supply fail. Also, given the limited technical, financial and management resources possessed by developing countries and the ability of water resources managers to respond not only to climate change but also to population growth, demand fluctuations, technology development, and economic, social and legislative conditions, adjusting to shortages and/or implementing adaptation measures will impose a heavy burden on national economies. Ultimately, the impacts of climate change will depend on the baseline condition of the water supply system.

More of the water-stressed countries are in Africa than in any other region. This number is likely to increase, independent of climate change, as a result of increases in demand resulting from population growth, degradation of watersheds caused by land use change and siltation of river basins. A further reduction in precipitation in the Sahel and southern Africa, if accompanied by high annual variability, could be detrimental to the hydrological balance of the continent and disrupt various water-dependent socio-economic activities. Similarly, in the Middle East and arid regions of western Asia, current water shortages are unlikely to be reduced and may be exacerbated by climate change.

In contrast, in high latitude or high altitude areas, increasing temperature will thaw permafrost and melt more snow and ice. There will be more running and standing water, and river and lake ice will break up earlier and freeze later. Under current climate models for doubled atmospheric carbon dioxide concentrations, runoff from glaciers



in central Asia is projected to increase threefold by 2050 with an overall 25 percent reduction of mountain glacier mass by that time.

In Latin America, hydropower generation and grain and livestock production are particularly vulnerable to changes in water supply, particularly in Costa Rica, Panama and the Andes piedmont, as well as adjacent areas in Chile and western Argentina. The impacts on water resources could be sufficient to lead to conflicts among users, regions and countries.

The Himalayas have a critical role in the provision of water to continental monsoon Asia. Increased temperatures and increased seasonal variability in precipitation are expected to result in increased recession of glaciers and increasing danger from glacial lake outburst floods. A reduction in average flow of snow-fed rivers, coupled with an increase in peak flows and sediment yield, would have major impacts on hydropower generation, urban water supply and agriculture. A reduction in snowmelt water will put the dry-season flow of these rivers under more stress than is the case now. Increased population and increasing demand in the agricultural, industrial and hydropower sectors will put additional stress on the water resources of this region.

## **Food and Fibre**

Food and fibre production is another essential component of social health. Currently, 800 million people are malnourished and, as the world's population increases and incomes in some countries rise, food consumption is expected to double over the next three to four decades. The most recent doubling in food production occurred over a 25 year period and was driven by technological progress in irrigation, chemical aids and high-yielding crop varieties. Sustaining such progress is uncertain because of problems associated with intensifying production on land already in use (e.g., chemical and biological runoff, salinization of soils, soil erosion and compaction). Another option is expanding the amount of land under cultivation, but this will undoubtedly lead to increases in competition for land and pressure on natural ecosystems, increased agricultural emissions of greenhouse gases, a reduction in natural sinks of carbon, and expansion of agriculture to marginal lands. Because agricultural systems are tied closely to weather and climatic factors, identification of vulnerabilities and prediction of impacts under various climate change scenarios can be undertaken with some confidence. Changes in climate will interact with economic and political stresses that result from actions to increase agricultural production, thus affecting crop yields and productivity in different ways, depending on the types of agricultural practices and systems in place.

Agriculture is the principal economic mainstay of most African countries, contributing 20-30 per cent of GDP in sub-Saharan Africa and 55 per cent of the total value of African exports. In most African countries, farming depends on the quality and consistency of the rainy season, a situation that leads to high vulnerability to climate change. Increased droughts could seriously impact the availability of food generating famines that have already been too prevalent in this part of the world. However, in subtropical Africa there could be benefits to climate change with warmer winters reducing the incidence of damaging frosts, making it possible to grow horticultural produce at higher elevations than is possible at present.

In the Middle East and arid western Asia, land degradation problems and limited water supplies restrict present agricultural productivity and threaten the food security of some countries. There are few projections of the impacts of climate change on food and fibre production for the region. The adverse impacts that may result in the region are suggested by the results of studies that estimate that wheat production in Kazakhstan and Pakistan



would decline under selected scenarios of climate change. The studies, however, are too few to draw strong conclusions regarding agriculture across the entire region. Countries of the former Soviet Union are undergoing major economic changes, particularly in agricultural systems and management. This transition is likely to provide options to change crop types and introduce more efficient irrigation, thus generating positive opportunities for conservation of resources to offset the projected impacts of climate change. In northern and central Asia, a northward shift of crop zones is expected to increase agricultural productivity in northern Siberia but to decrease (by about 25 per cent) grain production in southwestern Siberia because of a more arid climate.

In Latin America, even after allowing for the positive effects of elevated carbon dioxide on crop growth and moderate levels of adaptation at the farm level, decreases in agricultural production are projected for many regions (e.g., Mexico, countries of the Central American isthmus, Brazil, Chile, Argentina and Uruguay). In addition, livestock production will decrease if temperate grasslands have to face substantial decreases in water availability. Extreme events (e.g., floods, droughts, frosts, storms) have the potential to adversely affect rangelands and agricultural production (e.g., banana crops in Central America). The livelihoods of traditional peoples, such as many Andean communities, will be threatened if the productivity or surface area of rangelands or traditional crops is reduced.

In southern and southeast Asia, the sensitivity of major cereal and tree crops to changes in temperature, moisture and carbon dioxide concentration of the magnitudes projected for the region has been demonstrated in many studies. For example, impacts on rice yield, wheat yield and sorghum yield suggest that any increase in production associated with carbon dioxide fertilization will be more than offset by reductions in yield from temperature or moisture changes. Complicating the impact assessment of this region is the vulnerability of agricultural areas to episodic environmental hazards, including floods, droughts and cyclones. Low-income rural populations that depend on traditional agricultural systems or on marginal lands are particularly vulnerable.

## **Coastal Systems**

Coastal zones are characterized by a rich diversity of ecosystems and a great number of socioeconomic activities. Human populations in the coastal zones of many countries have been increasing at double the national rate of population growth. Approximately half of the global population lives in coastal zones. Many countries already face severe sea-level rise problems due to factors other than climate change and many regions are already at risk of flooding from storm surges. Climate change will exacerbate these problems, leading to potential impacts on ecosystems, human coastal infrastructure and large numbers of people.

Several African coastal zones, many of which already are under stress from population pressure and conflicting uses, would be adversely affected by sea-level rise associated with climate change. The coastal nations of west and central Africa (e.g., Senegal, Gambia, Sierra Leone, Nigeria, Cameroon, Gabon, Angola) have low-lying coasts that are susceptible to erosion and hence are threatened by sea-level rise. Most of the countries in this area have major and rapidly expanding cities on the coast. A number of studies indicate that a sizable proportion of the northern part of the Nile delta will be lost through a combination of inundation and erosion, with consequent loss of agricultural land and urban areas. Adaptation measures in African coastal zones are available but would be very costly, as a percentage of GDP, for many countries.





As warming occurs, the Arctic could experience a thinner and reduced ice cover. Coastal and river navigation will increase, with new opportunities for water transport, tourism and trade. The Arctic Ocean could become a major global trade route. Reductions in ice will benefit offshore oil production. In the southern polar region, further breakup of ice shelves in the Antarctic peninsula is likely but little change is expected to other coastlines or large ice shelves.

The coastal systems of small island states are particularly susceptible to climate change impacts. Higher rates of erosion and coastal land loss are expected in many small islands as a consequence of the projected rise in sea level. For example, in the case of the Majuro atoll in the Marshall Islands and Kiribati, it is estimated that for a one metre rise in sea level as much as 80 percent and 12.5 percent respectively of total land would be vulnerable. Low-lying island states and atolls also are expected to experience increased sea flooding, inundation and salinization (of soils and groundwater) as a direct consequence of sea-level rise.

Coastal lands of southern and southeast Asia are particularly vulnerable to sea-level rise. Densely settled and intensively used low-lying coastal plains, islands and deltas are especially vulnerable to coastal erosion and land loss, inundation and sea flooding, upstream movement of the saline/freshwater front and seawater intrusion into groundwater aquifers. Especially at risk are large delta regions of Bangladesh, Myanmar, Viet Nam and Thailand, and the low-lying areas of Indonesia, the Philippines and Malaysia.

Socio-economic impacts could be felt in major cities and ports, tourist resorts, commercial fishing, coastal agriculture and infrastructure development. International studies assuming a one-metre rise in sea level have projected the displacement of several millions of people from the region's coastal zone. The costs of response measures to reduce the impact of sea-level rise in the region could be immense.

## Human Health

Human health is vulnerable to climate change adversely through increases in heat stress mortality, tropical vector-borne diseases, urban air pollution problems, and beneficially through decreases in cold-related illnesses. Compared with the total burden of ill health, however, these changes are not likely to be large. For example, the percentage of the developing world's population living in cities is expected to increase from 25 percent (in 1960) to more than 50 percent by 2020, with percentages in some regions far exceeding these averages. If not accompanied by improved sanitation services and drinking water supplies such demographic change could lead to serious urban environmental problems. Consequently, while the direct and indirect impacts of climate change on human health do constitute a hazard to human population health, quantifying the actual level of projected health impacts is difficult. The significance of climate-induced health disorders depends on other factors, such as migration, provision of clean urban environments, improved nutrition, increased availability of potable water, improvements in sanitation, the extent of disease vector-control measures, changes in resistance of vector organisms to insecticides, and more widespread availability of health care.

The impacts of climate change on human health display similar patterns throughout the developing world. Africa is expected to be at risk primarily from increased incidences of vector-borne diseases and reduced nutritional status. However, a warmer environment could open up new areas for malaria; altered temperature and rainfall patterns

also could increase the incidence of yellow fever, dengue fever and other illnesses. In view of the poor economic status of most African nations, global efforts will be necessary to tackle the potential health effects.

In the Middle East and arid western Asia, heat stress and a possible spread in vector-borne diseases are likely to result from changes in climate. Decreases in water availability and food production would lead to indirect impacts on human health.

In Latin America, climate changes could increase the impacts of already serious chronic malnutrition and diseases for some populations. The geographical distributions of vector-borne diseases (e.g. malaria, dengue) and infectious diseases (e.g. cholera) would expand southward and to higher elevations if temperature and precipitation increase. Pollution and high concentrations of ground-level ozone, exacerbated by increasing surface temperature, would have the potential to negatively affect human health and welfare, especially in the rapidly expanding urban areas of the region.

In southern and southeast Asia, the incidence and extent of some vector-borne diseases are expected to increase with global warming. Malaria, schistosomiasis and dengue, which are significant causes of mortality and morbidity in tropical Asia, are very sensitive to climate and are likely to spread into new regions on the margins of presently endemic areas as a consequence of climate change. Newly affected populations initially would experience higher fatality rates. Waterborne and water-related infectious diseases, which already account for the majority of epidemic emergencies in the region, also are expected to increase when higher temperatures and higher humidity are superimposed on existing conditions and projected increases in population, urbanization, declining water quality and other socio-economic trends.

