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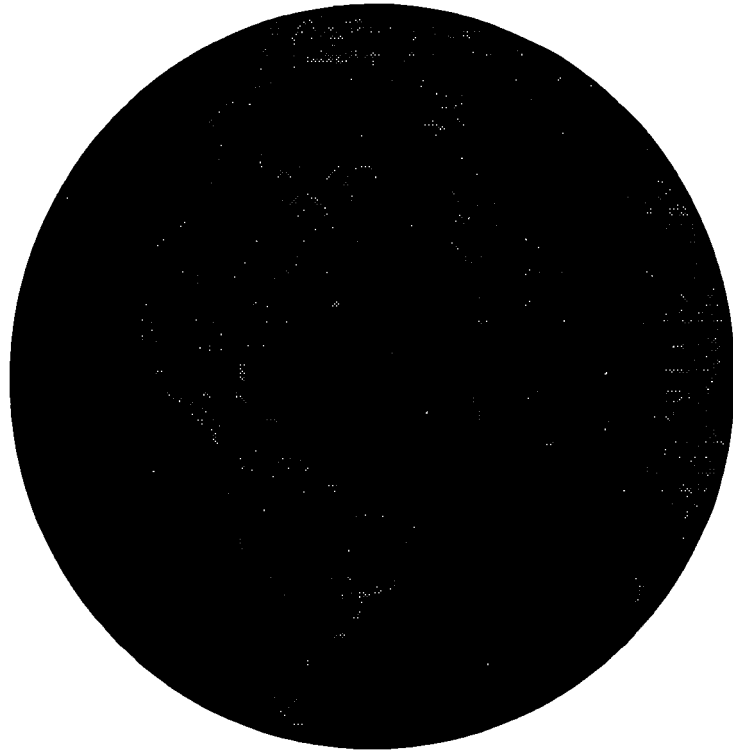
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*Climate
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This booklet contains the text of the United Nations Framework Convention on
Climate Change, which starts on page 2.

Introduction

During the 1980s, scientific evidence about the possibility of global climate change led to growing public concern. By 1990, a series of international conferences had issued urgent calls for a global treaty to address the problem. The United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) responded by establishing an intergovernmental working group to prepare for treaty negotiations. Rapid progress was made, in part because of work by the Intergovernmental Panel on Climate Change (IPCC) and by meetings such as the 1990 Second World Climate Conference.

In response to the working group's proposal, the United Nations General Assembly at its 1990 session set up the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC). The INC/FCCC was given a mandate to draft a framework convention and any related legal instruments it considered necessary. Negotiators from over 150 States met during five sessions between February 1991 and May 1992. They adopted the United Nations Framework Convention on Climate Change on 9 May 1992 at UN Headquarters in New York.

Soon after, at the June 1992 United Nations Conference on Environment and Development (known as the Rio "Earth Summit"), the Convention received 155 signatures. Other States have since signed, and a growing number have ratified. The Convention will enter into force 90 days after the 50th ratification. The first session of the Conference of the Parties must then be convened within the following year. This meeting of all ratifying States will be hosted by Germany, possibly in early 1995. The INC/FCCC, which is continuing with important preparatory work, will then be dissolved and the Conference of the Parties will take over responsibility for the lengthy process of implementing the Convention.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The Parties to this Convention,

Acknowledging that change in the Earth's climate and its adverse effects are a common concern of humankind,

Concerned that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases, that these increases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind,

Noting that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs,

Aware of the role and importance in terrestrial and marine ecosystems of sinks and reservoirs of greenhouse gases,

Noting that there are many uncertainties in predictions of climate change, particularly with regard to the timing, magnitude and regional patterns thereof,

Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions,

Recalling the pertinent provisions of the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972,

Recalling also that States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction,

Reaffirming the principle of sovereignty of States in international cooperation to address climate change,

Recognizing that States should enact effective environmental legislation, that environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply, and that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries,

Recalling the provisions of General Assembly resolution 44/228 of 22 December 1989 on the United Nations Conference on Environment and Development, and resolutions 43/53 of 6 December 1988, 44/207 of 22 December 1989, 45/212 of 21 December 1990 and 46/169 of 19 December 1991 on protection of global climate for present and future generations of mankind,

Recalling also the provisions of General Assembly resolution 44/206 of 22 December 1989 on the possible adverse effects of sea-level rise on islands and coastal areas, particularly low-lying coastal areas and the pertinent provisions of General Assembly resolution 44/172 of 19 December 1989 on the implementation of the Plan of Action to Combat Desertification,

Recalling further the Vienna Convention for the Protection of the Ozone Layer, 1985, and the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, as adjusted and amended on 29 June 1990,

Noting the Ministerial Declaration of the Second World Climate Conference adopted on 7 November 1990,

Conscious of the valuable analytical work being conducted by many States on climate change and of the important contributions of the World Meteorological Organization, the United Nations Environment Programme and other organs, organizations and bodies of the United Nations system, as well as other international and intergovernmental bodies, to the exchange of results of scientific research and the coordination of research,

Recognizing that steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas,

Recognizing that various actions to address climate change can be justified economically in their own right and can also help in solving other environmental problems,

Recognizing also the need for developed countries to take immediate action in a flexible manner on the basis of clear priorities, as a first step towards comprehensive response strategies at the global, national and, where agreed, regional levels that take into account all greenhouse gases, with due consideration of their relative contributions to the enhancement of the greenhouse effect,

Recognizing further 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,

Recognizing the special difficulties of those countries, especially developing countries, whose economies are particularly dependent on fossil fuel production, use and exportation, as a consequence of action taken on limiting greenhouse gas emissions,

Affirming 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 the eradication of poverty,

Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development and that, in order for developing countries to progress towards that goal, their energy consumption will need to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general, including through the application of new technologies on terms which make such an application economically and socially beneficial,

Determined to protect the climate system for present and future generations,

Have agreed as follows:

ARTICLE 1

DEFINITIONS *

For the purposes of this Convention:

1. "Adverse effects of climate change" means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.

* Titles of articles are included solely to assist the reader.

2. "Climate change" means a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
3. "Climate system" means the totality of the atmosphere, hydrosphere, biosphere and geosphere and their interactions.
4. "Emissions" means the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.
5. "Greenhouse gases" means those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation.
6. "Regional economic integration organization" means an organization constituted by sovereign States of a given region which has competence in respect of matters governed by this Convention or its protocols and has been duly authorized, in accordance with its internal procedures, to sign, ratify, accept, approve or accede to the instruments concerned.
7. "Reservoir" means a component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored.
8. "Sink" means any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.
- *9. "Source" means any process or activity which releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas into the atmosphere.

ARTICLE 2

OBJECTIVE

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.

ARTICLE 3

PRINCIPLES

In their actions to achieve the objective of the Convention and to implement its provisions, the Parties shall be guided, inter alia, by the following:

1. The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.
2. 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.
3. The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties.
4. The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change.
5. The Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change. Measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.

ARTICLE 4

COMMITMENTS

1. All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:

- (a) Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;
- (b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change;
- (c) Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors;
- (d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;
- (e) Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods;
- (f) Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, formulated and determined nationally, with a view to minimizing adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change;

- (g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies;
- (h) Promote and cooperate in the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, and to the economic and social consequences of various response strategies;
- (i) Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations; and
- (j) Communicate to the Conference of the Parties information related to implementation, in accordance with Article 12.

2. The developed country Parties and other Parties included in Annex I commit themselves specifically as provided for in the following:

- (a) Each of these Parties shall adopt national ^{1/} policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs.
 - < These policies and measures will demonstrate that developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions consistent with the objective of the Convention, recognizing that the return by the end of the present decade to earlier levels of anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol would contribute to such modification, and taking into account the differences in these Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort regarding that objective. >
 - These Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention and, in particular, that of this subparagraph;

- (b) In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for the period referred to in subparagraph (a), with the aim of returning individually or jointly to their 1990 levels these anthropogenic emissions of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol. This information will be reviewed by the Conference of the Parties, at its first session and periodically thereafter, in accordance with Article 7;
- (c) Calculations of emissions by sources and removals by sinks of greenhouse gases for the purposes of subparagraph (b) above should take into account the best available scientific knowledge, including of the effective capacity of sinks and the respective contributions of such gases to climate change. The Conference of the Parties shall consider and agree on methodologies for these calculations at its first session and review them regularly thereafter;
- (d) The Conference of the Parties shall, at its first session, review the adequacy of subparagraphs (a) and (b) above. Such review shall be carried out in the light of the best available scientific information and assessment on climate change and its impacts, as well as relevant technical, social and economic information. Based on this review, the Conference of the Parties shall take appropriate action, which may include the adoption of amendments to the commitments in subparagraphs (a) and (b) above. The Conference of the Parties, at its first session, shall also take decisions regarding criteria for joint implementation as indicated in subparagraph (a) above. A second review of subparagraphs (a) and (b) shall take place not later than 31 December 1998, and thereafter at regular intervals determined by the Conference of the Parties, until the objective of the Convention is met;
- (e) Each of these Parties shall:
 - (i) Coordinate as appropriate with other such Parties, relevant economic and administrative instruments developed to achieve the objective of the Convention; and
 - (ii) Identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur;

^{1/} This includes policies and measures adopted by regional economic integration organizations.

- (f) The Conference of the Parties shall review, not later than 31 December 1998, available information with a view to taking decisions regarding such amendments to the lists in Annexes I and II as may be appropriate, with the approval of the Party concerned;
- (g) Any Party not included in Annex I may, in its instrument of ratification, acceptance, approval or accession, or at any time thereafter, notify the Depositary that it intends to be bound by subparagraphs (a) and (b) above. The Depositary shall inform the other signatories and Parties of any such notification.

3. The developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.

4. The developed country Parties and other developed Parties included in Annex II shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

5. The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

6. In the implementation of their commitments under paragraph 2 above, a certain degree of flexibility shall be allowed by the Conference of the Parties to the Parties included in Annex I undergoing the process of transition to a market economy, in order to enhance the ability of these Parties to address climate change, including with regard to the historical level of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol chosen as a reference.

7. The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.

8. In the implementation of the commitments in this Article, the Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on:

- (a) Small island countries;
- (b) Countries with low-lying coastal areas;
- (c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;
- (d) Countries with areas prone to natural disasters;
- (e) Countries with areas liable to drought and desertification;
- (f) Countries with areas of high urban atmospheric pollution;
- (g) Countries with areas with fragile ecosystems, including mountainous ecosystems;
- (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products; and
- (i) Land-locked and transit countries.

Further, the Conference of the Parties may take actions, as appropriate, with respect to this paragraph.

9. The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.

10. The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives.

ARTICLE 5

RESEARCH AND SYSTEMATIC OBSERVATION

In carrying out their commitments under Article 4, paragraph 1(g), the Parties shall:

- (a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and systematic observation, taking into account the need to minimize duplication of effort;
- (b) Support international and intergovernmental efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities, particularly in developing countries, and to promote access to, and the exchange of, data and analyses thereof obtained from areas beyond national jurisdiction; and
- (c) Take into account the particular concerns and needs of developing countries and cooperate in improving their endogenous capacities and capabilities to participate in the efforts referred to in subparagraphs (a) and (b) above.

ARTICLE 6

EDUCATION, TRAINING AND PUBLIC AWARENESS

In carrying out their commitments under Article 4, paragraph 1(i), the Parties shall:

- (a) Promote and facilitate at the national and, as appropriate, subregional and regional levels, and in accordance with national laws and regulations, and within their respective capacities:
 - (i) The development and implementation of educational and public awareness programmes on climate change and its effects;
 - (ii) Public access to information on climate change and its effects;
 - (iii) Public participation in addressing climate change and its effects and developing adequate responses; and
 - (iv) Training of scientific, technical and managerial personnel.

- (b) Cooperate in and promote, at the international level, and, where appropriate, using existing bodies:
 - (i) The development and exchange of educational and public awareness material on climate change and its effects; and
 - (ii) The development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries.

ARTICLE 7

CONFERENCE OF THE PARTIES

1. A Conference of the Parties is hereby established.
2. The Conference of the Parties, as the supreme body of this Convention, shall keep under regular review the implementation of the Convention and any related legal instruments that the Conference of the Parties may adopt, and shall make, within its mandate, the decisions necessary to promote the effective implementation of the Convention. To this end, it shall:
 - (a) Periodically examine the obligations of the Parties and the institutional arrangements under the Convention, in the light of the objective of the Convention, the experience gained in its implementation and the evolution of scientific and technological knowledge;
 - (b) Promote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;
 - (c) Facilitate, at the request of two or more Parties, the coordination of measures adopted by them to address climate change and its effects, taking into account the differing circumstances, responsibilities and capabilities of the Parties and their respective commitments under the Convention;
 - (d) Promote and guide, in accordance with the objective and provisions of the Convention, the development and periodic refinement of comparable methodologies, to be agreed on by the Conference of the Parties, *inter alia*, for preparing inventories of greenhouse gas emissions by sources and removals by sinks, and for evaluating the effectiveness of measures to limit the emissions and enhance the removals of these gases;

- (e) Assess, on the basis of all information made available to it in accordance with the provisions of the Convention, the implementation of the Convention by the Parties, the overall effects of the measures taken pursuant to the Convention, in particular environmental, economic and social effects as well as their cumulative impacts and the extent to which progress towards the objective of the Convention is being achieved;
- (f) Consider and adopt regular reports on the implementation of the Convention and ensure their publication;
- (g) Make recommendations on any matters necessary for the implementation of the Convention;
- (h) Seek to mobilize financial resources in accordance with Article 4, paragraphs 3, 4 and 5, and Article 11;
- (i) Establish such subsidiary bodies as are deemed necessary for the implementation of the Convention;
- (j) Review reports submitted by its subsidiary bodies and provide guidance to them;
- (k) Agree upon and adopt, by consensus, rules of procedure and financial rules for itself and for any subsidiary bodies;
- (l) Seek and utilize, where appropriate, the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-governmental bodies; and
- (m) Exercise such other functions as are required for the achievement of the objective of the Convention as well as all other functions assigned to it under the Convention.

3. The Conference of the Parties shall, at its first session, adopt its own rules of procedure as well as those of the subsidiary bodies established by the Convention, which shall include decision-making procedures for matters not already covered by decision-making procedures stipulated in the Convention. Such procedures may include specified majorities required for the adoption of particular decisions.

4. The first session of the Conference of the Parties shall be convened by the interim secretariat referred to in Article 21 and shall take place not later than one year after the date of entry into force of the Convention. Thereafter, ordinary sessions of the Conference of the Parties shall be held every year unless otherwise decided by the Conference of the Parties.

5. Extraordinary sessions of the Conference of the Parties shall be held at such other times as may be deemed necessary by the Conference, or at the written request of any Party, provided that, within six months of the request being communicated to the Parties by the secretariat, it is supported by at least one third of the Parties.

6. The United Nations, its specialized agencies and the International Atomic Energy Agency, as well as any State member thereof or observers thereto not Party to the Convention, may be represented at sessions of the Conference of the Parties as observers. Any body or agency, whether national or international, governmental or non-governmental, which is qualified in matters covered by the Convention, and which has informed the secretariat of its wish to be represented at a session of the Conference of the Parties as an observer, may be so admitted unless at least one third of the Parties present object. The admission and participation of observers shall be subject to the rules of procedure adopted by the Conference of the Parties.

ARTICLE 8

SECRETARIAT

1. A secretariat is hereby established.

2. The functions of the secretariat shall be:

- (a) To make arrangements for sessions of the Conference of the Parties and its subsidiary bodies established under the Convention and to provide them with services as required;
- (b) To compile and transmit reports submitted to it;
- (c) To facilitate assistance to the Parties, particularly developing country Parties, on request, in the compilation and communication of information required in accordance with the provisions of the Convention;
- (d) To prepare reports on its activities and present them to the Conference of the Parties;
- (e) To ensure the necessary coordination with the secretariats of other relevant international bodies;
- (f) To enter, under the overall guidance of the Conference of the Parties, into such administrative and contractual arrangements as may be required for the effective discharge of its functions; and
- (g) To perform the other secretariat functions specified in the Convention and in any of its protocols and such other functions as may be determined by the Conference of the Parties.

3. The Conference of the Parties, at its first session, shall designate a permanent secretariat and make arrangements for its functioning.

ARTICLE 9

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE

1. A subsidiary body for scientific and technological advice is hereby established to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention. This body shall be open to participation by all Parties and shall be multidisciplinary. It shall comprise government representatives competent in the relevant field of expertise. It shall report regularly to the Conference of the Parties on all aspects of its work.
2. Under the guidance of the Conference of the Parties, and drawing upon existing competent international bodies, this body shall:
 - (a) Provide assessments of the state of scientific knowledge relating to climate change and its effects;
 - (b) Prepare scientific assessments on the effects of measures taken in the implementation of the Convention;
 - (c) Identify innovative, efficient and state-of-the-art technologies and know-how and advise on the ways and means of promoting development and/or transferring such technologies;
 - (d) Provide advice on scientific programmes, international cooperation in research and development related to climate change, as well as on ways and means of supporting endogenous capacity-building in developing countries; and
 - (e) Respond to scientific, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body.
3. The functions and terms of reference of this body may be further elaborated by the Conference of the Parties.

ARTICLE 10

SUBSIDIARY BODY FOR IMPLEMENTATION

1. A subsidiary body for implementation is hereby established to assist the Conference of the Parties in the assessment and review of the effective implementation of the Convention. This body shall be open to participation by all Parties and comprise government representatives who are experts on matters related to climate change. It shall report regularly to the Conference of the Parties on all aspects of its work.
2. Under the guidance of the Conference of the Parties, this body shall:
 - (a) Consider the information communicated in accordance with Article 12, paragraph 1, to assess the overall aggregated effect of the steps taken by the Parties in the light of the latest scientific assessments concerning climate change;
 - (b) Consider the information communicated in accordance with Article 12, paragraph 2, in order to assist the Conference of the Parties in carrying out the reviews required by Article 4, paragraph 2(d); and
 - (c) Assist the Conference of the Parties, as appropriate, in the preparation and implementation of its decisions.

ARTICLE 11

FINANCIAL MECHANISM

1. A mechanism for the provision of financial resources on a grant or concessional basis, including for the transfer of technology, is hereby defined. It shall function under the guidance of and be accountable to the Conference of the Parties, which shall decide on its policies, programme priorities and eligibility criteria related to this Convention. Its operation shall be entrusted to one or more existing international entities.

2. The financial mechanism shall have an equitable and balanced representation of all Parties within a transparent system of governance.

3. The Conference of the Parties and the entity or entities entrusted with the operation of the financial mechanism shall agree upon arrangements to give effect to the above paragraphs, which shall include the following:

- (a) Modalities to ensure that the funded projects to address climate change are in conformity with the policies, programme priorities and eligibility criteria established by the Conference of the Parties;
- (b) Modalities by which a particular funding decision may be reconsidered in light of these policies, programme priorities and eligibility criteria;
- (c) Provision by the entity or entities of regular reports to the Conference of the Parties on its funding operations, which is consistent with the requirement for accountability set out in paragraph 1 above; and
- (d) Determination in a predictable and identifiable manner of the amount of funding necessary and available for the implementation of this Convention and the conditions under which that amount shall be periodically reviewed.

4. The Conference of the Parties shall make arrangements to implement the above-mentioned provisions at its first session, reviewing and taking into account the interim arrangements referred to in Article 21, paragraph 3, and shall decide whether these interim arrangements shall be maintained. Within four years thereafter, the Conference of the Parties shall review the financial mechanism and take appropriate measures.

5. The developed country Parties may also provide and developing country Parties avail themselves of, financial resources related to the implementation of the Convention through bilateral, regional and other multilateral channels.

ARTICLE 12

COMMUNICATION OF INFORMATION RELATED TO IMPLEMENTATION

1. In accordance with Article 4, paragraph 1, each Party shall communicate to the Conference of the Parties, through the secretariat, the following elements of information:

- (a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties;
- (b) A general description of steps taken or envisaged by the Party to implement the Convention; and
- (c) Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.

2. Each developed country Party and each other Party included in Annex I shall incorporate in its communication the following elements of information:

- (a) A detailed description of the policies and measures that it has adopted to implement its commitment under Article 4, paragraphs 2(a) and 2(b); and
- (b) A specific estimate of the effects that the policies and measures referred to in subparagraph (a) immediately above will have on anthropogenic emissions by its sources and removals by its sinks of greenhouse gases during the period referred to in Article 4, paragraph 2(a).

3. In addition, each developed country Party and each other developed Party included in Annex II shall incorporate details of measures taken in accordance with Article 4, paragraphs 3, 4 and 5.

4. Developing country Parties may, on a voluntary basis, propose projects for financing, including specific technologies, materials, equipment, techniques or practices that would be needed to implement such projects, along with, if possible, an estimate of all incremental costs, of the reductions of emissions and increments of removals of greenhouse gases, as well as an estimate of the consequent benefits.

5. Each developed country Party and each other Party included in Annex I shall make its initial communication within six months of the entry into force of the Convention for that Party. Each Party not so listed shall make its initial communication within three years of the entry into force of the Convention for that Party, or of the availability of financial resources in accordance with Article 4, paragraph 3. Parties that are least developed countries may make their initial communication at their discretion. The frequency of subsequent communications by all Parties shall be determined by the Conference of the Parties, taking into account the differentiated timetable set by this paragraph.

6. Information communicated by Parties under this Article shall be transmitted by the secretariat as soon as possible to the Conference of the Parties and to any subsidiary bodies concerned. If necessary, the procedures for the communication of information may be further considered by the Conference of the Parties.

7. From its first session, the Conference of the Parties shall arrange for the provision to developing country Parties of technical and financial support, on request, in compiling and communicating information under this Article, as well as in identifying the technical and financial needs associated with proposed projects and response measures under Article 4. Such support may be provided by other Parties, by competent international organizations and by the secretariat, as appropriate.

8. Any group of Parties may, subject to guidelines adopted by the Conference of the Parties, and to prior notification to the Conference of the Parties, make a joint communication in fulfilment of their obligations under this Article, provided that such a communication includes information on the fulfilment by each of these Parties of its individual obligations under the Convention.

9. Information received by the secretariat that is designated by a Party as confidential, in accordance with criteria to be established by the Conference of the Parties, shall be aggregated by the secretariat to protect its confidentiality before being made available to any of the bodies involved in the communication and review of information.

10. Subject to paragraph 9 above, and without prejudice to the ability of any Party to make public its communication at any time, the secretariat shall make communications by Parties under this Article publicly available at the time they are submitted to the Conference of the Parties.

ARTICLE 13

RESOLUTION OF QUESTIONS REGARDING IMPLEMENTATION

The Conference of the Parties shall, at its first session, consider the establishment of a multilateral consultative process, available to Parties on their request, for the resolution of questions regarding the implementation of the Convention.

ARTICLE 14

SETTLEMENT OF DISPUTES

1. In the event of a dispute between any two or more Parties concerning the interpretation or application of the Convention, the Parties concerned shall seek a settlement of the dispute through negotiation or any other peaceful means of their own choice.

2. When ratifying, accepting, approving or acceding to the Convention, or at any time thereafter, a Party which is not a regional economic integration organization may declare in a written instrument submitted to the Depositary that, in respect of any dispute concerning the interpretation or application of the Convention, it recognizes as compulsory *ipso facto* and without special agreement, in relation to any Party accepting the same obligation:

- (a) Submission of the dispute to the International Court of Justice, and/or
- (b) Arbitration in accordance with procedures to be adopted by the Conference of the Parties as soon as practicable, in an annex on arbitration.

A Party which is a regional economic integration organization may make a declaration with like effect in relation to arbitration in accordance with the procedures referred to in subparagraph (b) above.

3. A declaration made under paragraph 2 above shall remain in force until it expires in accordance with its terms or until three months after written notice of its revocation has been deposited with the Depositary.

4. A new declaration, a notice of revocation or the expiry of a declaration shall not in any way affect proceedings pending before the International Court of Justice or the arbitral tribunal, unless the parties to the dispute otherwise agree.

5. Subject to the operation of paragraph 2 above, if after twelve months following notification by one Party to another that a dispute exists between them, the Parties concerned have not been able to settle their dispute through the means mentioned in paragraph 1 above, the dispute shall be submitted, at the request of any of the parties to the dispute, to conciliation.

6. A conciliation commission shall be created upon the request of one of the parties to the dispute. The commission shall be composed of an equal number of members appointed by each party concerned and a chairman chosen jointly by the members appointed by each party. The commission shall render a recommendatory award, which the parties shall consider in good faith.

7. Additional procedures relating to conciliation shall be adopted by the Conference of the Parties, as soon as practicable, in an annex on conciliation.

8. The provisions of this Article shall apply to any related legal instrument which the Conference of the Parties may adopt, unless the instrument provides otherwise.

ARTICLE 15

AMENDMENTS TO THE CONVENTION

1. Any Party may propose amendments to the Convention.

2. Amendments to the Convention shall be adopted at an ordinary session of the Conference of the Parties. The text of any proposed amendment to the Convention shall be communicated to the Parties by the secretariat at least six months before the meeting at which it is proposed for adoption. The secretariat shall also communicate proposed amendments to the signatories to the Convention and, for information, to the Depositary.

3. The Parties shall make every effort to reach agreement on any proposed amendment to the Convention by consensus. If all efforts at consensus have been exhausted, and no agreement reached, the amendment shall as a last resort be adopted by a three-fourths majority vote of the Parties present and voting at the meeting. The adopted amendment shall be communicated by the secretariat to the Depositary, who shall circulate it to all Parties for their acceptance.

4. Instruments of acceptance in respect of an amendment shall be deposited with the Depositary. An amendment adopted in accordance with paragraph 3 above shall enter into force for those Parties having accepted it on the ninetieth day after the date of receipt by the Depositary of an instrument of acceptance by at least three fourths of the Parties to the Convention.

5. The amendment shall enter into force for any other Party on the ninetieth day after the date on which that Party deposits with the Depositary its instrument of acceptance of the said amendment.

6. For the purposes of this Article, "Parties present and voting" means Parties present and casting an affirmative or negative vote.

ARTICLE 16

ADOPTION AND AMENDMENT OF ANNEXES TO THE CONVENTION

1. Annexes to the Convention shall form an integral part thereof and, unless otherwise expressly provided, a reference to the Convention constitutes at the same time a reference to any annexes thereto. Without prejudice to the provisions of Article 14, paragraphs 2(b) and 7, such annexes shall be restricted to lists, forms and any other material of a descriptive nature that is of a scientific, technical, procedural or administrative character.

2. Annexes to the Convention shall be proposed and adopted in accordance with the procedure set forth in Article 15, paragraphs 2, 3 and 4.

3. An annex that has been adopted in accordance with paragraph 2 above shall enter into force for all Parties to the Convention six months after the date of the communication by the Depositary to such Parties of the adoption of the annex, except for those Parties that have notified the Depositary, in writing, within that period of their non-acceptance of the annex. The annex shall enter into force for Parties which withdraw their notification of non-acceptance on the ninetieth day after the date on which withdrawal of such notification has been received by the Depositary.

4. The proposal, adoption and entry into force of amendments to annexes to the Convention shall be subject to the same procedure as that for the proposal, adoption and entry into force of annexes to the Convention in accordance with paragraphs 2 and 3 above.

5. If the adoption of an annex or an amendment to an annex involves an amendment to the Convention, that annex or amendment to an annex shall not enter into force until such time as the amendment to the Convention enters into force.

ARTICLE 17

PROTOCOLS

1. The Conference of the Parties may, at any ordinary session, adopt protocols to the Convention.
2. The text of any proposed protocol shall be communicated to the Parties by the secretariat at least six months before such a session.
3. The requirements for the entry into force of any protocol shall be established by that instrument.
4. Only Parties to the Convention may be Parties to a protocol.
5. Decisions under any protocol shall be taken only by the Parties to the protocol concerned.

ARTICLE 18

RIGHT TO VOTE

1. Each Party to the Convention shall have one vote, except as provided for in paragraph 2 below.
2. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to the Convention. Such an organization shall not exercise its right to vote if any of its member States exercises its right, and vice versa.

ARTICLE 19

DEPOSITARY

The Secretary-General of the United Nations shall be the Depositary of the Convention and of protocols adopted in accordance with Article 17.

ARTICLE 20

SIGNATURE

This Convention shall be open for signature by States Members of the United Nations or of any of its specialized agencies or that are Parties to the Statute of the International Court of Justice and by regional economic integration organizations at Rio de Janeiro, during the United Nations Conference on Environment and Development, and thereafter at United Nations Headquarters in New York from 20 June 1992 to 19 June 1993.

ARTICLE 21

INTERIM ARRANGEMENTS

1. The secretariat functions referred to in Article 8 will be carried out on an interim basis by the secretariat established by the General Assembly of the United Nations in its resolution 45/212 of 21 December 1990, until the completion of the first session of the Conference of the Parties.
2. The head of the interim secretariat referred to in paragraph 1 above will cooperate closely with the Intergovernmental Panel on Climate Change to ensure that the Panel can respond to the need for objective scientific and technical advice. Other relevant scientific bodies could also be consulted.
3. The Global Environment Facility of the United Nations Development Programme, the United Nations Environment Programme and the International Bank for Reconstruction and Development shall be the international entity entrusted with the operation of the financial mechanism referred to in Article 11 on an interim basis. In this connection, the Global Environment Facility should be appropriately restructured and its membership made universal to enable it to fulfil the requirements of Article 11.

ARTICLE 22

RATIFICATION, ACCEPTANCE, APPROVAL OR ACCESSION

1. The Convention shall be subject to ratification, acceptance, approval or accession by States and by regional economic integration organizations. It shall be open for accession from the day after the date on which the Convention is closed for signature. Instruments of ratification, acceptance, approval or accession shall be deposited with the Depositary.

2. Any regional economic integration organization which becomes a Party to the Convention without any of its member States being a Party shall be bound by all the obligations under the Convention. In the case of such organizations, one or more of whose member States is a Party to the Convention, the organization and its member States shall decide on their respective responsibilities for the performance of their obligations under the Convention. In such cases, the organization and the member States shall not be entitled to exercise rights under the Convention concurrently.

3. In their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by the Convention. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence.

ARTICLE 23

ENTRY INTO FORCE

1. The Convention shall enter into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification, acceptance, approval or accession.

2. For each State or regional economic integration organization that ratifies, accepts or approves the Convention or accedes thereto after the deposit of the fiftieth instrument of ratification, acceptance, approval or accession, the Convention shall enter into force on the ninetieth day after the date of deposit by such State or regional economic integration organization of its instrument of ratification, acceptance, approval or accession.

3. For the purposes of paragraphs 1 and 2 above, any instrument deposited by a regional economic integration organization shall not be counted as additional to those deposited by States members of the organization.

ARTICLE 24

RESERVATIONS

No reservations may be made to the Convention.

ARTICLE 25

WITHDRAWAL

1. At any time after three years from the date on which the Convention has entered into force for a Party, that Party may withdraw from the Convention by giving written notification to the Depositary.

2. Any such withdrawal shall take effect upon expiry of one year from the date of receipt by the Depositary of the notification of withdrawal, or on such later date as may be specified in the notification of withdrawal.

3. Any Party that withdraws from the Convention shall be considered as also having withdrawn from any protocol to which it is a Party.

ARTICLE 26

AUTHENTIC TEXTS

The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

IN WITNESS WHEREOF the undersigned, being duly authorized, to that effect, have signed this Convention.

DONE at New York this ninth day of May one thousand nine hundred and ninety-two.

Annex I

Australia
Austria
Belarus^{a/}
Belgium
Bulgaria^{a/}
Canada
Czechoslovakia^{a/}
Denmark
European Economic Community
Estonia^{a/}
Finland
France
Germany
Greece
Hungary^{a/}
Iceland
Ireland
Italy
Japan
Latvia^{a/}
Lithuania^{a/}
Luxembourg
Netherlands
New Zealand
Norway
Poland^{a/}
Portugal
Romania^{a/}
Russian Federation^{a/}
Spain
Sweden
Switzerland
Turkey
Ukraine^{a/}
United Kingdom of Great Britain and Northern Ireland
United States of America

Annex II

Australia
Austria
Belgium
Canada
Denmark
European Economic Community
Finland
France
Germany
Greece
Iceland
Ireland
Italy
Japan
Luxembourg
Netherlands
New Zealand
Norway
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom of Great Britain and Northern Ireland
United States of America

^{a/} Countries that are undergoing the process of transition to a market economy.

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2

Divider Title: _____

I. DECISIONS ADOPTED BY THE CONFERENCE OF THE PARTIES

Decision 1/CP.1

The Berlin Mandate: Review of the adequacy of Article 4, paragraph 2 (a) and (b), of the Convention, including proposals related to a protocol and decisions on follow-up

The Conference of the Parties, at its first session,

Having reviewed Article 4, paragraph 2(a) and (b), of the United Nations Framework Convention on Climate Change, and

Having concluded that these subparagraphs are not adequate,

Agrees to begin a process to enable it to take appropriate action for the period beyond 2000, including the strengthening of the commitments of the Parties included in Annex I to the Convention (Annex I Parties) in Article 4, paragraph 2(a) and (b), through the adoption of a protocol or another legal instrument:

I

1. The process shall be guided, inter alia, by the following:

(a) The provisions of the Convention, including Article 3, in particular the principles in Article 3.1, which reads as follows: "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof;"

(b) The specific needs and concerns of developing country Parties referred to in Article 4.8; the specific needs and special situations of least developed countries referred to in Article 4.9; and the situation of Parties, particularly developing country Parties, referred to in Article 4.10 of the Convention;

(c) The legitimate needs of the developing countries for the achievement of sustained economic growth and the eradication of poverty, recognizing also that all Parties have a right to, and should, promote sustainable development;

(d) The fact that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that the per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs;

(e) The fact that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions;

(f) Coverage of all greenhouse gases, their emissions by sources and removals by sinks and all relevant sectors;

(g) The need for all Parties to cooperate in good faith and to participate in this process.

II

2. The process will, inter alia:

(a) Aim, as the priority in the process of strengthening the commitments in Article 4.2(a) and (b) of the Convention, for developed country/other Parties included in Annex I, both

- to elaborate policies and measures, as well as
- to set quantified limitation and reduction objectives within specified time-frames, such as 2005, 2010 and 2020, for their anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol,

taking into account the differences in starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties to the global effort, and also the process of analysis and assessment referred to in section III, paragraph 4, below;

(b) Not introduce any new commitments for Parties not included in Annex I, but reaffirm existing commitments in Article 4.1 and continue to advance the implementation of these commitments in order to achieve sustainable development, taking into account Article 4.3, 4.5 and 4.7;

(c) Take into account any result from the review referred to in Article 4.2(f), if available, and any notification referred to in Article 4.2(g).

(d) Consider, as provided in Article 4.2(e), the coordination among Annex I Parties, as appropriate, of relevant economic and administrative instruments, taking into account Article 3.5;

(e) Provide for the exchange of experience on national activities in areas of interest, particularly those identified in the review and synthesis of available national communications; and

(f) Provide for a review mechanism.

III

3. The process will be carried out in the light of the best available scientific information and assessment on climate change and its impacts, as well as relevant technical, social and economic information, including, inter alia, reports of the Intergovernmental Panel on Climate Change. It will also make use of other available expertise.

4. The process will include in its early stages an analysis and assessment, to identify possible policies and measures for Annex I Parties which could contribute to limiting and reducing emissions by sources and protecting and enhancing sinks and reservoirs of greenhouse gases. This process could identify environmental and economic impacts and the results that could be achieved with regard to time horizons such as 2005, 2010, and 2020.

5. The protocol proposal of the Alliance of Small Island States (AOSIS), which contains specific reduction targets and was formally submitted in accordance with Article 17 of the Convention, along with other proposals and pertinent documents, should be included for consideration in the process.

6. The process should begin without delay and be conducted as a matter of urgency, in an open-ended ad hoc group of Parties hereby established, which will report to the second session of the Conference of the Parties on the status of this process. The sessions of this group should be scheduled to ensure completion of the work as early as possible in 1997, with a view to adopting the results at the third session of the Conference of the Parties.

*9th plenary meeting
7 April 1995*

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Divider Title: _____



UNITED
NATIONS



**Framework Convention on
Climate Change**

Distr.
LIMITED

FCCC/CP/1996/L.17
18 July 1996

Original: ENGLISH

CONFERENCE OF THE PARTIES
Second session
Geneva, 8 - 19 July 1996
Agenda item 5

**REVIEW OF THE IMPLEMENTATION OF THE CONVENTION AND
OF DECISIONS OF THE FIRST SESSION OF THE
CONFERENCE OF THE PARTIES**

Ministerial Declaration

The Ministers and other heads of delegations present at the second session of the Conference of the Parties to the United Nations Framework Convention on Climate Change,

Noting that this, our meeting at Ministerial level under the Convention, is a demonstration of our intention to continue to take an active and constructive role in addressing the threat of climate change,

1. Recall Article 2 of the Convention; the principles of equity and of common but differentiated responsibilities and respective capabilities in Article 3.1 of the Convention; and the provisions of Article 3.3 concerning precautionary measures; as well as the specific national and regional development priorities, objectives and circumstances of the Parties to the Convention;

* This text was introduced by the President at the 6th plenary meeting, on 18 July.

2. Recognize and endorse the Second Assessment Report of the IPCC as currently the most comprehensive and authoritative assessment of the science of climate change, its impacts and response options now available. Ministers believe that the Second Assessment Report should provide a scientific basis for urgently strengthening action at the global, regional and national levels, particularly action by Annex I Parties to limit and reduce emissions of greenhouse gases, and for all Parties to support the development of a Protocol or another legal instrument; and note the findings of the IPCC, in particular the following:

- The balance of evidence suggests a discernible human influence on global climate. Without specific policies to mitigate climate change, the global average surface temperature relative to 1990 is projected to increase by about 2C (between 1C and 3.5C) by 2100; average sea level is projected to rise by about 50 centimetres (between 15 and 95 centimetres) above present levels by 2100. Stabilisation of atmospheric concentrations at twice pre-industrial levels will eventually require global emissions to be less than 50 per cent of current levels;
- The projected changes in climate will result in significant, often adverse, impacts on many ecological systems and socio-economic sectors, including food supply and water resources, and on human health. In some cases, the impacts are potentially irreversible; developing countries and small island countries are typically more vulnerable to climate change;
- Significant reductions in net greenhouse gas emissions are technically possible and economically feasible by utilising an array of technology policy measures that accelerate technology development, diffusion and transfer; and significant no regrets opportunities are available in most countries to reduce net greenhouse gas emissions;

3. Believe that the findings of the Second Assessment Report indicate that the continued rise of greenhouse gas concentrations in the atmosphere will lead to dangerous interference with the climate system, given the serious risk of an increase in temperature and particularly the very high rate of temperature change;

4. Recognize also the need for continuing work by the IPCC to further reduce scientific uncertainties, in particular regarding socio-economic and environmental impacts on developing countries, including those vulnerable to drought, desertification or sea-level rise;

5. Reaffirm the existing commitments under the Convention, including those intended to demonstrate that Annex I Parties are taking the lead in modifying longer-term trends in emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol, and agree to strengthen the process under the Convention for the regular review of the implementation of present and future commitments;

6. Take note that Annex I Parties are fulfilling their commitments to implement national policies and measures on the mitigation of climate change. Also take note that this is not the only commitment that Annex I Parties have made and that many of these Parties need to make additional efforts to overcome difficulties that they face in achieving the aim of returning their emissions of greenhouse gases to 1990 levels by 2000;

7. Acknowledge the considerable work done by the Ad Hoc Group on the Berlin Mandate (AGBM) since the first session of the Conference of the Parties, including the substantive proposals presented by a number of Parties, and call on all Parties to come forward with proposals to facilitate substantive negotiations beginning at the fifth session of AGBM in December 1996;

8. Instruct their representatives to accelerate negotiations on the text of a legally-binding protocol or another legal instrument to be completed in due time for adoption at the third session of the Conference of the Parties. The outcome should fully encompass the remit of the Berlin Mandate, in particular:

- commitments for Annex I Parties regarding:
 - * policies and measures including, as appropriate, regarding energy, transport, industry, agriculture, forestry, waste management, economic instruments, institutions and mechanisms;
 - * quantified legally-binding objectives for emission limitations and significant overall reductions within specified timeframes, such as 2005, 2010, 2020, with respect to their anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol;
- commitments for all Parties on continuing to advance the implementation of existing commitments in Article 4.1;
- a mechanism to allow the regular review and strengthening of the commitments embodied in a Protocol or other legal instrument;
- commitments to a global effort to speed up the development, application, diffusion and transfer of climate-friendly technologies, practices and processes; in this regard, further concrete action should be taken;

9. Welcome the efforts of developing country Parties to implement the Convention and thus to address climate change and its adverse impacts and, to this end, to make their initial national communications in accordance with guidelines adopted by the Conference of the Parties at its second session; and call on the GEF to provide expeditious and timely support to these Parties and initiate work towards a full replenishment in 1997;

10. **Recognize** that the continuing advancement of existing commitments by developing country Parties, in the context of their national priorities for sustainable development, requires determined and timely action, in particular by Annex II Parties. Access to financial resources and to environmentally-sound technologies consistent with Articles 4.3, 4.4, 4.5 and 4.7 will be most critical;

11. **Thank** the Government of the Swiss Confederation for its contribution to the work of the second session of the Conference of the Parties in Geneva and **look forward** to meeting again at the third session in Kyoto, in 1997, thanks to the generous offer of the Government of Japan.

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Divider Title: _____

The Honorable Timothy E. Wirth
Under Secretary for Global Affairs
on behalf of the United States of America

Second Conference of the Parties
Framework Convention on Climate Change

Geneva, Switzerland

July 17, 1996

Thank you, Mr. Chairman. Let me begin by congratulating you, Mr. Chimutengwende, on your selection as Chair of the Conference. My government appreciates your willingness to assume this important role and the leadership you have brought to this task. I also want to take this opportunity to congratulate the distinguished representative from Germany, Angela Merkel, for the remarkable job that she has done in guiding our work over the past several years. The task of moving forward more than 150 nations is difficult enough. In this instance, however, the challenge has been compounded by the fact that we are dealing with what is probably the most complicated scientific, environmental, economic and political challenge in history. The international community is in your debt for hosting us and helping us reach the mandate agreed upon in Berlin last year.

Since Berlin, our deliberations have benefitted from the careful, comprehensive and uncompromised work of the Intergovernmental Panel on Climate Change. Their efforts serve as the foundation for international concern and their clear warnings about current trends are the basis for the sense of urgency within my government. We are not swayed by and strongly object to the recent allegations about the integrity of the IPCC's conclusions. These allegations were raised not by the scientists involved in the IPCC, not by participating governments, but rather by naysayers and special interests bent on belittling, attacking and obfuscating climate change science. We want to take this false issue off the table and reinforce our belief that the IPCC's findings meet the highest standards of scientific integrity. We also note with regret that the Subsidiary Body for Scientific and Technological Advice (SBSTA), blocked by a very small group of countries, did not agree on how to use the IPCC report. Let me make clear the U.S. view: The science calls upon us to take urgent action; the IPCC report is the best science we have, and we should use it. .

In the ongoing scientific effort, Mr. Chairman, I want to note that the United States is proud of the more than \$1 billion annual investment it has been making in recent years on global change research. This is a cost we have taken on in order to enhance our own and the world's understanding of the Earth's atmospheric, oceanic and biological systems and represents not only the seriousness with which we view these matters, but also the willingness of President Clinton and the American people to help pioneer progress on behalf of the environment.

The United States of America takes very seriously the IPCC's recently issued Second Assessment Report, which underscores and amplifies the panel's initial work -- refining estimates and revealing new understandings that serve to signal even louder alarm bells. From our perspective, the most salient of these findings are as follows:

The chemical composition of the atmosphere is being altered by anthropogenic emissions of greenhouse gases.

The continued buildup of these gases will enhance the natural greenhouse effect and cause the global climate to change.

Based on these facts and additional underlying science, the second assessment reported that "the balance of evidence suggests that there is a discernible human influence on global climate." This seemingly innocuous comment is in fact a remarkable statement: for the first time ever, the world's scientists have reached the conclusion that the world's changing climatic conditions are more than the natural variability of weather. Human beings are altering the Earth's natural climate system.

In turn, the best scientific evidence indicates that human-induced climate change, if allowed to continue unabated, could have profound consequences for the economy and the quality of life of future generations:

Human health is at risk from projected increases in the spread of diseases like malaria, yellow fever and cholera;

Food security is threatened in certain regions of the world;

Water resources are expected to be increasingly stressed, with substantial economic, social and environmental costs in regions that are already water-limited, and perhaps even political costs where there is already conflict over limited resources.

Coastal areas -- where a large percentage of the global population lives -- are at risk from sea level rise.

In our opinion, the IPCC has clearly demonstrated that action must be taken to address this challenge and that, as agreed in Berlin, more needs to be done through the Convention. This problem cannot be wished away. The science cannot be ignored and is increasingly compelling. The obligation of policymakers is to respond with the same thoughtfulness that has characterized the work of the world's scientific community.

Unhappily, Mr. Chairman, while the established international scientific process is working well, the international policy process, as established under the Convention, has not been as successful. The shortcomings of the Convention -- its failure to address the post-2000 period, for example -- were well explored in Berlin and do not bear repeating today. The most salient fact is now more apparent than ever: the current Convention structure has not achieved the results that were anticipated. Few nations in either the developed or developing world have been fully successful in meeting their commitments under articles 4.1 and 4.2 of the Convention. We have to do better.

Over the past year, the United States has been engaged at home and internationally in serious analysis of the successes and failures of the current Convention structure, as well as of the practicality of the various proposals for next steps that have been put forward in recent discussions. While we still have much work to do, our analysis and consideration of this issue to date have led us to certain conclusions about the form of an agreement we hope these negotiations will consider and pursue. In the months ahead, our ongoing analysis and assessment will allow us to more precisely articulate the specific contents that the United States could support.

We begin, Mr. Chairman, from the following set of principles, which will guide our consideration of various proposals, and which we believe should guide our multilateral negotiations:

First, our negotiations focus on outcomes that are real and achievable. Sound policies pursued in the near term will allow us to avoid the prospect of truly draconian and economically disruptive policies in the future. Measured adjustments now and in the years ahead will enable all nations to reduce emissions in an economically sensible manner. Denial and delay will only make our economies vulnerable in the future.

Second, the United States will continue to seek market-based solutions that are flexible and cost-effective. We will not accept proposals that are offered for competitive, not environmental reasons. Serious proposals in the future must not be thinly veiled attempts to gain economic advantage. This is a global problem with global impacts and therefore requires solutions that are fair, and that will ensure prosperity -- now and in the future -- for all the world's people.

And third, the agreement should lay the foundation for continuing progress by all nations in the future. The United States believes that international cooperation on this challenge remains critical to any effective response, and that all nations -- developed and developing -- must contribute to the solution to this challenge. We believe that, while this is a long-term challenge, we must start making progress now and engage the public and private sectors over the medium-term as well. Climate change is a serious problem and will require sustained long-term investment and the full creativity of the marketplace.

President Clinton has urged all Americans and all nations to prepare their economies for the 21st century. Meeting this challenge requires that the genius of the private sector be brought to bear on the challenge of developing the technologies that are necessary to ensure our long-term environmental and economic prosperity.

Based on these principles -- encompassing environmental protection, realism

that this effort must be a partnership with all nations. We stand ready to continue our efforts to provide technical expertise to work with developing countries to reduce greenhouse gas emissions, and to continue the partnership which we have begun with many.

In summary, we have come to the conclusion that the current structure of the Convention is less than ideal. Performance under the current regime -- or lack thereof -- suggests that a new model must be considered. Next steps must be structured in a way that will help produce the desired results -- not just more rhetoric. We believe that circumstances warrant the adoption of a realistic but binding target, leaving it to individual governments to decide the most appropriate measures needed to meet the agreed target. We are convinced that the target must be both realistic and binding because it is only through the surety of a commitment of this nature that governments will take their obligations seriously and the only way we can be assured of progress.

We are also convinced that it is the target that should be binding, not the individual measures, thus allowing maximum flexibility in implementation. Continued use of non-binding targets that are not met makes a mockery of the treaty process. It leaves the impression that rhetoric is what counts rather than real emission reductions -- an outcome that is both unacceptable and counterproductive.

Mr. Chairman, the United States is committed to making the international climate change process work. The science is convincing; concern about global warming is real and that we must continue to take steps to address this problem consistent with our long-term economic and environmental aspirations. Working together, it is imperative that we marshal the creativity and will necessary to address this far-reaching challenge. The United States hopes we can negotiate an agreement that is comprehensive, flexible, fair and certain, and which will help prepare our country and the world -- environmentally and economically -- for the next century.

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Divider Title: _____

THE HONORABLE TIMOTHY E. WIRTH
BEFORE THE
ENERGY AND NATURAL RESOURCES COMMITTEE
UNITED STATES SENATE
September 17, 1996

Good morning, Mr. Chairman. I am pleased to rejoin your company this morning to describe the Clinton Administration's efforts to address the far-reaching challenge of global climate change. As you know, the parties to the Framework Convention on Climate Change, agreed upon and ratified by the Senate in 1992, recently held the second major meeting -- or Conference of the Parties -- in Geneva. As requested in your letter of invitation, I would like to discuss the rationale for the position articulated by the United States in Geneva and to answer any questions that members of the Committee have.

The United States had four primary objectives for the Geneva meeting: 1) we wanted to put our shoulder behind the outstanding and unparalleled science that has been developed by the world's best scientists through the Intergovernmental Panel on Climate Change; 2) we wanted to shift the negotiations toward strategies that will achieve environmental results in an economically sensible manner -- so we rejected unrealistic proposals by some countries, and proposed that future commitments be realistic, verifiable and binding; 3) we wanted to ensure that national and international flexibility were preserved, allowing for the use of the most innovative and cost-effective mechanisms here and abroad, such as joint implementation and international emissions trading; and 4) we wanted to make sure that all nations, including developing nations, are involved in these negotiations and next steps that will be reached through them.

I want to begin, Mr. Chairman, with the issue of science -- for it is scientific research, and broad consensus among the world's leading experts, that form the foundation for our concern and proposed strategies on this issue. As you know, this Committee has a long history of engagement with scientific experts involved in this issue -- and I remember well a long series of hearings between 1987 and 1992 that I had the privilege of working on from your side of the dais during my term in the Senate, under the leadership of then Chairman Johnston.

One of the most memorable of those hearings occurred right here in this room in June of 1988. You will recall that that was the day that a brave and pioneering NASA scientist named Jim Hansen -- a leading authority on climate change -- told this Committee and the world that he believed that the scientific evidence was ever more apparent that global climatic changes were occurring outside the range of natural variability and that he believed global warming was underway. That was a bold assertion at that time and there were few scientists at that time who were willing to go as far as Dr. Hansen.

Almost a decade later, Mr. Chairman, a great deal of scientific progress has been made. At the behest of the Bush Administration, the international community set about to establish an inclusive international scientific body to answer questions about global climate change. Accordingly, the Intergovernmental Panel on Climate Change (IPCC) was established as a partnership of the World Meteorological Organization and the United Nations Environment Program. Over the past five years, the IPCC has emerged as the world's preeminent scientific and technical body concerned with the threat of global climate change. The IPCC involves more than 2000 scientists from more than 100 countries and uses recognized standards of peer-review in its scientific method.

In December of last year, the IPCC finalized its Second Assessment Report -- representing the most recent, authoritative and comprehensive scientific analysis we have available to us on this issue. The second assessment was the result of years of effort, extensive peer review and exhaustive analysis and consultation. The most important of the IPCC's scientific findings are as follows:

- The chemical composition of the atmosphere is being altered by anthropogenic emissions of greenhouse gases.
- The continued buildup of these gases will enhance the natural greenhouse effect and cause the global climate to change.
- Based on these facts and additional underlying science, the second assessment reported that "the balance of evidence suggests that there is a discernible human influence on global climate."

This last finding represents the first time that a consensus has emerged among leading climate scientists that the world's changing climatic conditions are more than the natural variability of weather. In short, the IPCC's results have further underscored the compelling nature of scientific understanding of this issue.

Nonetheless, uncertainty remains. The scientific community cannot yet tell us precisely how much, when or at what rate the Earth's climate will respond to greenhouse gas buildup. However, making the best possible estimate based on what is known about the complex climate system, the scientific community believes that current emissions trends (resulting over the next several decades in the effective doubling from pre-industrial concentrations of carbon dioxide in the atmosphere) will lead to global temperatures which, on average, are 2 to 6.5 degrees Fahrenheit warmer than today, increasing at a rate greater than any known for the past 10,000 years.

Based on these estimates, the best scientific evidence indicates that human-induced climate change, if allowed to continue unabated, could have profound consequences for the economy and the quality of life of future generations:

Human health is at risk from projected increases in the spread of diseases like malaria, yellow fever and cholera;

Food security is threatened in certain regions of the world;

Water resources are expected to be increasingly stressed, with substantial economic, social and environmental costs in regions that are already water-limited, and perhaps even political costs where there is already conflict over limited resources.

Coastal areas -- where a large percentage of the global population lives -- are at risk from sea level rise.

In our opinion, the IPCC has clearly demonstrated to policymakers that further action must be taken to address this challenge. We are not swayed by and strongly object to recent allegations about the integrity of the IPCC's conclusions. These allegations were raised not by the scientists involved in the IPCC, not by participating governments, but rather by naysayers and special interests bent on belittling, attacking and obfuscating climate change science. It is our strong belief that the IPCC's findings meet the highest standards of scientific integrity. This is the best science we have and it is the responsibility of policy makers to consider the panel's findings and respond with corresponding thoughtfulness.

Unhappily, while the established international scientific process is working well, the international policy process has not been as successful. While an important first step, there a

number of shortcomings in the Framework Convention on Climate Change (FCCC). Perhaps most important, the current Convention structure has not achieved its primary aims; few nations in either the developed or developing world have been fully successful in meeting their objective of reducing greenhouse gas emissions. We have to do better.

Last year, at the first Conference of the Parties in Berlin, treaty participants agreed to launch a new round of negotiations aimed at defining steps that would be taken after the year 2000. The so-called "Berlin Mandate" defined the broad terms by which next steps under the Convention would be negotiated. The Berlin Mandate directed the negotiations toward 1) defining emissions limitations objectives for Annex I nations in the post-2000 period; and 2) advancing implementation of commitments by developing nations.

In Berlin, as today, it was our belief that the final consensus reflects our belief that this is a global problem requiring global solutions: all countries must work together to do more to guard against harmful climate changes. While the Berlin agreement specifies that there will be no new commitments for developing country Parties, it calls for advancing the implementation of the existing treaty commitments agreed to by developing countries and allows for negotiations on new commitments to begin as soon as work under the Berlin agreement is complete. Under the existing treaty, developing countries are required to adopt policies and measures to reduce greenhouse gas emissions. We are working now to develop specific proposals for advancing implementation of these existing commitments by the developing countries.

Over the past year, the United States has been engaged at home and abroad in serious analysis of the successes and failures of the current Convention structure in preparation for the negotiations that have been underway since Berlin. Based on

these extensive efforts, the United States articulated in Geneva a proposed structure for next steps that we think should form the basis for negotiations over the next 16 months. We call this a "framework"; it has yet to be fleshed out with specific numbers and we have work to do to further develop several issues associated with this approach. In the months ahead, our ongoing analysis and assessment will allow us to more precisely articulate the specific contents that the United States could support.

Now, before discussing the elements of our proposal, let me touch on the underlying rationale for the approach we recommended in Geneva. The new U.S. approach is based most fundamentally on a desire to ensure that the negotiations focus on outcomes that are real and achievable. We believe that sound policies pursued in the near term will allow us to avoid the prospect of truly draconian and economically disruptive policies in the future. The old adage, so appropriate to much of public policy applies here: an ounce of prevention is worth a pound of cure -- the cost of action in the medium-term is less than the cost of inaction in the long-term.

Second, our approach was formulated on the premise that prospective solutions must be flexible and cost-effective. We do not view favorably a cookie cutter approach to the actions nations might take, and we certainly will not accept proposals that are offered for competitive advantage, not environmental progress.

And third, our approach is based on the belief that the agreement being negotiated should lay the foundation for continuing progress by all nations in the future. The United States is immovable in its belief that international cooperation on this challenge remains critical to any effective response and that all nations -- developed and developing -- will have to

become more ambitious in contributing to the solution to this challenge as we move forward.

Based on these principles -- environmental protection, economic prosperity, flexibility, fairness and comprehensiveness -- the United States recommended in Geneva that future negotiations focus on an agreement that sets a realistic, verifiable and binding medium-term emissions target. We believe that the medium-term target must be met through maximum flexibility in the selection of implementation measures, including the use of measures such as reliable joint implementation and trading mechanisms.

The proposal we made in Geneva represents a departure from the treaty's current approach, which has relied on non-binding "aims" for emissions reductions in the year 2000. Unfortunately, this approach is not working -- few nations in either the developed or developing world have been fully successful in meeting their commitments under articles 4.1 and 4.2 of the Convention. In our view, continued use of non-binding targets that are not met would make a mockery of the treaty process. It leaves the impression that rhetoric is what counts rather than real emission reductions -- an outcome that is both unacceptable and counterproductive.

Similarly, we think that the current treaty needs to be strengthened through consideration of certain long-term objectives. Our view is that it will be necessary to continue working toward a longer-term concentration goal (e.g. for the next 50-100 years), as set out in the Convention's objective, recognizing that scientific understanding and technology will improve over time. Working toward such a goal would better establish the long-term, global nature of the problem.

Taken together, we believe that the U.S. recommendations related to binding medium-term targets and a longer-term

concentration goal will help ensure that the international community focuses on more sensible emissions reduction goals (knowing that the goal must be met), and on the need for all nations to contribute to the solution over the long-term. In addition, these two ideas are critical prerequisites to enabling important and cost-effective joint implementation and international emissions trading opportunities, which we believe are essential. Finally, in response to consultations with key stakeholders, these efforts are intended to make it clear over the long-term where we are going and therefore to help guide corporate planning and investments.

Having defined in broad terms the basic components or "framework" of an agreement we could support, as outlined in Geneva, I want to mention what we did not say and what we will not support.

First and foremost, we have not come to any conclusions about a specific target or set timetable for emissions reductions. We have established a comprehensive interagency process, led by the Department of Commerce, to undertake the necessary economic analysis that will be required to determine an approach that the United States believes is realistic and achievable. We believe strongly that this analysis and assessment is a necessary prerequisite to identifying a target that is realistic, achievable and consistent with the national interest and national prosperity.

Second, we did not in any way repudiate the growing number of successful voluntary programs that U.S. industry has launched to reduce emissions. Unfortunately, there has been some misunderstanding regarding the distinction between non-binding emissions reduction targets and voluntary programs. Our belief that the non-binding emissions reduction aim has not worked internationally in no way diminishes our enthusiasm for the outstanding voluntary programs that U.S. industry, state and

local governments, schools and churches has embarked upon nationally to reduce emissions. Voluntary programs have played a central role in the Administration's Climate Change Action Plan, have helped us to reduce emissions significantly -- simultaneously saving millions of dollars in avoided energy costs -- and we expect them to continue to play an important role far into the future.

At Geneva, we rejected certain proposals for targets that have been proposed by other countries or groups of countries. Our preliminary analysis before Geneva made clear that many of these proposals were neither realistic nor achievable -- either because they would compromise other important principles, such as the need for flexibility in time and place of implementation (in the case of proposals for binding policies and measures), or because they involve timeframes and objectives that are not consistent with national and international prosperity (for example, in the case of the proposal by the Alliance of Small Island States calling for a 20 percent reduction in the year 2005).

We also rejected in Geneva proposals by some nations that the negotiations move toward consideration of some ambitious mandatory, internationally coordinated policies and measures. We believe that the significant differences in national circumstances suggest that few, if any individual measures are likely to be applicable to all countries.

The framework proposed by the United States won remarkable support in Geneva. Based on our presentation, we were able to obtain broad acceptance for the U.S. framework in the Ministerial Declaration that was issued at the meeting's end -- a testament not only to the soundness of our proposals, but also to the expectations the international community has for U.S. leadership in the most important and difficult tasks facing the world. Our job in the months ahead is to search for agreement

on next steps that will produce results that are consistent with our environmental and economic aspirations.

This, leads me to the final area I want to touch upon -- the ambitious calendar that exists for the next year and a half, and the need for extensive public discussion and consultation on these matters in the months ahead.

The Administration's plans for engaging the public, industry and non-governmental experts included a major workshop on analysis and assessment where presentations were made by more than 50 experts from inside and outside of government about technical issues associated with our emissions trends and capability to reduce emissions in the next century. We have also engaged in a broad series of roundtable discussions with industry and non-governmental organizations to scope out common ground and identify key issues. In June, the State Department hosted a major conference on the market opportunities that are emerging as nations begin to tackle the challenge of reducing greenhouse gas emissions. There are a range of technologies and business interests that American firms are superbly positioned to take advantage of as nations all over the world seek to enhance efficiency and deploy new technology in service of economic and environmental goals.

To advance our preliminary work and follow-up on the framework outlined in Geneva, the Administration has established an unprecedented and comprehensive interagency process, under the direction of the Department of Commerce and including DOE, EPA, CEA, and all other appropriate agencies and Administration representatives. When the process is completed, this team will have created an analytic "toolbox" capable of assessing the economic effects of a broad range of climate change policies, in terms of growth, employment, sectoral and industry effectiveness, competitiveness and other issues. In addition, as preparation for the negotiations ahead, we are considering approaches to a

number of the elements of the framework we proposed in Geneva, such as options for advancing the commitments of developing countries and similar issues that will be discussed in the months ahead.

As always, we will work closely with the Congress, industry and the public at large. We have already begun some of this work, through these hearings and in a wide variety of meetings over the past several months. Together, I believe we can ensure that United States plays a lead role in fashioning an agreement next year that is comprehensive, flexible, fair and certain. In this way, we hope to outline an agreement that will help prepare our country and the world -- environmentally and economically -- for the 21st century.

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U.S. Submission on
Elements of a New Legal Instrument
(October 21, 1996)

General

In the U.S. view, the new legal instrument should respond effectively to the serious threat posed by global climate change; should reflect outcomes that are real and achievable; should be consistent with economic prosperity; should allow for maximum flexibility and cost-effectiveness in its implementation; and should lay the foundation for continuing progress by all countries.

Meeting the ultimate objective of the Convention will require concerted, long-term efforts by all Parties. While it is important for developed countries to take the lead, it is also essential that the Kyoto agreement recognize the growing contribution of developing country emissions and begin to plan for appropriate, cost-effective ways to address these emissions in a sustainable manner. In this connection, at COP-2 the United States called for continued work toward a longer-term concentration goal (e.g. for the next 50-100 years), recognizing that scientific understanding and technology will improve over time.

In putting forward these suggestions for a new legal instrument, the United States has rejected proposals by some countries calling for short-term targets that we believe are neither realistic nor achievable. We have also rejected the use of inflexible, internationally harmonized policies and measures. In the spirit of providing individual countries greater flexibility in meeting any agreed upon limitations, we believe that it is critical that flexibility in implementation be accorded all countries, including through emissions trading and joint implementation among nations.

We believe that the following elements would serve as a useful basis for the consideration of topics that would need to be included in a new legal instrument. Given the continuing uncertainties surrounding the form of such an instrument, we have noted particular aspects of these issues that may differ depending on whether the Parties choose a protocol or an amendment to the Convention to codify their agreement.

Preamble

If the legal instrument takes the form of a protocol, it might include a preamble. If it takes the form of an amendment, it would not, although the decision adopting the amendment could.

Definitions

A protocol would need to incorporate some or all of the definitions in Article 1 of the Convention, include its own definitions, or some combination of the two. An amendment, to the extent it introduces new terms, might also require amendment of Article 1.

Objective

We do not believe that it is either necessary or desirable to develop a separate objective for this legal instrument, whether an amendment or a protocol. The Convention's Article 2 would apply to an amendment. A protocol should incorporate Article 2 of the Convention.

Level and Structure of the Target

The Geneva Declaration calls for quantified, legally-binding objectives within specified timeframes. This is consistent with the U.S. call at COP-2 for a shift in the negotiations away from unrealistic, near-term proposals to legally-binding, medium-term targets that are both realistic and achievable.

A number of ideas and approaches regarding the structure of the target have been suggested thus far in the discussions within the Ad Hoc Group on the Berlin Mandate (AGBM). Many of these ideas and approaches have focused on a single-year target, but we believe it will be important to consider a broader range of possibilities (e.g., cumulative or aggregate targets covering a number of years, multiple-year rolling average targets, flexibility over time through banking and borrowing, etc.) We anticipate that more such ideas and approaches will be tabled and considered as we work toward a new legal instrument for adoption at COP-3.

The Berlin Mandate calls for adoption of the protocol/other legal instrument at COP-3, making calls to date for differentiated commitments in this timeframe impracticable.

In addition to being realistic and achievable, it will be important that the target/timetable be sufficiently specific (to facilitate compliance), flexible in terms of its implementation (to encourage cost-effectiveness and broad participation) and straight-forward (to ensure negotiation and adoption by COP-3). As we noted at COP-2, as a general proposition, the United States opposes mandatory, harmonized policies and measures. However, we are open to the possibility of exploring consensus on agreed procedural measures, for example, those that might be necessary to implement an international trading regime or ensure enhanced reporting.

The United States is continuing its domestic analysis and assessment efforts so as to contribute to this discussion in upcoming negotiating sessions.

Advancing Article 4.1 Commitments

"Continuing to advance the implementation of Article 4.1 commitments" will be a critical component of next steps and must be reflected in the Kyoto agreement. Given the global nature of this problem, we must work together toward a global solution, recognizing our common but differentiated responsibilities and capabilities. A number of assumptions underlie U.S. views on next steps:

- Article 4.1:
 - applies to all Parties;
 - speaks to commitments ranging from inventories of emissions, to reporting, to adopting measures to mitigate climate change;
 - speaks to the requirement to promote the development and diffusion of technologies;
- The Convention anticipates that the status of countries will evolve over time (e.g., Article 4.2(f))
- Paragraph 2.b of the Berlin Mandate governs what will be included on this issue in the Kyoto agreement

Bearing in mind these assumptions, there are a number of approaches that can be taken through a new legal instrument. For example, the Parties could agree to:

- continued and more systematic support for efforts to develop national action plans (particularly in developing countries) following the revised Annex I Guidelines for National Communications and the newly adopted Non-Annex I Guidelines for Initial Communications

- redoubled efforts to adopt and implement "no-regrets" measures
- expanded programs aimed at developing, diffusing and deploying climate-friendly technologies (including through systematic efforts to identify and remove barriers to technology diffusion and to enhance the role of international financial institutions in responding to the threat of global climate change)
- further consideration of thresholds at which the status of countries would change, and the process involved in such a change in status
- further consideration of future steps (post-Kyoto) toward the objective of the Convention

International Emissions Trading and Joint Implementation

In the U.S. view, flexibility will be an essential element of the Kyoto agreement, including international emissions trading and joint implementation; it will therefore be a priority task to establish the guidelines for a credible emissions trading and joint implementation regime by December 1997.

Properly designed emissions trading and joint implementation regimes will motivate parties to achieve and strengthen national commitments to limit or reduce greenhouse gas emissions, because the cost savings potential in these types of programs can achieve more environmental protection than less flexible, less cost-effective regimes.

A number of principles must underlie an emissions trading and joint implementation regime. At a minimum, such a regime must be credible, efficient, transparent and verifiable.

Various design questions need to be addressed, and we intend to present our further thinking in this regard in the near future.

Institutions

For reasons of administrative efficiency and in light of budgetary constraints, a new legal instrument should utilize existing institutions to the maximum extent practicable.

A protocol would need to specify its institutions. In the case of an amendment, the institutions established under the Convention would apply. (Note: We do not believe it would be appropriate for non-Parties to a protocol to be officers of an institution serving the protocol.)

Compliance

The term "compliance" is used in this context to refer to the cluster of processes/mechanisms that provide incentives for the Parties to abide by their legal commitments.

Ensuring effective compliance will be critical for environmental as well as economic competitiveness reasons. Unless Parties comply, there will be little incentive for each Party to act and we will not achieve our environmental objectives. Uneven compliance will undermine confidence in the new legal instrument and encourage "free-riding."

A key means of promoting compliance will be to ensure that commitments are realistic and achievable (as noted above). In addition, it will be important to consider supplementary means for promoting compliance, including ways to ascertain whether Parties are meeting their obligations. In this context, we will need to consider elaborating existing reporting and review mechanisms.

Unless otherwise provided, an amendment to the Convention would be covered by the Convention's reporting requirements, as well as dispute settlement provisions and any multilateral consultative process that might be established. A protocol would need to specify whether any of these Convention mechanisms would apply, as well as any additional compliance-related provisions.

Decision-Making

Only the Parties to the protocol or amendment should have decision-making authority with respect to that instrument.

Final Clauses

A protocol would need to contain several final clauses, including, for example, provisions on entry into force and amendment. An amendment's final clauses are already set forth in the Convention.

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Divider Title: _____

N.Y. TIMES
JULY 17, 1996

In a Shift, U.S. Will Seek a Binding Agreement by Nations to Combat Global Warming

By JOHN H. CUSHMAN Jr.

WASHINGTON, July 16 — For the first time, the United States will seek a binding international agreement to reduce the kinds of air pollution, chiefly from burning fossil fuels, that threaten to warm the global climate, Administration officials said today.

Endorsing the view that the build-up of so-called greenhouse gases in the atmosphere, mainly carbon dioxide, is probably already beginning to warm the planet, the Administration will urge the world's nations to adopt, by the end of next year, "realistic, verifiable and binding" targets for reversing the trend.

Although the Administration has devised no specific target or timetable, its position signals a more ag-

gressive campaign against climate change than the voluntary measures it endorsed in the past, and puts it on a course that promises to be politically difficult.

Environmentalists praised the new approach, but officials of the energy industry reacted skeptically, although they said the impact of the plan would depend on the specific goals, which have not been spelled out.

The United States, with its huge appetite for energy, burns more fossil fuels than any other country in the world and its output of greenhouse gases has continued to rise despite conservation measures. Proposals for the stringent measures that would be required to reduce emis-

sions have been politically explosive.

"This is a big deal," said Timothy E. Wirth, the Under Secretary of State for Global Affairs, in a telephone interview from Geneva. On Wednesday he is scheduled to present the American position at a negotiating session among some 150 nations who signed the 1992 treaty on climate change.

"Saying that we want to have a target that is binding is a clear indication that the United States is very serious about taking steps and leading the rest of the world," he said. "We will be getting more and more specific as the next year and a half rolls through."

The Geneva talks are a prelude to a conference in Tokyo late next year

where the signers of the treaty plan to set forth the next steps in heading off worldwide climate change. The Administration would have preferred to wait until after the election before introducing tougher measures, but the diplomatic timetable would not allow that.

In the treaty, negotiated in Rio de Janeiro during the Bush Administration, industrial countries set a non-binding goal of limiting emissions of greenhouse gases by the year 2000 to the levels that prevailed in 1990. But the United States and most other countries are unlikely to meet that goal, and have since conceded that even deeper cuts in pollution are needed.

In remarks prepared for delivery by Mr. Wirth on Wednesday, the United States rejects some proposals for steep and immediate cuts in pollution, such as the 20 percent cut within a decade that is being sought by small island nations fearful of being swamped by rising oceans as the planet warms.

Mr. Wirth will call that goal unrealistic, given the economic disruption that would occur if energy consumption were restricted so sharply. A copy of his prepared text was obtained by The New York Times today.

He will also say that the United States wants flexibility to allow every country to meet the new targets in whatever way seems best to each government, and he signaled that the Administration intends to use market-based approaches, like the trading of pollution permits, to help its industries do so in whatever fashion they deem most efficient.

Those positions seemed intended

to deflect some of the political fallout from industry groups that have strongly opposed strict new measures to combat global warming. The Administration in the past has adopted purely voluntary approaches, which have cut the growth in pollution but have failed to actually reduce emissions.

John Schlaes, executive director of an industry group that opposes quick action to head off global warming, said that the key to the Administration's proposals would lie in details of the timing and extent of any emis-

sion reductions that are to be sought. His group, the Global Climate Coalition, is made up of oil, coal and electric companies and industries that use large amounts of energy.

"Any kind of binding target, without doing the appropriate analysis and assessment, and then having a dialogue with the American public, doesn't make sense," he said in a telephone interview from Geneva, where he is observing the negotiations.

Environmental groups generally reacted positively to the Administration's position, although not all of them favor the market-based approach that Mr. Wirth mentioned.

"It shows that the Administration is serious about this issue," said Michael Oppenheimer, an atmospheric

physicist who is a senior scientist at the Environmental Defense Fund in New York. "It shows that they have accepted the judgment of the scientific community that climate change is happening and that something has to be done about it."

In his prepared remarks, Mr. Wirth calls for quick action, not decades of delay, and for concrete measures, not vague promises, in the binding measures that would be negotiated in time for the meeting scheduled in Tokyo at the end of next year.

"We are not interested in grand rhetorical goals that are impossible to realize," he says in his speech. "We want the negotiations to focus on outcomes that are real and achievable."

Mr. Wirth and other senior leaders are expected to issue a joint statement of policy on Thursday, joined by many nations, and a key test for the Administration is the extent to which its views are incorporated into that statement.

Although his statement is cautious about what steps to take next, it is unequivocal in calling the efforts to date a failure. "We have to do better," it says bluntly.

The Administration had held its negotiating stance close to the vest in recent weeks, officials said, partly to avoid heavy criticism from industries that contend that acting precipitously will do economic damage.

Mr. Wirth said today that those critics, who have also attacked the scientific work supporting the theory of global warming, are "bent upon destroying" the climate treaty.

U.S. Urges Binding Accord on Global Warming

By Gary Lee
Washington Post Staff Writer

The Clinton administration announced yesterday that it is seeking the adoption of a binding agreement requiring the world's industrial nations to reduce the levels of industrial emissions that are contributing to global warming.

Undersecretary of State Timothy E. Wirth, appearing at an international conference on climate change in Geneva, outlined a proposal that would establish goals for reducing emissions of "greenhouse gases"—pollutants from smokestacks and tailpipes that scientists have identified as a major contributor to global warming—and would require industrial nations to meet those goals. The details of the plan should be worked out by the end of next year, Wirth said.

The proposal represents a departure from current administration policy, which relies on factories and utilities to introduce voluntary measures to cut overall emissions of greenhouse gases to 1990 levels by the year 2000.

"If you look at where we've gotten so far, we're going to miss those targets," Wirth said in a telephone interview from Geneva. "It seems to us that a voluntary approach doesn't do it."

Of the leading signatories of the 1992 Climate Change Treaty, which established the target emissions-reduction levels, only Great Britain and Germany are expected to meet the goals by 2000. The United States, the world's largest consumer of fossil fuels, is expected to reach only 7 to 10 percent above the 1990 target at the end of the century, Wirth said.

The U.S. proposal is designed as an endorsement of a major report released late last year by the International Panel on Climate Change (IPCC). The U.N.-appointed body of scientists concluded that there is significant evidence Earth's temperatures are rising and that "greenhouse emissions" caused by human activity are a key contributor to the increase.

In recent weeks, a coalition of U.S. industries and oil producing nations has sought to raise questions about the IPCC report, saying it was based on faulty or incomplete science. The coalition has used the ongoing climate change conference in Geneva, a gathering of the 150 nations that signed the agreement, to advance its campaign against the IPCC.

In his speech yesterday, Wirth defended the IPCC conclusions. "We are not swayed by and strongly object to the recent allegations about the IPCC conclusions," Wirth told the gathering. "The science calls on us to take urgent action; the IPCC report is the best science we have, and we should use it."

The Global Climate Coalition and other U.S. industry groups attacked Wirth's proposal. "A cap on greenhouse gas . . . emissions from the electric utility industry would have severe repercussions for the U.S. economy and the envi-

ronment," John Novak, a spokesman for the Edison Electric Institute, said in a statement to reporters. The voluntary measures already introduced by utilities to cut emissions are proving successful, he added.

Environmental activists and scientific researchers endorsed the U.S. proposal. "This represents an acknowledgment that there is a very serious problem with warming and that something concrete must be done about it," said Michael Oppenheimer, a climate change specialist at the Environmental Defense Fund. "Most importantly, it states that it is time for industrial countries to go beyond statements of good will and make a real and meaningful commitment to achieving reductions."

Some activists suggested the proposal, introduced in the midst of President Clinton's re-election bid, was largely a campaign ploy designed to buttress the administration's standing in the environmental community.

Wirth said that support for the proposal was "surprisingly strong" among participants at the Geneva conference, but acknowledged that passage of mandatory emissions-reduction measures would be difficult to achieve. The administration has until now stopped short of mandatory emissions reduction measures. Administration officials have said it would be futile to try to pass such proposals in a Republican-controlled congress that has sought to cut federal funding for climate change research.

But support for an international agreement would probably encourage Congress to support emissions reductions. Eileen B. Claussen, assistant secretary of state for international environmental affairs, said in an interview.

Wirth declined to suggest what emissions targets should be established in an international treaty. But the goals should be moderate and achievable, he said, adding that industries should be given flexibility in how they reach the targets. He rejected more drastic proposals put forward by some nations for reductions of up to 20 percent over the next ten years.

How to Cool the Earth

THE GREAT MAJORITY of the world's scientific experts have come to a consensus that human activity is contributing to a measurable warming of the atmosphere. This warming, if unchecked, could have grave consequences for the earth's ecology and the future of the human species. Yet such consequences remain far enough in the future, and difficult enough to forecast, that reaching a comparable political consensus on how to combat this warming poses an immense challenge.

The Clinton administration has stepped up to this dilemma with a new policy that moves the debate in a constructive direction. Speaking on Wednesday to an international conference in Geneva, Timothy E. Wirth, undersecretary of state for global affairs, for the first time urged the nations of the world to accept binding targets for progress in this field, and the United Nations conference endorsed the proposal on Friday. Such targets would be for the "medium term"—most likely meaning the year 2010 or 2020—and would give each nation flexibility to meet its goal according to policies it would devise. These policies would work with, not against, the free-market economy.

The chief cause of global warming is the burning of fossil fuels, such as oil and coal, which release gases that become trapped in the atmosphere, retaining more of the sun's warmth than would otherwise be the case. This means that not only factories and power plants but how we drive, how we cook—modern life itself—is the issue, which may be why Mr. Wirth called this "probably the most complicated scientific, environmental, economic and political challenge in history."

According to the current scientific consensus,

average air temperature has increased by between 0.3 and 0.6 degrees Centigrade during the last century and is likely to increase by another one to three degrees in the next. This seemingly small rise could provoke dramatic changes in sea levels, weather patterns, agriculture and even the spread of disease.

What to do? First, the U.S. government was right to accept the current scientific evidence, despite a misguided effort by some industry groups to discredit it. At the same time, there should be a recognition that this scientific field remains young, that some scientists of integrity do not accept the current consensus and that policies may have to be adjusted as knowledge increases.

Second, the developed world is largely responsible for the problem and should take the lead in offering solutions. The United States alone accounts for nearly 22 percent of global emissions of carbon dioxide. But China, India and the developing world must also be part of any solution, since economic growth in those countries will soon propel them into the ranks of top emitters.

Third, no proposed solution can work if it comes at the expense of economic growth. Instead, governments should begin with policies that could both foster prosperity and reduce emissions. They should, for example, eliminate market distortions—subsidies for coal mines, hidden tax breaks for car owners—and encourage conservation and new, energy-efficient technologies, such as cleaner cars. A binding, realistic international agreement could give industry the guidelines and incentives it needs to invest in such technologies.

U.S. Proposes Binding Limits For Emissions

Officials Ask Other Nations To Follow Suit in Pact On Greenhouse Gases

By BHUSHAN BAHREE

Staff Reporter of THE WALL STREET JOURNAL
GENEVA — The Clinton administration yesterday offered to set legally binding targets to cap emissions in the U.S. as part of an international treaty to reduce greenhouse gases sometime after the year 2000.

U.S. officials who outlined this sudden shift in policy said that, in return, other nations would have to commit themselves to similar action. They added that all countries must participate in such a treaty, which is being negotiated under the auspices of the United Nations.

Some 150 countries are chasing a deadline of December 1997, when they are scheduled to meet in Kyoto, Japan. At that meeting, the hope to conclude a treaty seeking to reduce carbon dioxide and other greenhouse gases that are being associated with global warming.

"The leadership of the United States of America is required and necessary," U.S. Undersecretary of State for Global Affairs Timothy E. Wirth told reporters. Mr. Wirth, who unveiled the new U.S. policy, said voluntary regimes have not worked and the issue is so important that "we, the U.S., want to put our shoulder behind it."

Mr. Wirth acknowledged that the U.S. proposal for binding policies conflicts with a European preference for a nonbinding target. But under the U.S. proposal, even with binding targets nations would be free to reduce emissions any way they wish.

Environmental groups attending the negotiations here were jubilant. But some U.S. industry representatives, outflanked by the sudden U.S. policy switch, were horrified.

"I'm surprised and deeply concerned," said John Shlaes, executive director of the Global Climate Coalition. The group, whose membership includes major U.S. oil, mining, chemical and auto companies, warned that the Clinton administration's new plan "could eliminate millions of American jobs, reduce the nation's ability to compete globally, and force Americans into second-class lifestyles."

Mr. Wirth acknowledged that the Global Climate Coalition was unhappy, but added that two other U.S. business groups here at the negotiations had a different perspective. "I don't mean they're going to like everything that we're doing either, but it's very different from where the GCC is," Mr. Wirth said.

John Gummer, Britain's Secretary of State for the Environment, was more forthright when it came to the energy industry interests. He told the Climate Change meeting here that "it's simply not good enough for major producers of fossil fuels, both oil and coal, to claim that their financial interests should stand in the way of progress in making significant reductions in greenhouse gas emissions." Among actions suggested by Mr. Gummer was an end to all subsidies on the use of fossil fuels.

Meanwhile, Mr. Wirth said the U.S. couldn't at this time suggest a target for the reduction of greenhouse gases, or a time frame. "We will be negotiating this ourselves within the U.S. between now and December, and then internationally during 1997," he said. But Mr. Wirth emphasized that a proposal by small island nations — which are fearful that global warming could cause flooding — to reduce world carbon dioxide emissions by 20% by the year 2005, was not viable. "We can't get from here to there," Mr. Wirth said.

Eileen Claussen, U.S. Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, said the deadline would certainly occur sometime after that date.

Clement B. Malin, a Texaco Inc. executive representing the International Chamber of Commerce in Geneva said that, as specific proposals emerge, "the importance of their economic impact will need to be judged" and the chamber of commerce expects to have an input in the process. He said the U.S. position stressing flexibility in choosing solutions to meet emission targets was an encouraging sign.

—Barbara Rosewicz and Timothy Noah
in Washington contributed to this article.

FINANCIAL TIMES WEDNESDAY JULY 31 1996

ENVIRONMENT

Leyla Boulton on the latest greenhouse gas debate

US 'back in driving seat' on climate

The US has returned to the driving seat in international climate change negotiations after it helped push through a pledge by developed nations earlier this month to seek legally binding reductions in greenhouse gas emissions after 2000.

This is the conclusion of Michael Grubb, a fellow at the Royal Institute for International Affairs, the London-based think tank, and a lead author for the Intergovernmental Panel on Climate Change, which studies the phenomenon for governments.

The US is widely recognised to have a poor record in responding to the existing voluntary curbs on greenhouse gases - despite accounting for 25 per cent of emissions.

The curbs are supposed to bring emissions back to 1990 levels by 2000 - a goal which will be met only by Britain and Germany and only then for reasons not connected to climate change.

Some sceptics in Europe also point out that the fine print of the

Geneva agreement still leaves room for countries to wriggle out of a legally binding deal when they meet in Kyoto next December because it refers to legally binding reductions "or another legal instrument".

But Grubb said the "brutal" US attack at the meeting in Geneva earlier this month on energy lobby groups which had questioned the integrity of the IPCC, together with its support for legally binding commitments, showed that the Clinton administration saw climate change as a "serious problem".

"It suits the United States system better to get a binding international commitment and go back to Congress and say 'Now you must agree measures to implement this'."

This renewed commitment - which follows the petering out of an unpopular onslaught by the Republican Congress on environmental regulation - also boosted the Americans' preferred instruments for achieving reductions in greenhouse gas

emissions. These are tradeable emission permits and joint implementation, a process giving companies credit for reducing emissions in less-developed countries.

Grubb said this made the US one of the few countries which knew how it wanted to achieve greenhouse gas reductions. At the other extreme are Scandinavian nations such as Denmark and Sweden which are pushing through hard-hitting carbon taxes that are raising protests from their own industries.

John Gummer, the UK environment secretary who also played an influential role at the Geneva talks, made a strong play at Geneva for greater energy efficiency and the phasing-out of subsidies to the energy industry.

Because this can save money rather than cost money, promoting more efficient fuel use is likely to be the easiest way to minimise greenhouse gas emissions from the burning of fossil fuels.

Donor industries continued

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LOS ANGELES TIMES EDITORIALS

More Than Hot Air Needed in Resisting Global Warming

U.S. should promptly name air pollution targets

Last week at the United Nations' second climate convention in Geneva, Timothy Wirth, the undersecretary of state for global affairs, committed the United States to "realistic, verifiable and binding" targets for reducing the kinds of air pollution that threaten to warm the global climate. Many experts see the burning of fossil fuels as the chief culprit.

Environmentalists are not holding their breath in anticipation of quick action, for the Clinton administration refused to define those targets at the conference, saying they would be specified when economic analyses were completed sometime within the next 18 months. A few cynics are betting that it will be at least five months—past the November election—before the administration gets specific.

Still, Wirth's statement is a welcome departure from previous U.S. policy, which has stressed only voluntary approaches to reducing pollutants. The U.S. commitment is expected to put pressure on Europe and Japan to agree to specific reductions. Though the European Union has called for large cuts in emissions, it has only hinted that they should be legally binding, while Japan, which will host the next global climate convention, in 1997, has spoken only of "morally binding" limits.

The Clinton administration is attempting to win favor from business by signaling that it intends to use market-based approaches, like the trading of pollution permits, to help American industries reduce emissions in whatever fashion they deem most efficient. That makes sense. But Wirth's announcement in Geneva still cost the administration some political capital. Opposition came from some oil, power and automobile groups (one, the Washington-based Global Climate Coalition, warned that "millions of jobs" could be lost) and from six

Democratic senators who wrote a letter to President Clinton calling it premature to agree to any "numerical targets . . . because an adequate basis of analysis and assessment is not complete."

The senators are correct in saying that scientists have yet to fully understand global warming. Most researchers concur that the surface of Earth (especially in the northern latitudes) has warmed by as much as two degrees Fahrenheit in the last century and that these small increases could prompt fairly large global changes, like altered plant growth or the spread of malaria, cholera and other diseases. But authorities don't know whether these temperature changes are attributable primarily to

accelerated carbon dioxide emissions or whether other factors, such as changes in land use, play a significant role. Still, most scientists say there's little doubt that humans are augmenting a 10,000-year-old warming trend by burning fossil fuels, causing heat to be trapped in the Earth's atmosphere.

Inevitably, global warming will produce winners and losers in nature, as some plants and animals thrive and others die. But in political culture, policymakers ought to strive to keep the human damage to a minimum.

The responsibility for doing this falls largely on the United States, for it burns more fossil fuel than any other country. Washington assumed some responsibility in Geneva last week by at least acknowledging that climate change is happening and that something must be done about it. But the Clinton administration should commit itself to specific, legally binding targets. Otherwise, the 1996 Geneva conference may begin to look like the 1992 one in Rio at which nations promised reductions in greenhouse gas emissions that most of them have yet to carry out.

*The responsibility for
addressing global warming
falls largely on the United
States, for it burns more
fossil fuel than any other
country.*

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Administration Gets Bipartisan Pummeling On Climate Change

BY DENNIS WAMSTED

The Clinton administration continues to get beat up on Capitol Hill for its global climate change policy.

At a hearing Thursday before the House Commerce energy and power subcommittee, Democrats and

Republicans alike pummeled the administration, particularly on its apparent willingness to commit the U.S. to binding emissions reduction targets while at the same time drafting only non-binding targets for the world's developing nations.

The criticism started at the outset, with subcommittee Chairman Dan Schaefer (R-Colo.) saying in his opening statement that the administration "signed a blank check [at the Geneva

meeting in July] and is leaving it to other nations, with different national interests, to fill in the blanks.

"I hope the administration can assure me today that this is not what the U.S. has done," Schaefer continued. "But I must tell you now, the lofty ideals contained in today's written testimony do not give me those assurances."

Further, Schaefer said, if the U.S. no longer believes that non-binding aims are appropriate, which essentially is what the administration said in Geneva, "why are we agreeing to them for [the developing countries]?" he asked.

"Under the framework being considered," he continued, "developing countries have an incentive to grow their emissions as much as possible so that they can

have a higher baseline for that day, in the apparently distant future, when they might be called upon to limit their emissions."

The pummeling did not stop there. During the question and answer period, Rep. John Dingell (D-Mich.), the ranking minority member of the full committee and an outspoken critic of the administration's current approach, asked Eileen

(Continued on page 3)

Phrase Of The Day

Perhaps the nation's gas and electric utilities should ask Marc Chupka, acting assistant Energy secretary for policy and international affairs, for permission to use his new phrase the next time they have some employee layoffs to announce. One of four administration officials called to testify before the House Commerce energy and power subcommittee, Chupka said mandated greenhouse gas emissions reductions would pose "economic adjustment challenges" for the U.S. economy.

Maybe what this means is that being fired presents workers with the challenge of adjusting to a new economic status: Broke.

Pummeling On Climate Change...

(Continued from page one)

Claussen, assistant secretary of State for oceans, international, environmental and scientific affairs, whether the U.S. would sign a treaty committing it to binding reductions, while not similarly committing developing nations such as China and India.

Claussen's answer? "We may."

To which Dingell replied, "I think that would very poorly received up here."

Dingell also reiterated his longstanding criticism of the administration's approach to the issue. This approach, negotiating first, analyzing later, is equivalent to putting the cart before the horse—it just will not work, he said.

Along these lines, Dingell did get Claussen to commit the administration essentially to a standstill agreement, whereby it will not commit the U.S. to any further agreements, such as the July ministerial declaration in Geneva, until it completes its current analytical work. That work is scheduled for completion later this year or early in 1997.

Here's why the stock market feels queasy about four more years of Bill Clinton. Quietly, Tony Snow says, Clinton has embraced an eco-treaty that will gut the U.S. economy.

Clinton planting seeds of doom

Creators Syndicate

WASHINGTON — The Clinton presidency has spawned a jumble of entertainments, including the parlor-game exercise of trying to identify Bill Clinton's real, true soul. Is the man a subterranean liberal or a misunderstood New Democrat?



Tony Snow

The administration whispered the answer last week at a meeting in Geneva.

Timothy Wirth, the undersecretary of state for global affairs, committed the United States to an agreement that probably will require the U.S. economy to generate 10 percent less carbon dioxide in 2010 than it did in 1990, even though the nation's population will have grown 25 percent.

Wirth said the deal set the stage for the "the most complicated scientific, environmental, economic and political challenge in history."

Think of it as a Gringo Gulag: A future president would have the invigorating duty of forcing hundreds of millions of Americans to accept changes that will crimp their lives and cripple their futures — all because Bill Clinton cut a deal that made environmentalists happy during the 1996 election season.

Consider some key features of the treaty. The United States, virtually alone among major economic powers, would accept binding limits on emissions from fossil fuels — the source of 85 percent of our energy.

Our European competitors would not suffer similar restraints. They merely would have to achieve such reductions as a continent. And developing economies, including Korea and China, wouldn't have to change their behavior at all. The document doesn't ask them

The agreement would raise the price of everything — instantly. A DRI/McGraw Hill study estimates the government would have to impose a tax of 60 cents per gallon just to hold carbon emissions at 1990 levels and would have to slap a 50-percent price hike on heating oil. If the administration accepts the proposal to reduce pollution 10 percent, the price hikes could double.

Businesses either would have to pay gigantic fees or move to places that impose no such levies. That would be a no-brainer for manufacturers: Heavy industries would head for places such as India and China, which have large, low-wage labor pools and would not have to abide by the anti-pollution pact. Ironically, such a shift simply would shift jobs and pollution from one part of the planet to another.

The government has another option, of course. It could resist the temptation to tax and create a rationing system, instead. If you wanted to use energy, you'd have to pay for a permit.

This would give the government life-or-death power over six-sevenths of the economy — a sure recipe for mega-corruption. If we can't run a food-stamp program without extensive fraud, can you imagine what would happen with a system that would bring energy under Washington's ambit?

This agreement, quietly negotiated far away from the turmoil of presidential politics, ensures recession and oppression — without the benefit of representation.

Congress and the White House haggled for a decade over the provisions of the Clean Air Act extension of 1992. This time around, the Clinton cadres avoided unpleasantness by misleading key players on Capitol Hill.

Deputy Undersecretary of State Rafe Pomerance assured jittery lawmakers on June 19 that the administration would not accept any emissions limits during the Geneva deliberations

than four weeks later.

Now, you don't have to be Alvin Toffler to anticipate the long-term outcome of this deal. America's heavy industries and energy-dependent industries would, in the words of one well-known baron of commerce, "go down the crapper."

Consad Research Corp. estimates the changes would kill off 1.6 million jobs over the next nine years and put another 3.5 million or so "at risk." Texas, California, Pennsylvania, Ohio, Illinois, Indiana, Louisiana and Michigan would take the hardest hits.

One always should take all such projections with a grain of salt, but even the White House admits the change will hurt people. As Wirth noted coyly in Switzerland, "In a world of change, everybody doesn't remain advantaged."

The agreement also would set off geopolitical chaos. If today's globe features "haves" and "have-nots," this writ would create a world of "cans" and "cannots" — and American entrepreneurs would find themselves on the enemies list. And as manufacturing moved East, economic warfare would erupt.

This kind of thing makes ClintonCare look awesomely tame. With health care, the president wanted to mess up one-seventh of the economy. In this case, he wants to gut six-sevenths, without the consent of the people, while placing everybody under the suzerainty of Boutros Boutros-Ghali or some other U.N. potentate.

Talk about overreactions: In order to fend off what may be a fabricated fear of global warming, Bill Clinton has just committed the next generation of Americans to an economic ice age. Is it any wonder the markets (and workers) feel uneasy?

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Global warming or hot air?

You might say that 1996 was the year without a summer, so cool was it here in Washington. Indeed the city enjoyed a streak of 35 days under 90 degrees this summer, which nearly broke a record for the area. This unsummer followed one of the most brutally cold winters in memory. So what are government types in Washington worrying about? Global warming.

Today, Tim Wirth, also known as the State Department Under Secretary for Global Affairs, is scheduled to testify before a Senate committee on what the administration proposes to do about all this warming. Among the possibilities are mandatory government rollbacks in man-made emissions said to cause all the aforementioned warming you've had to endure lately. Such rollbacks might mean higher energy taxes on consumers, lost industry jobs, rationing and worse.

Now if the world were really in danger of boiling over, no doubt most people would be willing to make the necessary sacrifices. Perhaps the State Department could set the right tone by sacrificing its heating supplies this winter when, presumably, they wouldn't be needed anyway because of global warming.

But there is precious little scientific evidence to suggest a fiery end to the world, either now or sometime late in the next century. Not that proponents of the theory aren't looking for it.

Last month, news broke that a California researcher had discovered that the little-known Edith's checkerspot butterfly had packed up and moved north to cool off. "Western Butterfly Shifting North as Global Climate Warms," the New York Times warned in an ominous headline. The scientist reported that such a population shift is exactly one of the predicted biological effects of global warming.

So how much warmer was it where the butterfly lived? Neither the study nor the story could say. So how did the researcher know global warming caused it to move? She didn't. "I cannot say that climate warming has caused the [butterfly] shift," she conceded to the New York Times.

Earlier this summer, a scientific panel found itself embroiled in controversy over the alteration of key findings raising doubts about global warming. In its original version, the report of the Intergovernmental Panel on Climate Change included the following statements:

- "None of the studies cited above has shown clear evidence that we can attribute the observed [climate] changes to the specific cause of increases in greenhouse gases."

- "No study to date has positively attributed all or part [of the climate change observed to date] to anthropogenic [man-made] causes."

- "Any claims of positive detection of significant climate change are likely to remain controversial until uncertainties in the total natural variability of the climate system are reduced."

In the final version of the report, these findings disappeared down the memory hole. Given their substance, it's not hard to see why. A Nov. 15, 1995, State Department letter had urged that chapters in the report not be "finalized" and that "chapter authors be prevailed upon to modify their text in an appropriate manner." Senators on the Energy and Natural Resources Committee ought to ask Mr. Wirth what the State Department meant by "appropriate" and what happened to the missing findings.

In the end the world may discover that it has less to fear from global warming than it does from hot air in Washington.

Industry Funds Global-Warming Skeptics

Scientists Dispute Charges That Oil and Coal Money Biased Their Work

By Gary Lee
Washington Post Staff Writer

A Washington environmental group charged yesterday that three researchers who are outspoken critics of the scientific evidence for global warming have received hundreds of thousands of dollars from the petroleum and coal industries, and that this funding has influenced their views.

One of the scientists also regularly receives research funding from the government of Kuwait, a leading oil producer, according to the documents released yesterday by Ozone Action, an environmental group that lobbies on the issues of air quality and global climate change.

In interviews yesterday, two of the researchers, Robert Balling of Arizona State University and Patrick Michaels of the University of Virginia, acknowledged receiving research funding from the energy industry but disputed the charge that such funding biased their scientific findings to favor industry positions. The third researcher, Sherwood Idso of Phoenix, did not return two telephone calls for comment.

The researchers, frequently called to testify before congressional panels and other public groups, have raised questions about whether global warming is occurring. They also have suggested that if the phenomenon is real, it is generally caused by natural factors and not by the burning of fossil fuels and other human activities.

Balling, director of the climatology program at Arizona State, has received as much as \$311,000 from the

oil and coal industries and from Kuwait, according to the documents.

A large proportion of his funding came from the Cyprus Minerals Co., an Arizona-based organization composed of various petroleum and coal companies. He also received funding from the Kuwait Foundation for the Advancement of Sciences, a research institution funded by the Kuwaiti government.

Michaels, a professor at the University of Virginia, received about \$150,000 from petroleum and coal interests, including the Western Fuels Association, an umbrella industry organization, the documents said. Michaels and Balling confirmed their funding sources in separate depositions before a Minnesota court last year.

Balling and Michaels were invited two weeks ago by GOP lawmakers to make their case to the House Science Committee, which wants to cut by 40 percent federal funding for a program designed to monitor climate trends.

Idso, a Phoenix-based physicist who has worked closely with Balling, has received an undisclosed amount of funding from oil, gas and utility sources, according to Ozone Action.

"Shedding light on where these critics get their funding helps us to explain how industry is able to add confusion to the general sense that global warming is a problem and something should be done about it," said John Passacantando, executive director of Ozone Action. "Except for the fact that they get funding from the oil and coal industries, they would have no platform at all."

Michaels acknowledged that some

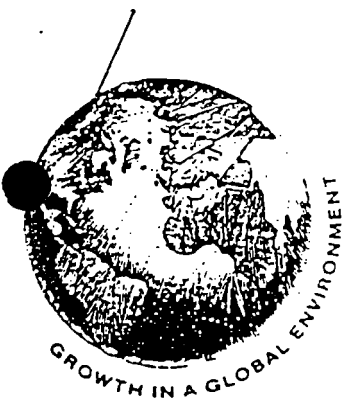
of the climate change research he directs at the University of Virginia is funded by grants from the energy industry but stressed that the funding goes to the institution and not to him personally.

Any assertion that his funding sources bias him in favor of industry is "ludicrous," he said. "In fact, we receive 70 percent of funding from public and 30 percent from private concerns," he said. "By extension that would make my research 70 percent beholden to public interests and 30 percent to private interests."

Balling said he receives about \$20,000 a year in speaking fees from oil and coal groups, and that he has received a total of about \$200,000 in personal income from such groups over the past eight years. His research institution receives \$150,000 or so annually from such sources, he added.

"Regardless of the source of the funding, [the research] is peer-reviewed by specialists and published in noted scientific journals," he said. "The system provides a good screening process for good research."

In published articles and speeches, Balling has argued that the trend in global warming is exaggerated by other scientists and that warming occurred at a much greater pace before there was extensive burning of fossil fuels. He also has said that if warming does occur, it would benefit the environment.



GLOBAL CLIMATE COALITION

FOR IMMEDIATE RELEASE

Wednesday, July 17, 1996

U.S. Business Faults Clinton Administration Climate Change Policy, Foresees Significant Negative Job, Trade, Economic Impacts

GENEVA, July 17—The Clinton Administration today committed the United States to a plan for addressing climate change that could eliminate millions of American jobs, reduce the nation's ability to compete globally, and force Americans into second-class lifestyles.

"U.S. negotiators have made a unqualified commitment to legally binding U.S. targets to cap emissions in the United States, despite acknowledging that they do not have the analysis and assessment that is necessary to fully understand the impacts on Americans," John Shlaes, executive director of the Global Climate Coalition, said today.

Depending on what targets and timetables are adopted, the U.S. economy could lose millions of jobs and suffer significant losses in international trade. In addition, it means higher costs to Americans for everyday necessities, including food, transportation fuels and electricity.

Undersecretary of State Timothy Wirth was in Geneva today to address the United Nations Conference of Parties to the Framework Convention on Climate Change. In a briefing for business, industry, labor and environmental organizations he revealed some of the Administration's negotiating position. Wirth admitted that there will be winners and losers among American workers. "In a world of change, everybody doesn't remain advantaged," Wirth told the group.

Economic studies show that millions of U.S. jobs could be lost to slower economic growth and developing countries—such as China, India and Korea. They will have no obligation to limit their greenhouse gas emissions, are approaching half the globe's total emissions and will account for three-fourths of future emissions.

"The Clinton Administration is willing to risk a wild ride for Americans on a roller-coaster economy while giving developing countries a free ride," Shlaes said "It is clear that the Administration is pursuing a political agenda. This decision was made without adequate economic facts and is based on uncertain climate science," he added.

Wirth dismissed as ineffective and as a “failure” U.S. industry’s participation in voluntary programs for limiting greenhouse gas emissions, even though they have made a significant contribution to limiting emissions. The U.S. government has yet to analyze the many programs to determine which are effective and how to improve the voluntary approach.

“We are also alarmed and dismayed by the U.S. delegation’s approval of language which restricts joint implementation to developed nations rather than involving all nations. This takes off the table a beneficial and cost-effective means to mitigate greenhouse gas emissions,” Shlaes said.

However, the Administration appears to have rejected 2005 as a target year and the use of international common policies,” he added.

The Global Climate Coalition urges Congress to carefully examine the Administration’s negotiating position and get answers to these questions:

- What specific targets and timetables does the Administration have in mind?
- What analysis and assessment has been used to support the current position?
- What is the impact of binding targets on U.S. trade competitiveness and American jobs?
- What is the cost to taxpayers?
- When and how will the developing countries be held accountable for their emissions?
- What emissions cap is being considered and what impact will it have on U.S. business and industry?
- Will that cap apply to all greenhouse gases?

“Congress should understand that the real losers in this process are American consumers and workers. The Administration is betting that the public won’t understand the complexities of this issue or question its decisions at the United Nations” Shlaes said.

—xxx—

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International Climate Change Partnership

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ICCP Supports U.S. Call for Long-Term Focus on Climate Change Issue

For Immediate Release

**Contact: Kevin Fay, Executive Director
Phone (U.S.): 703-841-0626**

Wednesday, July 17, 1996

**Kathryn Shanks, ICCP Chair
Phone (Geneva): 41-22-908-9081**

GENEVA, SWITZERLAND - The International Climate Change Partnership (ICCP) today supported the U.S. government position for a long-term focus on the climate change issue, rather than impractical short-term targets for greenhouse gas emissions reduction, at climate talks in Geneva. The ICCP joined the U.S. in opposing calls for harmonized international policies and measures, and unrealistic targets and timetables to control emissions.

While the ICCP supports a long-term focus, strong concerns remain about the premature development of any concentration goal without a clear understanding of the economic costs, scientific basis and required emissions reduction levels.

In addition, the ICCP supported U.S. proposals for flexible, cost-effective and fair approaches to greenhouse gas emissions reductions that will ensure economic prosperity. "A long-term focus will send a necessary market signal to the public and private sectors. This will enable the required sustained long-term investment and technological innovation necessary to meet the challenges associated with this issue," said Kevin Fay, ICCP Executive Director.

Fay cautioned, however, that many details remain undefined; and he reiterated the ICCP view that the timing of COP 3 is inadequate to thoughtfully resolve many of these details. "As an example, the U.S. desire for a medium-term binding commitment is unrealistic without carefully defined roles for developed and developing countries," said Fay.

The ICCP acknowledged that the U.S. has recognized additional essential elements of a policy frame-work for future action on climate change. These elements include:

- * Identification of a longer-term greenhouse gas focus;
- * Participation and cooperation by all nations - developed and developing;
- * A mixture of policy instruments including, joint implementation and emissions trading;
- * Flexibility for individual governments to tailor national implementation strategies according to their unique national circumstances;
- * Uniform procedural measures which are needed for compliance, reporting and verification of emissions and reductions; and
- * Opposition to the use of climate change talks to further national competitive positions.

Members of the ICCP remain concerned that the international negotiating process is not more open to input from business and industry and that the technology assessment process will be inconclusive for the COP 3 negotiations. Industry expertise can add value to the negotiations by providing important information concerning the availability of finite capital resources and useful asset life within individual industries.

The ICCP commends the U.S. delegation participating in these global negotiations for their continued engagement in the process, their commitment to continued interaction with business interests and their pledge for further economic and technical assessment as the foundation of the evolving U.S. position on this issue.

ICCP is a global coalition of companies and trade associations from diverse industries committed to constructive and responsible participation in the international policy process concerning global climate change.



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JULY 17, 1996

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**BUSINESS LEADERS SUPPORT U.S.
STATEMENT AT CLIMATE NEGOTIATIONS**
Challenge Clinton Administration to Clarify Details

GENEVA: Leaders from the Business Council for Sustainable Energy today expressed support for the U.S. ministerial statement made at the Climate Summit in Geneva. Undersecretary of State Timothy Wirth, addressing the Second Conference of the Parties, challenged negotiators to develop a flexible, cost-effective, binding international agreement to reduce global greenhouse gas emissions after the year 2000. The U.S. endorsed current climate science and set out principles for evaluating climate proposals that stressed a long-term emissions goal, medium-term targets, and so-called "short-term" signals to the private sector.

While supporting long-term targets, the U.S. statement recognized the range of sound policies and technologies that can be utilized in the near-term to avoid the need for draconian policies in the future. "By making an effective and verifiable joint implementation regime part of its post-2000 approach," said Terry Thorn, Senior Vice President of Enron Corp., "the U.S. government has recognized the private sector's role as a leading partner in dealing with global climate change. Thorn added, "we support the use of an air credit trading regime for Annex 1 Parties with an opt-in provision for developing and transitional economies. This system captures market efficiencies, will promote technology transfer, and breaks the international political deadlock on climate policy."

Business leaders supported the long-term commitment but called on the U.S. to clarify its position on short-term signals to reduce greenhouse gas emissions. "We are pleased the U.S. recognizes that energy efficiency, natural gas, and renewable energy technologies are available today to cut emissions," noted Jim Wolf, Vice President of American Standard. The Business Council laid out four short-term actions the U.S. could support to more expressly link clean technologies to the goals of the Berlin Mandate:

- Implementation of an Annex I emissions credit trading regime for carbon by the year 2000.
- Development of international rules for opting into the emissions credit trading regime for non-Annex I Parties.
- Commitments to specific medium- and long-term climate control goals on the part of Annex I Parties.
- Prioritization of lending practices at the World Bank and other multilateral lending agencies to promote energy efficiency and clean technologies and services.

"The U.S. offered sound principles for controlling greenhouse gas emissions" stated Michael Marvin, Executive Director of the Business Council. Marvin added that "industry supports a cost-effective and flexible approach to climate policy — now we need the details."

* * * *

*The Business Council for Sustainable Energy is
comprised of leading companies and trade associations in energy efficiency,
natural gas, and renewable energy markets throughout the world.*

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PRESS RELEASE

Environmentalists Welcome US Call for Binding Greenhouse Gas Commitments; Await Elaboration of Key Issues

17 July, 1996, Geneva-

Members of the US Climate Action Network (USCAN) welcomed Undersecretary of State Tim Wirth's call today for a legally binding agreement to reduce post-2000 industrialized country emissions of carbon dioxide and other greenhouse gases. Undersecretary Wirth's address at the United Nations in Geneva was made at the opening session of high-level talks intended to jump-start negotiations on preventing dangerous climate change. This round of negotiations is due to be completed by December, 1997. The current climate treaty, signed at the 1992 Rio Earth Summit, contains only a voluntary aim of reducing emissions to 1990 levels by the year 2000, a target that the U.S. and most other industrialized countries will not achieve.

While welcoming the call for a legally binding emission limit, USCAN member groups noted that the U.S. position remains vague on such crucial issues as the level and timetable for emission reductions. The U.S. also has not specified a long-term target for limiting greenhouse gas concentrations or human-caused global warming.

"This is an important step forward," said Alden Meyer, Director of Government Relations for the Union of Concerned Scientists and USCAN Chair. "The experience of the last few years has made it abundantly clear that voluntary agreements are not adequate to protect the climate. We hope this strong U.S. call for binding emission reduction targets will galvanize these negotiations and lead to a meaningful agreement. To maintain its leadership role, the US must now fill in the critical missing elements of its proposal."

The U.S. unequivocally reaffirmed its support for the international scientific consensus that human activities are threatening to cause dangerous changes in the global climate. "Greenhouse gas concentrations have already increased by 50% compared to preindustrial levels; research on potential health, coastal, and environmental impacts shows that concentrations must be stabilized at well below the equivalent of doubling CO₂ in order to reduce the risk of human and ecological disasters," said Daniel Lashof, senior scientist at the Natural Resources Defense Council. "The U.S. should build on today's statement by setting a long-term target that would prevent dangerous climate change."

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"Claims by coal and oil lobbyists notwithstanding, analyses of opportunities for reducing greenhouse gas emissions show that substantial reductions are not only feasible, but could spur a net increase in economic growth," said Pat Keegan, Director of the Climate Change Program at the International Institute for Energy Conservation. "The barriers to achieving these reductions are political, not technological."

Progress was also made at the negotiations on the critical issue of engaging developing countries in the long-term task of limiting greenhouse gas emissions. Guidelines for developing country reports on their emissions and on strategies to limit them were approved by the meeting; the first such reports will be due next year. "This will build on the progress made by many developing countries in identifying and implementing measures that both reduce emissions and promote their economic development," said Karan Capoor, policy analyst with the Environmental Defense Fund. "This progress demonstrates developing countries' willingness to participate in the global effort needed to address the threat of climate change."

The US Climate Action Network is made up of 30 energy and environmental groups working to achieve aggressive national and international climate change policies.

Note: There will be a live call-in press conference today at 7 PM Geneva time (1 PM Eastern Standard Time) where USCAN members and other NGOs will discuss these developments. To participate, call 155-5330 (in Geneva) or 1-800-351-4898, (from the United States). The code for the call is "Geneva."

In addition, members of USCAN can be reached for comment c/o the Hotel Longchamp at 011-41-22-731-6750.

GLOBAL WARMING

THE WHITE HOUSE VS. THE GREENHOUSE

Reversing course, the Clintonites get behind emission controls

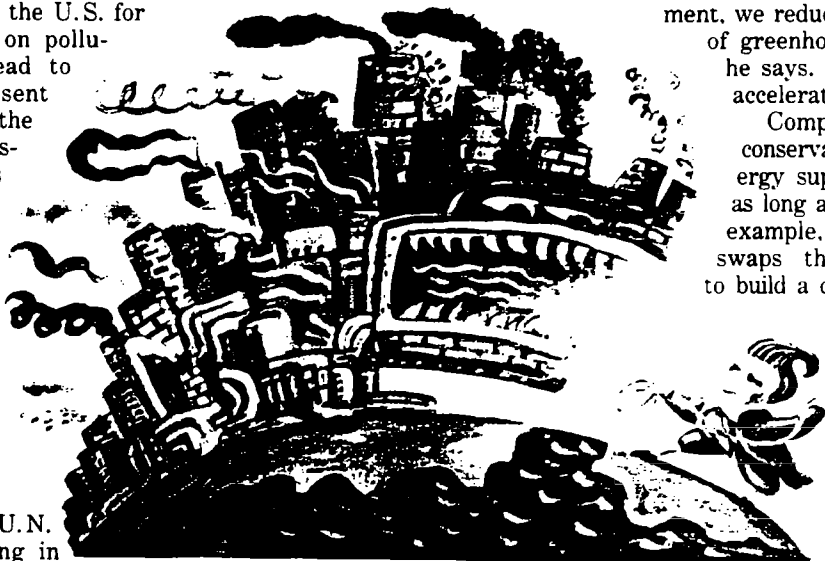
Last month's call by the U.S. for mandatory limits on pollutants that can lead to global warming has sent shock waves through the American energy industry. As the world's largest producer of greenhouse gases, the U.S. had long opposed mandatory reductions. On July 17, however, Timothy E. Wirth, the Under Secretary of State for Global Affairs, surprised industry observers and environmentalists with a dramatic reversal at a U.N. change meeting in

The administration's embrace of mandatory limits is seen as more than political posturing. It has set the stage for more serious negotiations. In 1992 at the Earth Summit in Rio de Janeiro, negotiators called only for voluntary reductions in emissions to 1990 levels by 2000. That effort to reduce greenhouse gas emissions has fallen far short.

In January, the U.N.'s Intergovernmental Panel on Climate Change (IPCC) said the "balance of evidence" suggests there is a "discernible human influence on global climate." It was the first time that the panel, made up of scientists from around the world, had said that the effects of greenhouse gas emissions were being felt.

FLOODS, STORMS. The IPCC predicted that the atmosphere would warm 2 degrees Celsius by 2100. That doesn't sound like much, but it could lead to a variety of unpredictable climate changes that could spawn more floods and storms and disrupt agriculture around the world.

Researchers continue to debate the consequences of global warming, but there is no debate over the rise in atmospheric carbon dioxide—one of the important greenhouse gases. Carbon dioxide levels have climbed sharply



in recent years (chart). By some estimates, global carbon dioxide emissions—mainly produced by the burning of coal and oil—may increase 60% in the next two decades, with most of the growth in China and the developing world.

Unsurprisingly, the energy industry is fighting mad. John Shlaes—the executive director of the Global Climate Coalition, which represents coal and oil interests—calls mandatory emission caps "an energy-rationing program for Americans." Shlaes had expected the Administration to stop short of mandatory limits.

Rio's nonbinding agreement has al-

ready had an impact—thanks mainly to efforts by the utility industry. According to Michael Oppenheimer, senior scientist with the Environmental Defense Fund, U.S. emissions would have grown 13% from 1992 to 2000 in the absence of the Rio accord. Instead, says Oppenheimer, they will probably grow by 7%. He sees that as a sign that steeper reductions are possible. "Even in a period of moderate economic growth, without a binding agreement, we reduced the expected growth of greenhouse gases by one-half,"

he says. Mandatory limits would accelerate that decline, he says.

Companies that invest in conservation and alternative energy support Wirth's proposal—as long as it offers flexibility. For example, businesses advocate swaps that would allow them to build a clean-coal plant in China,

say, and earn emissions credits back home.

Says Michael L. Marvin, executive director of the Business Council for Sustainable Energy, a group that represents energy-efficient companies: "I

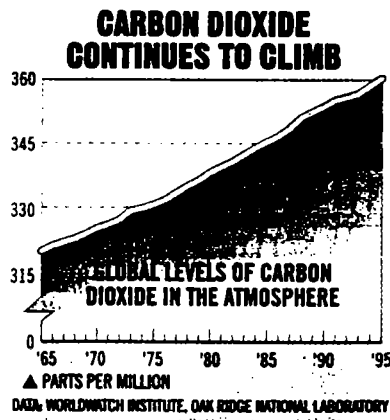
think we want to make sure that maintaining a healthy economy is as important as any other goal" in the negotiations.

SQUISHY PREDICTIONS. Although the U.S. called for mandatory limits, it did not say where those limits should be set. U.S. negotiators said only that they support a specific, attainable target by 2010 or 2020, according to Eileen B. Claussen, the Assistant Secretary of State for Oceans, Environment, and Science. A final agreement is due by December, 1997.

One problem is that no one knows exactly what the economic impact of mandatory limits will be. Computer models intended to project possible consequences make notoriously squishy predictions. "Any answer can be arrived at through small manipulations of initial assumptions," says Hadi Dowlatabadi, a global change expert at Carnegie Mellon University.

Despite the economic uncertainty, there are already encouraging signs of a consensus. At the end of the Geneva meeting, all but 14 countries had tentatively endorsed the U.S. proposal. Holdouts included the 11 OPEC nations and Russia. Many clearly see the U.S. proposal as an important step in a long negotiating process.

By Naomi Freundlich in New York



Infectious Disease May Rise As the World Gets Warmer

New Populations Will Be at Risk, Researchers Say

By David Brown
Washington Post Staff Writer

Global climate change over the next century may markedly increase the range of many infectious diseases, especially those spread by insects and water, according to a new report.

Malaria, with a current worldwide mortality of about 2 million people a year, may kill an additional million people annually as temperatures rise and the microbe-carrying mosquito spreads. Dengue, a painful virus infection currently in epidemic resurgence in Latin America, may move north into the United States. Warmer ocean temperatures may aid the spread of cholera in shellfish, according to the report.

"Global climate change can alter the distribution of infectious diseases, placing new and potentially large human populations at risk," wrote Jonathan A. Patz, an epidemiologist, in today's *Journal of the American Medical Association*.

The predictions made by Patz, of the Johns Hopkins School of Hygiene and Public Health, and his co-authors at Harvard University and George Washington University, are based on estimates that average global temperature will rise about 4 degrees Fahrenheit (2 degrees Celsius) by the year 2100. Global sea-level rise over the same period is expected to be between six inches and three feet, a change that also may increase the prevalence of infectious diseases.

A hotter environment may reduce some temperate-zone infections, such as Rocky Mountain spotted fever, but will tend to favor a larger number of tropical diseases, according to the report. Many of the latter infections are transmitted to human beings by insects and animals that will become more likely to carry infectious organisms or will spread over larger geographic areas.

Malaria, transmitted by certain species of mosquito, is the world's most prevalent "vector-borne" disease. Its spread is highly dependent on temperature and humidity, factors that affect mosquitoes' breeding.

The researchers pointed to a 1987 epidemic of malaria in Rwanda as a case study of what may occur in many areas. A high-altitude, malaria-free region experienced a large number of cases following a period of record-setting high temperatures and rainfall. In particular, small changes in minimum temperature "exponentially affected" rates of the infection, the researchers reported.

Currently, about 2 billion people in the world are at risk of contracting malaria. Should the global warming predictions prove true, an additional 620 million will be at risk by the year 2050, Patz said yesterday at a news conference here. The latter group will have none of the partial immunity conferred by repeated infection, and may tend to get more severe cases.

Dengue, a disease also known as "break-bone

fever" because of the pain it causes, is also transmitted by mosquitoes and is expected to spread with higher temperatures. The effect of temperature goes beyond merely enlarging the insects' native range.

Female mosquitoes (the only sex that bites) are smaller in warmer temperatures, so they must take more blood meals in order to acquire the protein necessary to make eggs. Heat also shortens the period between the time a mosquito acquires the dengue virus and the time the virus has reproduced sufficiently for the insect's bite to transmit the disease.

"At higher temperature, the mosquito bites more often, and the bite is more likely to be infectious," Patz said.

Dengue is occasionally fatal if a person is repeatedly infected. A recent epidemic in Latin America has numbered about 140,000 cases, but has caused fewer than 100 reported deaths. An American case was diagnosed in Hidalgo County, Tex., in October. The mosquito capable of transmitting dengue exists as far north as Memphis, Patz said.

Other diseases that may become more prevalent with global warming include river blindness, whose black-fly vectors may increase in number by 25 percent in West Africa; sleeping sickness, whose tsetse-fly vectors may spread as vegetation changes in sub-Saharan Africa; and St. Louis encephalitis, a mosquito-borne disease found in the United States and elsewhere that favors warm, wet winters and hot summers.

A rise in ocean temperatures may favor the growth and spread of algae blooms, which in turn may increase the population of certain types of plankton that can carry the cholera bacterium. Warmer water also may extend the range of various "red tides" of microorganisms that can poison shellfish and people who eat them.

At the news conference, however, Patz noted that "climate is not the only factor driving these diseases." Interventions such as putting screens on windows and limiting the amount of standing water in populated areas can markedly affect disease rates, especially in developed countries such as the United States.

Among the suggestions offered by Patz and his colleagues was the establishment of "sentinel diagnostic centers" at the borders of areas where there are diseases likely to spread with global warming.

Patz's report was one of several articles on "emerging diseases" in this week's issue of the journal. One of the others described a rise of 22 percent in the number of deaths caused by infectious diseases between 1980 and 1992, excluding deaths from AIDS.

At the urging of the journal's editor, George D. Lundberg, about 35 other medical journals around the world will publish articles on emerging infections this month to heighten public and professional awareness of the problem.

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8

Divider Title: _____

Climate Change Action Plan
(dollar amounts in millions)

	1994	1995		1996		1997	
	<u>Actual</u> ^{1/}	<u>Pres Budget</u>	<u>Actual</u>	<u>Pres Budget</u>	<u>Enacted</u>	<u>Pres Budget</u>	<u>Enacted</u>
DOE	—	208	73	185	64	147	77
EPA	37	123	102	135	83	142	86
USDA	8	12	8	12	6	19	19
Corps	—	1	1	1	0	—	—
Total	45	344	184	333	153	308	182

1/ Reprogramming of existing resources since the Action Plan was published after Congress appropriated funds for FY 1994.

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Divider Title: _____

Summary for Policymakers

This summary, approved in detail at the fifth session of IPCC Working Group I, (Madrid, 27-29 November 1995), represents the formally agreed statement of the IPCC concerning current understanding of the science of climate change.

Summary for Policymakers

Considerable progress has been made in the understanding of climate change¹ science since 1990 and new data and analyses have become available.

Greenhouse gas concentrations have continued to increase

Increases in greenhouse gas concentrations since pre-industrial times (i.e., since about 1750) have led to a positive *radiative forcing*² of climate, tending to warm the surface and to produce other changes of climate.

- The atmospheric concentrations of greenhouse gases, *inter alia* carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) have grown significantly: by about 30%, 145% and 15% respectively (values for 1992). These trends can be attributed largely to human activities, mostly fossil fuel use, land-use change and agriculture.
- The growth rates of CO₂, CH₄ and N₂O concentrations were low during the early 1990s. While this apparently natural variation is not yet fully explained, recent data indicate that the growth rates are currently comparable to those averaged over the 1980s.
- The direct radiative forcing of the long-lived greenhouse gases (2.45 Wm⁻²) is due primarily to increases in the concentrations of CO₂ (1.56 Wm⁻²), CH₄ (0.47 Wm⁻²) and N₂O (0.14 Wm⁻²) (1992 values).
- Many greenhouse gases remain in the atmosphere for a long time (for CO₂ and N₂O, many decades to centuries), hence they affect radiative forcing on long time-scales.
- The direct radiative forcing due to the CFCs and HCFCs combined is 0.25 Wm⁻². However, their *net* radiative forcing is reduced by about 0.1 Wm⁻² because they have caused stratospheric ozone depletion which gives rise to a negative radiative forcing.
- Growth in the concentration of CFCs, but not HCFCs, has slowed to about zero. The concentrations of both CFCs and HCFCs, and their consequent ozone depletion, are expected to decrease substantially by 2050 through implementation of the Montreal Protocol and its Adjustments and Amendments.

- At present some long-lived greenhouse gases (particularly HFCs (a CFC substitute), PFCs and SF₆) contribute little to radiative forcing but their projected growth could contribute several per cent to radiative forcing during the 21st century.
- If carbon dioxide emissions were maintained at near current (1994) levels, they would lead to a nearly constant rate of increase in atmospheric concentrations for at least two centuries, reaching about 500 ppmv (approaching twice the pre-industrial concentration of 280 ppmv) by the end of the 21st century.
- A range of carbon cycle models indicates that stabilisation of atmospheric CO₂ concentrations at 450, 650 or 1000 ppmv could be achieved only if global anthropogenic CO₂ emissions drop to 1990 levels by, respectively, approximately 40, 140 or 240 years from now, and drop substantially below 1990 levels subsequently.
- Any eventual stabilised concentration is governed more by the accumulated anthropogenic CO₂ emissions from now until the time of stabilisation, than by the way those emissions change over the period. This means that, for a given stabilised concentration value, higher emissions in early decades require lower emissions later on. Among the range of stabilisation cases studied, for stabilisation at 450, 650 or 1000 ppmv accumulated anthropogenic emissions over the period 1991 to 2100 are 630 GtC³, 1030 GtC, and 1410 GtC respectively ($\pm$ approximately 15% in each case).

¹ Climate change in IPCC Working Group I usage refers to any change in climate over time whether due to natural variability or as a result of human activity. This differs from the usage in the Framework Convention on Climate Change where climate change refers to a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

² A simple measure of the importance of a potential climate change mechanism. Radiative forcing is the perturbation to the energy balance of the Earth-atmosphere system (in watts per square metre [Wm⁻²]).

³ 1 GtC = 1 billion (10⁹) tonnes of carbon.

For comparison the corresponding accumulated emissions for IPCC IS92 emission scenarios range from 770 to 2190 GtC.

- Stabilisation of CH₄ and N₂O concentrations at today's levels would involve reductions in anthropogenic emissions of 8% and more than 50% respectively.
- There is evidence that tropospheric ozone concentrations in the Northern Hemisphere have increased since pre-industrial times because of human activity and that this has resulted in a positive radiative forcing. This forcing is not yet well characterised, but it is estimated to be about 0.4 Wm⁻² (15% of that from the long-lived greenhouse gases). However the observations of the most recent decade show that the upward trend has slowed significantly or stopped.

Anthropogenic aerosols tend to produce negative radiative forcing

- Tropospheric aerosols (microscopic airborne particles) resulting from combustion of fossil fuels, biomass burning and other sources have led to a negative direct forcing of about 0.5 Wm⁻², as a global average, and possibly also to a negative indirect forcing of a similar magnitude. While the negative forcing is focused in particular regions and subcontinental areas, it can have continental to hemispheric scale effects on climate patterns.
- Locally, the aerosol forcing can be large enough to more than offset the positive forcing due to greenhouse gases.
- In contrast to the long-lived greenhouse gases, anthropogenic aerosols are very short-lived in the atmosphere, hence their radiative forcing adjusts rapidly to increases or decreases in emissions.

Climate has changed over the past century

At any one location year-to-year variations in weather can be large, but analyses of meteorological and other data over large areas and over periods of decades or more have provided evidence for some important systematic changes.

- Global mean surface air temperature has increased by between about 0.3 and 0.6°C since the late 19th

century; the additional data available since 1990 and the re-analyses since then have not significantly changed this range of estimated increase.

- Recent years have been among the warmest since 1860, i.e., in the period of instrumental record, despite the cooling effect of the 1991 Mt. Pinatubo volcanic eruption.
- Night-time temperatures over land have generally increased more than daytime temperatures.
- Regional changes are also evident. For example, the recent warming has been greatest over the mid-latitude continents in winter and spring, with a few areas of cooling, such as the North Atlantic ocean. Precipitation has increased over land in high latitudes of the Northern Hemisphere, especially during the cold season.
- Global sea level has risen by between 10 and 25 cm over the past 100 years and much of the rise may be related to the increase in global mean temperature.
- There are inadequate data to determine whether consistent global changes in climate variability or weather extremes have occurred over the 20th century. On regional scales there is clear evidence of changes in some extremes and climate variability indicators (e.g., fewer frosts in several widespread areas; an increase in the proportion of rainfall from extreme events over the contiguous states of the USA). Some of these changes have been toward greater variability; some have been toward lower variability.
- The 1990 to mid-1995 persistent warm-phase of the El Niño-Southern Oscillation (which causes droughts and floods in many areas) was unusual in the context of the last 120 years.

The balance of evidence suggests a discernible human influence on global climate

Any human-induced effect on climate will be superimposed on the background "noise" of natural climate variability, which results both from internal fluctuations and from external causes such as solar variability or volcanic eruptions. Detection and attribution studies attempt to distinguish between anthropogenic and natural influences. "Detection of change" is the process of demonstrating that an observed

change in climate is highly unusual in a statistical sense, but does not provide a reason for the change. "Attribution" is the process of establishing cause and effect relations, including the testing of competing hypotheses.

Since the 1990 IPCC Report, considerable progress has been made in attempts to distinguish between natural and anthropogenic influences on climate. This progress has been achieved by including effects of sulphate aerosols in addition to greenhouse gases, thus leading to more realistic estimates of human-induced radiative forcing. These have then been used in climate models to provide more complete simulations of the human-induced climate-change "signal". In addition, new simulations with coupled atmosphere-ocean models have provided important information about decade to century time-scale natural internal climate variability. A further major area of progress is the shift of focus from studies of global-mean changes to comparisons of modelled and observed spatial and temporal patterns of climate change.

The most important results related to the issues of detection and attribution are:

- The limited available evidence from proxy climate indicators suggests that the 20th century global mean temperature is at least as warm as any other century since at least 1400 AD. Data prior to 1400 are too sparse to allow the reliable estimation of global mean temperature.
- Assessments of the statistical significance of the observed global mean surface air temperature trend over the last century have used a variety of new estimates of natural internal and externally forced variability. These are derived from instrumental data, palaeodata, simple and complex climate models, and statistical models fitted to observations. Most of these studies have detected a significant change and show that the observed warming trend is unlikely to be entirely natural in origin.
- More convincing recent evidence for the attribution of a human effect on climate is emerging from pattern-based studies, in which the modelled climate response to combined forcing by greenhouse gases and anthropogenic sulphate aerosols is compared with observed geographical, seasonal and vertical patterns of atmospheric temperature change. These studies show that such pattern correspondences increase with time, as one would expect as an anthropogenic signal increases in strength. Furthermore, the probability is very low that these correspondences could occur by chance as a result of natural internal variability only. The vertical patterns of change are also inconsistent with those expected for solar and volcanic forcing.
- Our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability, and because there are uncertainties in key factors. These include the magnitude and patterns of long term natural variability and the time-evolving pattern of forcing by, and response to, changes in concentrations of greenhouse gases and aerosols, and land surface changes. Nevertheless, the balance of evidence suggests that there is a discernible human influence on global climate.

Climate is expected to continue to change in the future

The IPCC has developed a range of scenarios, IS92a-f, of future greenhouse gas and aerosol precursor emissions based on assumptions concerning population and economic growth, land-use, technological changes, energy availability and fuel mix during the period 1990 to 2100. Through understanding of the global carbon cycle and of atmospheric chemistry, these emissions can be used to project atmospheric concentrations of greenhouse gases and aerosols and the perturbation of natural radiative forcing. Climate models can then be used to develop projections of future climate.

- The increasing realism of simulations of current and past climate by coupled atmosphere-ocean climate models has increased our confidence in their use for projection of future climate change. Important uncertainties remain, but these have been taken into account in the full range of projections of global mean temperature and sea level change.
- For the mid-range IPCC emission scenario, IS92a, assuming the "best estimate" value of climate sensitivity¹ and including the effects of future increases in aerosol, models project an increase in

¹ In IPCC reports, climate sensitivity usually refers to the long term (equilibrium) change in global mean surface temperature following a doubling of atmospheric equivalent CO₂ concentration. More generally, it refers to the equilibrium change in surface air temperature following a unit change in radiative forcing (°C/Wm²).

global mean surface air temperature relative to 1990 of about 2°C by 2100. This estimate is approximately one third lower than the "best estimate" in 1990. This is due primarily to lower emission scenarios (particularly for CO₂ and the CFCs), the inclusion of the cooling effect of sulphate aerosols, and improvements in the treatment of the carbon cycle. Combining the lowest IPCC emission scenario (IS92c) with a "low" value of climate sensitivity and including the effects of future changes in aerosol concentrations leads to a projected increase of about 1°C by 2100. The corresponding projection for the highest IPCC scenario (IS92e) combined with a "high" value of climate sensitivity gives a warming of about 3.5°C. In all cases the average rate of warming would probably be greater than any seen in the last 10,000 years, but the actual annual to decadal changes would include considerable natural variability. Regional temperature changes could differ substantially from the global mean value. Because of the thermal inertia of the oceans, only 50-90% of the eventual equilibrium temperature change would have been realised by 2100 and temperature would continue to increase beyond 2100, even if concentrations of greenhouse gases were stabilised by that time.

- Average sea level is expected to rise as a result of thermal expansion of the oceans and melting of glaciers and ice-sheets. For the IS92a scenario, assuming the "best estimate" values of climate sensitivity and of ice melt sensitivity to warming, and including the effects of future changes in aerosol, models project an increase in sea level of about 50 cm from the present to 2100. This estimate is approximately 25% lower than the "best estimate" in 1990 due to the lower temperature projection, but also reflecting improvements in the climate and ice melt models. Combining the lowest emission scenario (IS92c) with the "low" climate and ice melt sensitivities and including aerosol effects gives a projected sea level rise of about 15 cm from the present to 2100. The corresponding projection for the highest emission scenario (IS92e) combined with "high" climate and ice-melt sensitivities gives a sea level rise of about 95 cm from the present to 2100. Sea level would continue to rise at a similar rate in future centuries beyond 2100, even if concentrations of greenhouse gases were stabilised by that time, and would continue to do so even beyond the time of

stabilisation of global mean temperature. Regional sea level changes may differ from the global mean value owing to land movement and ocean current changes.

- Confidence is higher in the hemispheric-to-continental scale projections of coupled atmosphere-ocean climate models than in the regional projections, where confidence remains low. There is more confidence in temperature projections than hydrological changes.
- All model simulations, whether they were forced with increased concentrations of greenhouse gases and aerosols or with increased concentrations of greenhouse gases alone, show the following features: greater surface warming of the land than of the sea in winter; a maximum surface warming in high northern latitudes in winter, little surface warming over the Arctic in summer; an enhanced global mean hydrological cycle, and increased precipitation and soil moisture in high latitudes in winter. All these changes are associated with identifiable physical mechanisms.
- In addition, most simulations show a reduction in the strength of the north Atlantic thermohaline circulation and a widespread reduction in diurnal range of temperature. These features too can be explained in terms of identifiable physical mechanisms.
- The direct and indirect effects of anthropogenic aerosols have an important effect on the projections. Generally, the magnitudes of the temperature and precipitation changes are smaller when aerosol effects are represented, especially in northern mid-latitudes. Note that the cooling effect of aerosols is not a simple offset to the warming effect of greenhouse gases, but significantly affects some of the continental scale patterns of climate change, most noticeably in the summer hemisphere. For example, models that consider only the effects of greenhouse gases generally project an increase in precipitation and soil moisture in the Asian summer monsoon region, whereas models that include, in addition, some of the effects of aerosols suggest that monsoon precipitation may decrease. The spatial and temporal distribution of aerosols greatly influence regional projections, which are therefore more uncertain.

- A general warming is expected to lead to an increase in the occurrence of extremely hot days and a decrease in the occurrence of extremely cold days.
- Warmer temperatures will lead to a more vigorous hydrological cycle; this translates into prospects for more severe droughts and/or floods in some places and less severe droughts and/or floods in other places. Several models indicate an increase in precipitation intensity, suggesting a possibility for more extreme rainfall events. Knowledge is currently insufficient to say whether there will be any changes in the occurrence or geographical distribution of severe storms, e.g., tropical cyclones.
- Sustained rapid climate change could shift the competitive balance among species and even lead to forest dieback, altering the terrestrial uptake and release of carbon. The magnitude is uncertain, but could be between zero and 200 GtC over the next one to two centuries, depending on the rate of climate change.
- estimation of future emissions and biogeochemical cycling (including sources and sinks) of greenhouse gases, aerosols and aerosol precursors and projections of future concentrations and radiative properties;
- representation of climate processes in models, especially feedbacks associated with clouds, oceans, sea ice and vegetation, in order to improve projections of rates and regional patterns of climate change;
- systematic collection of long-term instrumental and proxy observations of climate system variables (e.g., solar output, atmospheric energy balance components, hydrological cycles, ocean characteristics and ecosystem changes) for the purposes of model testing, assessment of temporal and regional variability and for detection and attribution studies.

Future unexpected, large and rapid climate system changes (as have occurred in the past) are, by their nature, difficult to predict. This implies that future climate changes may also involve "surprises". In particular these arise from the non-linear nature of the climate system. When rapidly forced, non-linear systems are especially subject to unexpected behaviour. Progress can be made by investigating non-linear processes and sub-components of the climatic system. Examples of such non-linear behaviour include rapid circulation changes in the North Atlantic and feedbacks associated with terrestrial ecosystem changes.

There are still many uncertainties

Many factors currently limit our ability to project and detect future climate change. In particular, to reduce uncertainties further work is needed on the following priority topics:

Summary for Policymakers:

**Scientific-Technical Analyses of Impacts,
Adaptations, and Mitigation of Climate Change**

*A Report of Working Group II
of the Intergovernmental Panel on Climate Change*

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1. Scope of the Assessment

The charge to Working Group II of the Intergovernmental Panel on Climate Change (IPCC) was to review the state of knowledge concerning the impacts of climate change on physical and ecological systems, human health, and socioeconomic sectors. Working Group II also was charged with reviewing available information on the technical and economic feasibility of a range of potential adaptation and mitigation strategies. This assessment provides scientific, technical, and economic information that can be used, *inter alia*, in evaluating whether the projected range of plausible impacts constitutes "dangerous anthropogenic interference with the climate system," as referred to in Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC), and in evaluating adaptation and mitigation options that could be used in progressing towards the ultimate objective of the UNFCCC (see Box 1).

2. Nature of the Issue

Human activities are increasing the atmospheric concentrations of greenhouse gases—which tend to warm the atmosphere—and, in some regions, aerosols—which tend to cool the atmosphere. These changes in greenhouse gases and aerosols, taken together, are projected to lead to regional and global changes in climate and climate-related parameters such as temperature,

Box 1. Ultimate Objective of the UNFCCC (Article 2)

"...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."

precipitation, soil moisture, and sea level. Based on the range of sensitivities of climate to increases in greenhouse gas concentrations reported by IPCC Working Group I and plausible ranges of emissions (IPCC IS92; see Table 1), climate models, taking into account greenhouse gases and aerosols, project an increase in global mean surface temperature of about 1–3.5°C by 2100, and an associated increase in sea level of about 15–95 cm. The reliability of regional-scale predictions is still low, and the degree to which climate variability may change is uncertain. However, potentially serious changes have been identified, including an increase in some regions in the incidence of extreme high-temperature events, floods, and droughts, with resultant consequences for fires, pest outbreaks, and ecosystem composition, structure, and functioning, including primary productivity.

Table 1: Summary of assumptions in the six IPCC 1992 alternative scenarios.

Scenario	Population	Economic Growth	Energy Supplies
IS92a,b	World Bank 1991 11.3 billion by 2100	1990–2025: 2.9% 1990–2100: 2.3%	12,000 EJ conventional oil 13,000 EJ natural gas Solar costs fall to \$0.075/kWh 191 EJ of biofuels available at \$70/barrel ^a
IS92c	UN Medium-Low Case 6.4 billion by 2100	1990–2025: 2.0% 1990–2100: 1.2%	8,000 EJ conventional oil 7,300 EJ natural gas Nuclear costs decline by 0.4% annually
IS92d	UN Medium-Low Case 6.4 billion by 2100	1990–2025: 2.7% 1990–2100: 2.0%	Oil and gas same as IS92c Solar costs fall to \$0.065/kWh 272 EJ of biofuels available at \$50/barrel
IS92e	World Bank 1991 11.3 billion by 2100	1990–2025: 3.5% 1990–2100: 3.0%	18,400 EJ conventional oil Gas same as IS92a,b Phase out nuclear by 2075
IS92f	UN Medium-High Case 17.6 billion by 2100	1990–2025: 2.9% 1990–2100: 2.3%	Oil and gas same as IS92e Solar costs fall to \$0.083/kWh Nuclear costs increase to \$0.09/kWh

^aApproximate conversion factor: 1 barrel = 6 GJ.

Source: IPCC, 1992: Emissions scenarios for IPCC: an update. In: *Climate Change 1992: The Supplementary Report to the IPCC Scientific Assessment* [J.T. Houghton, B.A. Callander, and S.K. Varney (eds.)]. Section A3, prepared by J. Leggett, W.J. Pepper, and R.J. Swart, and WMO/UNEP. Cambridge University Press, Cambridge, UK. 200 pp.

Human health, terrestrial and aquatic ecological systems, and socioeconomic systems (e.g., agriculture, forestry, fisheries, and water resources) are all vital to human development and well-being and are all sensitive to changes in climate. Whereas many regions are likely to experience the adverse effects of climate change—some of which are potentially irreversible—some effects of climate change are likely to be beneficial. Hence, different segments of society can expect to confront a variety of changes and the need to adapt to them.

Policymakers are faced with responding to the risks posed by anthropogenic emissions of greenhouse gases in the face of significant scientific uncertainties. It is appropriate to consider these uncertainties in the context of information indicating that climate-induced environmental changes cannot be reversed quickly, if at all, due to the long time scales associated with the climate system (see Box 2). Decisions taken during the next few years may limit the range of possible policy options in the future because high near-term emissions would require deeper reductions in the future to meet any given target concentration. Delaying action might reduce the overall costs of mitigation because of potential technological advances but could increase both the rate and the eventual magnitude of climate change, hence the adaptation and damage costs.

Policymakers will have to decide to what degree they want to take precautionary measures by mitigating greenhouse gas emissions and enhancing the resilience of vulnerable systems by means of adaptation. Uncertainty does not mean that a nation or the world community cannot position itself better to cope with the broad range of possible climate changes or protect against potentially costly future outcomes. Delaying such measures may leave a nation or the world poorly prepared to deal with adverse changes and may increase the possibility of irreversible or very costly consequences.

Box 2. Time Scales of Processes Influencing the Climate System

- Turnover of the capital stock responsible for emissions of greenhouse gases: **Years to decades** (without premature retirement)
- Stabilization of atmospheric concentrations of long-lived greenhouse gases given a stable level of greenhouse gas emissions: **Decades to millennia**
- Equilibration of the climate system given a stable level of greenhouse gas concentrations: **Decades to centuries**
- Equilibration of sea level given a stable climate: **Centuries**
- Restoration/rehabilitation of damaged or disturbed ecological systems: **Decades to centuries** (some changes, such as species extinction, are irreversible, and it may be impossible to reconstruct and reestablish some disturbed ecosystems)

Options for adapting to change or mitigating change that can be justified for other reasons today (e.g., abatement of air and water pollution) and make society more flexible or resilient to anticipated adverse effects of climate change appear particularly desirable.

3. Vulnerability to Climate Change

Article 2 of the UNFCCC explicitly acknowledges the importance of natural ecosystems, food production, and sustainable economic development. This report addresses the potential *sensitivity*, *adaptability*, and *vulnerability* of ecological and socioeconomic systems—including hydrology and water resources management, human infrastructure, and human health—to changes in climate (see Box 3).

Human-induced climate change adds an important new stress. Human-induced climate change represents an important additional stress, particularly to the many ecological and socioeconomic systems already affected by pollution, increasing resource demands, and nonsustainable management practices. The most vulnerable systems are those with the greatest sensitivity to climate changes and the least adaptability.

Most systems are sensitive to climate change. Natural ecological systems, socioeconomic systems, and human health are all sensitive to both the magnitude and the rate of climate change.

Impacts are difficult to quantify, and existing studies are limited in scope. Although our knowledge has increased significantly during the last decade, and qualitative estimates can be developed, quantitative projections of the impacts of climate change on any particular system at any particular location are difficult because regional-scale climate change predictions are uncertain; our current understanding of many critical processes is limited; and systems are subject to multiple climatic and non-climatic stresses, the interactions of which are not always linear or additive. Most impact studies have assessed how systems would respond to climate change resulting from an arbitrary doubling of equivalent atmospheric carbon dioxide (CO₂) concentrations. Furthermore, very few studies have considered dynamic responses to steadily increasing concentrations of greenhouse gases; fewer still have examined the consequences of increases beyond a doubling of equivalent atmospheric CO₂ concentrations or assessed the implications of multiple stress factors.

Successful adaptation depends upon technological advances, institutional arrangements, availability of financing, and information exchange. Technological advances generally have increased adaptation options for managed systems such as agriculture and water supply. However, many regions of the world currently have limited access to these technologies and appropriate information. The efficacy and cost-effective use of adaptation strategies will depend upon the availability of financial resources, technology transfer, and cultural, educational,

Box 3. Sensitivity, Adaptability, and Vulnerability

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).

Adaptability refers to 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 changes in conditions.

Vulnerability defines the extent to which climate change may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions.

Both the magnitude and the rate of climate change are important in determining the sensitivity, adaptability, and vulnerability of a system.

managerial, institutional, legal, and regulatory practices, both domestic and international in scope. Incorporating climate-change concerns into resource-use and development decisions and plans for regularly scheduled investments in infrastructure will facilitate adaptation.

Vulnerability increases as adaptive capacity decreases. The vulnerability of human health and socioeconomic systems—and, to a lesser extent, ecological systems—depends upon economic circumstances and institutional infrastructure. This implies that systems typically are more vulnerable in developing countries where economic and institutional circumstances are less favorable. People who live on arid or semi-arid lands, in low-lying coastal areas, in water-limited or flood-prone areas, or on small islands are particularly vulnerable to climate change. Some regions have become more vulnerable to hazards such as storms, floods, and droughts as a result of increasing population density in sensitive areas such as river basins and coastal plains. Human activities, which fragment many landscapes, have increased the vulnerability of lightly managed and unmanaged ecosystems. Fragmentation limits natural adaptation potential and the potential effectiveness of measures to assist adaptation in these systems, such as the provision of migration corridors. A changing climate's near-term effects on ecological and socioeconomic systems most likely will result from changes in the intensity and seasonal and geographic distribution of common weather hazards such as storms, floods, and droughts. In most of these examples, vulnerability can be reduced by strengthening adaptive capacity.

Detection will be difficult, and unexpected changes cannot be ruled out. Unambiguous detection of climate-induced

changes in most ecological and social systems will prove extremely difficult in the coming decades. This is because of the complexity of these systems, their many non-linear feedbacks, and their sensitivity to a large number of climatic and non-climatic factors, all of which are expected to continue to change simultaneously. The development of a baseline projecting future conditions without climate change is crucial, for it is this baseline against which all projected impacts are measured. As future climate extends beyond the boundaries of empirical knowledge (i.e., the documented impacts of climate variation in the past), it becomes more likely that actual outcomes will include surprises and unanticipated rapid changes.

Further research and monitoring are essential. Enhanced support for research and monitoring, including cooperative efforts from national, international, and multi-lateral institutions, is essential in order to improve significantly regional-scale climate projections; understand the responses of human health, ecological, and socioeconomic systems to changes in climate and other stress factors; and improve our understanding of the efficacy and cost-effectiveness of adaptation strategies.

3.1. *Terrestrial and Aquatic Ecosystems*

Ecosystems contain the Earth's entire reservoir of genetic and species diversity and provide many goods and services critical to individuals and societies. These goods and services include (i) providing food, fiber, medicines, and energy; (ii) processing and storing carbon and other nutrients; (iii) assimilating wastes, purifying water, regulating water runoff, and controlling floods, soil degradation, and beach erosion; and (iv) providing opportunities for recreation and tourism. These systems and the functions they provide are sensitive to the rate and extent of changes in climate. Figure 1 illustrates that mean annual temperature and mean annual precipitation can be correlated with the distribution of the world's major biomes.

The composition and geographic distribution of many ecosystems will shift as individual species respond to changes in climate; there will likely be reductions in biological diversity and in the goods and services that ecosystems provide society. Some ecological systems may not reach a new equilibrium for several centuries after the climate achieves a new balance.

Forests. Models project that a sustained increase of 1°C in global mean temperature is sufficient to cause changes in regional climates that will affect the growth and regeneration capacity of forests in many regions. In several instances this will alter the function and composition of forests significantly. As a consequence of possible changes in temperature and water availability under doubled equivalent-CO₂ equilibrium conditions, a substantial fraction (a global average of one-third, varying by region from one-seventh to two-thirds) of the existing forested area of the world will undergo major changes in broad vegetation types—with the greatest changes occurring in high latitudes and the least in the tropics. Climate change is expected to occur at a rapid rate relative to the speed at which forest species grow,

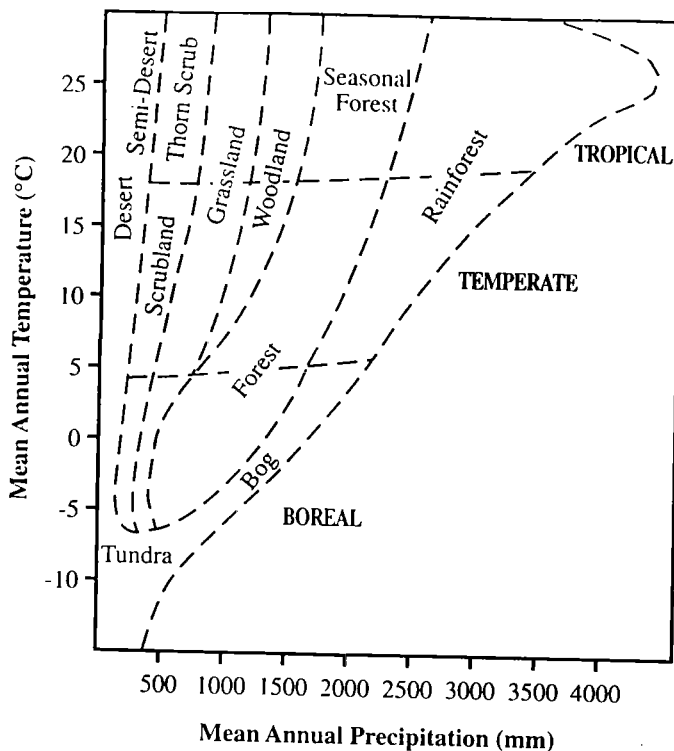


Figure 1: This figure illustrates that mean annual temperature and mean annual precipitation can be correlated with the distribution of the world's major biomes. While the role of these annual means in affecting this distribution is important, it should be noted that the distribution of biomes may also strongly depend on seasonal factors such as the length of the dry season or the lowest absolute minimum temperature, on soil properties such as water-holding capacity, on land-use history such as agriculture or grazing, and on disturbance regimes such as the frequency of fire.

reproduce, and reestablish themselves. For mid-latitude regions, a global average warming of 1–3.5°C over the next 100 years would be equivalent to a poleward shift of the present isotherms by approximately 150–550 km or an altitude shift of about 150–550 m; in low latitudes, temperatures would generally be increased to higher levels than now exist. This compares to past tree species migration rates that are believed to be on the order of 4–200 km per century. Therefore, the species composition of forests is likely to change; entire forest types may disappear, while new assemblages of species, hence new ecosystems, may be established. Figure 2 depicts potential distribution of biomes under current and a doubled equivalent- CO_2 climate. Although net primary productivity could increase, the standing biomass of forests may not because of more frequent outbreaks and extended ranges of pests and pathogens, and increasing frequency and intensity of fires. Large amounts of carbon could be released into the atmosphere during transitions from one forest type to another because the rate at which carbon can be lost during times of high forest mortality is greater than the rate at which it can be gained through growth to maturity.

Rangelands. In tropical rangelands, mean temperature increases should not lead to major alterations in productivity and

species composition, but altered rainfall amount and seasonality and increased evapotranspiration will. Increases in atmospheric CO_2 concentration may raise the carbon-to-nitrogen ratio of forage for herbivores, thus reducing its food value. Shifts in temperature and precipitation in temperate rangelands may result in altered growing seasons and boundary shifts between grasslands, forests, and shrublands.

Deserts and Desertification. Deserts are likely to become more extreme—in that, with few exceptions, they are projected to become hotter but not significantly wetter. Temperature increases could be a threat to organisms that exist near their heat-tolerance limits. The impacts on water balance, hydrology, and vegetation are uncertain. Desertification, as defined by the UN Convention to Combat Desertification, is land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Desertification is more likely to become irreversible if the environment becomes drier and the soil becomes further degraded through erosion and compaction. Adaptation to drought and desertification may rely on the development of diversified production systems.

Cryosphere. Models project that between one-third and one-half of existing mountain glacier mass could disappear over the next 100 years. The reduced extent of glaciers and depth of snow cover also would affect the seasonal distribution of river flow and water supply for hydroelectric generation and agriculture. Anticipated hydrological changes and reductions in the areal extent and depth of permafrost could lead to large-scale damage to infrastructure, an additional flux of CO_2 into the atmosphere, and changes in processes that contribute to the flux of methane (CH_4) into the atmosphere. Reduced sea-ice extent and thickness would increase the seasonal duration of navigation on rivers and in coastal areas that are presently affected by seasonal ice cover, and may increase navigability in the Arctic Ocean. Little change in the extent of the Greenland and Antarctic ice sheets is expected over the next 50–100 years.

Mountain Regions. The projected decrease in the extent of mountain glaciers, permafrost, and snow cover caused by a warmer climate will affect hydrologic systems, soil stability, and related socioeconomic systems. The altitudinal distribution of vegetation is projected to shift to higher elevation; some species with climatic ranges limited to mountain tops could become extinct because of disappearance of habitat or reduced migration potential. Mountain resources such as food and fuel for indigenous populations may be disrupted in many developing countries. Recreational industries—of increasing economic importance to many regions—also are likely to be disrupted.

Lakes, Streams, and Wetlands. Inland aquatic ecosystems will be influenced by climate change through altered water temperatures, flow regimes, and water levels. In lakes and streams, warming would have the greatest biological effects at high latitudes, where biological productivity would increase, and at the low-latitude boundaries of cold- and cool-water species ranges, where extinctions would be greatest. Warming

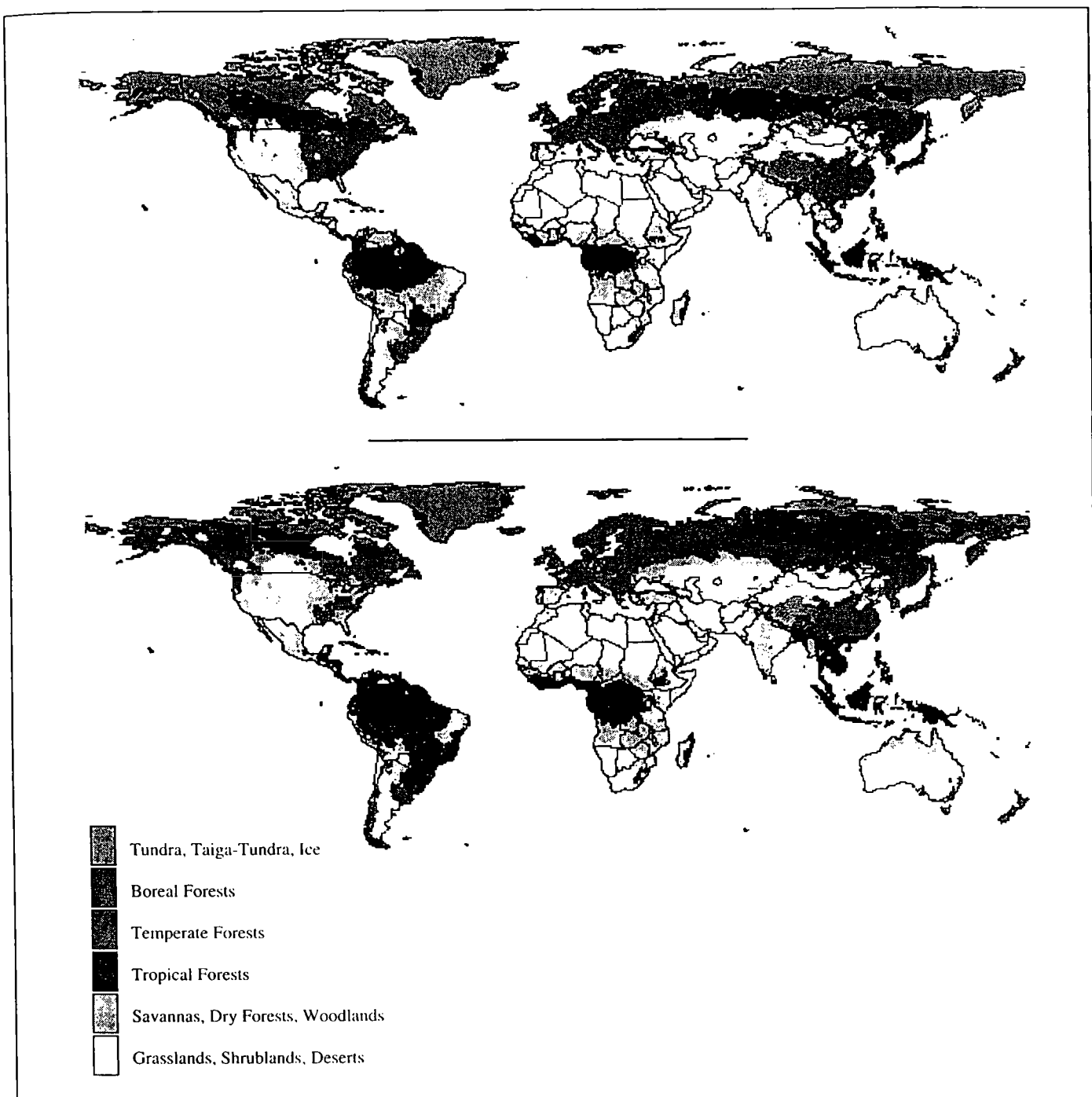


Figure 2: Potential distribution of the major world biomes under current climate conditions, simulated by Mapped Atmosphere-Plant-Soil System (MAPSS) model (top). "Potential distribution" indicates the natural vegetation that can be supported at each site, given monthly inputs of precipitation, temperature, humidity, and windspeed. The lower product illustrates the projected distribution of the major world biomes by simulating the effects of 2 x CO₂-equivalent concentrations (GFDL general circulation model), including the direct physiological effects of CO₂ on vegetation. Both products are adapted from: Neilson, R.P. and D. Marks, 1994: A global perspective of regional vegetation and hydrologic sensitivities from climatic change. *Journal of Vegetation Science*, 5, 715-730.

of larger and deeper temperate zone lakes would increase their productivity; although in some shallow lakes and in streams, warming could increase the likelihood of anoxic conditions. Increases in flow variability, particularly the frequency and duration of large floods and droughts, would tend to reduce water quality and biological productivity and habitat in streams. Water-level declines will be most severe in lakes and streams in dry evaporative drainages and in basins with small catchments. The geographical distribution of wetlands is likely to shift with changes in temperature and precipitation. There will be an impact of climate change on greenhouse gas release from non-tidal wetlands, but there is uncertainty regarding the exact effects from site to site.

Coastal Systems. Coastal systems are economically and ecologically important and are expected to vary widely in their response to changes in climate and sea level. Climate change and a rise in sea level or changes in storms or storm surges could result in the erosion of shores and associated habitat, increased salinity of estuaries and freshwater aquifers, altered tidal ranges in rivers and bays, changes in sediment and nutrient transport, a change in the pattern of chemical and microbiological contamination in coastal areas, and increased coastal flooding. Some coastal ecosystems are particularly at risk, including saltwater marshes, mangrove ecosystems, coastal wetlands, coral reefs, coral atolls, and river deltas. Changes in these ecosystems would have major negative effects on tourism, freshwater supplies, fisheries, and biodiversity. Such impacts would add to modifications in the functioning of coastal oceans and inland waters that already have resulted from pollution, physical modification, and material inputs due to human activities.

Oceans. Climate change will lead to changes in sea level, increasing it on average, and also could lead to altered ocean circulation, vertical mixing, wave climate, and reductions in sea-ice cover. As a result, nutrient availability, biological productivity, the structure and functions of marine ecosystems, and heat and carbon storage capacity may be affected, with important feedbacks to the climate system. These changes would have implications for coastal regions, fisheries, tourism and recreation, transport, off-shore structures, and communication. Paleoclimatic data and model experiments suggest that abrupt climatic changes can occur if freshwater influx from the movement and melting of sea ice or ice sheets significantly weakens global thermohaline circulation.

3.2. *Hydrology and Water Resources Management*

Climate change will lead to an intensification of the global hydrological cycle and can have major impacts on regional water resources. A change in the volume and distribution of water will affect both ground and surface water supply for domestic and industrial uses, irrigation, hydropower generation, navigation, instream ecosystems, and water-based recreation.

Changes in the total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing

of runoff and the intensity of floods and droughts; however, at present, specific regional effects are uncertain. Relatively small changes in temperature and precipitation, together with the non-linear effects on evapotranspiration and soil moisture, can result in relatively large changes in runoff, especially in arid and semi-arid regions. High-latitude regions may experience increased runoff due to increased precipitation, whereas runoff may decrease at lower latitudes due to the combined effects of increased evapotranspiration and decreased precipitation. More intense rainfall would tend to increase runoff and the risk of flooding, although this would depend not only on the change in rainfall but also on catchment physical and biological characteristics. A warmer climate could decrease the proportion of precipitation falling as snow, leading to reductions in spring runoff and increases in winter runoff.

The quantity and quality of water supplies already are serious problems today in many regions, including some low-lying coastal areas, deltas, and small islands, making countries in these regions particularly vulnerable to any additional reduction in indigenous water supplies. Water availability currently falls below 1,000 m³ per person per year—a common benchmark for water scarcity—in a number of countries (e.g., Kuwait, Jordan, Israel, Rwanda, Somalia, Algeria, Kenya) or is expected to fall below this benchmark in the next 2 to 3 decades (e.g., Libya, Egypt, South Africa, Iran, Ethiopia). In addition, a number of countries in conflict-prone areas are highly dependent on water originating outside their borders (e.g., Cambodia, Syria, Sudan, Egypt, Iraq).

The impacts of climate change will depend on the baseline condition of the water supply system and the ability of water resource managers to respond not only to climate change but also to population growth and changes in demands, technology, and economic, social, and legislative conditions. In some cases—particularly in wealthier countries with integrated water-management systems—improved management may protect water users from climate change at minimal cost; in many others, however, there could be substantial economic, social, and environmental costs, particularly in regions that already are water-limited and where there is a considerable competition among users. Experts disagree over whether water supply systems will evolve substantially enough in the future to compensate for the anticipated negative impacts of climate change on water resources and for potential increases in demand.

Options for dealing with the possible impacts of a changed climate and increased uncertainty about future supply and demand for freshwater include more efficient management of existing supplies and infrastructure; institutional arrangements to limit future demands/promote conservation; improved monitoring and forecasting systems for floods/droughts; rehabilitation of watersheds, especially in the tropics; and construction of new reservoir capacity to capture and store excess flows produced by altered patterns of snowmelt and storms.

3.3. Food and Fiber

Agriculture. Crop yields and changes in productivity due to climate change will vary considerably across regions and among localities, thus changing the patterns of production. Productivity is projected to increase in some areas and decrease in others, especially the tropics and subtropics (Table 2). However, existing studies show that on the whole global agricultural production could be maintained relative to baseline production in the face of climate change modeled by general circulation models (GCMs) at doubled equivalent- CO_2 equilibrium conditions, but that regional effects would vary widely. This conclusion takes into account the beneficial effects of CO_2 fertilization, but does not allow for changes in agricultural pests and the possible effects of changing climatic variability.

Focusing on global agricultural production does not address the potentially serious consequences of large differences at local and regional scales, even at mid-latitudes. There may be increased risk of hunger and famine in some locations; many of the world's poorest people—particularly those living in subtropical and tropical areas, and dependent on isolated agricultural systems in semi-arid and arid regions—are most at risk of increased hunger. Many of these at-risk populations are found in sub-Saharan Africa; south, east, and southeast Asia; and tropical areas of Latin America, as well as some Pacific island nations.

Adaptation—such as changes in crops and crop varieties, improved water-management and irrigation systems, and changes in planting schedules and tillage practices—will be important in limiting negative effects and taking advantage of beneficial changes in climate. The extent of adaptation depends on the affordability of such measures, particularly in developing countries; access to know-how and technology; the rate of climate change; and biophysical constraints such as water availability, soil characteristics, and crop genetics. The incremental costs of adaptation strategies could create a serious burden for developing countries; some adaptation strategies may result in cost savings for some countries. There are significant uncertainties about the capacity of different regions to adapt successfully to projected climate change.

Livestock production may be affected by changes in grain prices and rangeland and pasture productivity. In general, analyses indicate that intensively managed livestock systems have more potential for adaptation than crop systems. This may not be the case in pastoral systems, where the rate of technology adoption is slow and changes in technology are viewed as risky.

Forest Products. Global wood supplies during the next century may become increasingly inadequate to meet projected consumption due to both climatic and non-climatic factors. Boreal forests are likely to undergo irregular and large-scale losses of living trees because of the impacts of projected climate change. Such losses could initially generate additional wood supply from salvage harvests, but could severely reduce standing stocks and wood-product availability over the long

term. The exact timing and extent of this pattern is uncertain. Climate and land-use impacts on the production of temperate forest products are expected to be relatively small. In tropical regions, the availability of forest products is projected to decline by about half for non-climatic reasons related to human activities.

Fisheries. Climate-change effects interact with those of pervasive overfishing, diminishing nursery areas, and extensive inshore and coastal pollution. Globally, marine fisheries production is expected to remain about the same; high-latitude freshwater and aquaculture production are likely to increase, assuming that natural climate variability and the structure and strength of ocean currents remain about the same. The principal impacts will be felt at the national and local levels as species mix and centers of production shift. The positive effects of climate change—such as longer growing seasons, lower natural winter mortality, and faster growth rates in higher latitudes—may be offset by negative factors such as changes in established reproductive patterns, migration routes, and ecosystem relationships.

3.4. Human Infrastructure

Climate change and resulting sea-level rise can have a number of negative impacts on energy, industry, and transportation infrastructure; human settlements; the property insurance industry; tourism; and cultural systems and values.

In general, the sensitivity of the energy, industry, and transportation sectors is relatively low compared to that of agricultural or natural ecosystems, and the capacity for adaptation through management and normal replacement of capital is expected to be high. However, infrastructure and activities in these sectors would be susceptible to sudden changes, surprises, and increased frequency or intensity of extreme events. The subsectors and activities most sensitive to climate change include agroindustry, energy demand, production of renewable energy such as hydroelectricity and biomass, construction, some transportation activities, existing flood mitigation structures, and transportation infrastructure located in many areas, including vulnerable coastal zones and permafrost regions.

Climate change clearly will increase the vulnerability of some coastal populations to flooding and erosional land loss. Estimates put about 46 million people per year currently at risk of flooding due to storm surges. This estimate results from multiplying the total number of people currently living in areas potentially affected by ocean flooding by the probability of flooding at these locations in any year, given the present protection levels and population density. In the absence of adaptation measures, a 50-cm sea-level rise would increase this number to about 92 million; a 1-m sea-level rise would raise it to 118 million. If one incorporates anticipated population growth, the estimates increase substantially. Some small island nations and other countries will confront greater vulnerability because their existing sea and

Table 2: Selected crop study results for 2 x CO₂-equivalent equilibrium GCM scenarios.

Region	Crop	Yield Impact (%)	Comments
Latin America	Maize	-61 to increase	Data are from Argentina, Brazil, Chile, and Mexico; range is across GCM scenarios, with and without CO ₂ effect.
	Wheat	-50 to -5	Data are from Argentina, Uruguay, and Brazil; range is across GCM scenarios, with and without CO ₂ effect.
	Soybean	-10 to +40	Data are from Brazil; range is across GCM scenarios, with CO ₂ effect.
Former Soviet Union	Wheat Grain	-19 to +41 -14 to +13	Range is across GCM scenarios and region, with CO ₂ effect.
Europe	Maize	-30 to increase	Data are from France, Spain, and northern Europe; with adaptation and CO ₂ effect; assumes longer season, irrigation efficiency loss, and northward shift.
	Wheat	increase or decrease	Data are from France, UK, and northern Europe; with adaptation and CO ₂ effect; assumes longer season, northward shift, increased pest damage, and lower risk of crop failure.
	Vegetables	increase	Data are from UK and northern Europe; assumes pest damage increased and lower risk of crop failure.
North America	Maize	-55 to +62	Data are from USA and Canada; range is across GCM scenarios and sites, with/without adaptation and with/without CO ₂ effect.
	Wheat	-100 to +234	
	Soybean	-96 to +58	Data are from USA; less severe or increase with CO ₂ and adaptation.
Africa	Maize	-65 to +6	Data are from Egypt, Kenya, South Africa, and Zimbabwe; range is over studies and climate scenarios, with CO ₂ effect.
	Millet	-79 to -63	Data are from Senegal; carrying capacity fell 11–38%.
	Biomass	decrease	Data are from South Africa; agrozone shifts.
South Asia	Rice	-22 to +28	Data are from Bangladesh, India, Philippines, Thailand, Indonesia, Malaysia, and Myanmar; range is over GCM scenarios, with CO ₂ effect; some studies also consider adaptation.
	Maize	-65 to -10	
	Wheat	-61 to +67	
China	Rice	-78 to +28	Includes rainfed and irrigated rice; range is across sites and GCM scenarios; genetic variation provides scope for adaptation.
Other Asia and Pacific Rim	Rice	-45 to +30	Data are from Japan and South Korea; range is across GCM scenarios; generally positive in north Japan, and negative in south.
	Pasture	-1 to +35	Data are from Australia and New Zealand; regional variation.
	Wheat	-41 to +65	Data are from Australia and Japan; wide variation, depending on cultivar.

Note: For most regions, studies have focused on one or two principal grains. These studies strongly demonstrate the variability in estimated yield impacts among countries, scenarios, methods of analysis, and crops, making it difficult to generalize results across areas or for different climate scenarios.

coastal defense systems are less well-established. Countries with higher population densities would be more vulnerable. For these countries, sea-level rise could force internal or international migration of populations.

A number of studies have evaluated sensitivity to a 1-m sea-level rise. This increase is at the top of the range of IPCC Working Group I estimates for 2100; it should be noted, however, that sea level is actually projected to continue to rise beyond 2100. Studies using this 1-m projection show a particular risk for small islands and deltas. Estimated land losses range from 0.05% for Uruguay, 1% for Egypt, 6% for the Netherlands, and 17.5% for Bangladesh to about 80% for the Majuro Atoll in the Marshall Islands, given the present state of protection systems. Large numbers of people also are affected—for example, about 70 million each in China and Bangladesh. Many nations face lost capital value in excess of 10% of their gross domestic product (GDP). Although annual protection costs for many nations are relatively modest (about 0.1% of GDP), the average annual costs to many small island states total several percent of GDP. For some island nations, the high cost of providing storm-surge protection would make it essentially infeasible, especially given the limited availability of capital for investment.

The most vulnerable human settlements are located in damage-prone areas of the developing world that do not have the resources to cope with impacts. Effective coastal-zone management and land-use regulation can help direct population shifts away from vulnerable locations such as flood plains, steep hillsides, and low-lying coastlines. One of the potentially unique and destructive effects on human settlements is forced internal or international migration of populations. Programs of disaster assistance can offset some of the more serious negative consequences of climate change and reduce the number of ecological refugees.

Property insurance is vulnerable to extreme climate events. A higher risk of extreme events due to climate change could lead to higher insurance premiums or the withdrawal of coverage for property in some vulnerable areas. Changes in climate variability and the risk for extreme events may be difficult to detect or predict, thus making it difficult for insurance companies to adjust premiums appropriately. If such difficulty leads to insolvency, companies may not be able to honor insurance contracts, which

could economically weaken other sectors, such as banking. The insurance industry currently is under stress from a series of “billion dollar” storms since 1987, resulting in dramatic increases in losses, reduced availability of insurance, and higher costs. Some in the insurance industry perceive a current trend toward increased frequency and severity of extreme climate events. Examination of the meteorological data fails to support this perception in the context of a long-term change, although a shift within the limits of natural variability may have occurred. Higher losses strongly reflect increases in infrastructure and economic worth in vulnerable areas as well as a possible shift in the intensity and frequency of extreme weather events.

3.5. Human Health

Climate change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life. These impacts would arise by both direct and indirect pathways (Figure 3), and it is likely that the indirect impacts would, in the longer term, predominate.

Direct health effects include increases in (predominantly cardiorespiratory) mortality and illness due to an anticipated increase

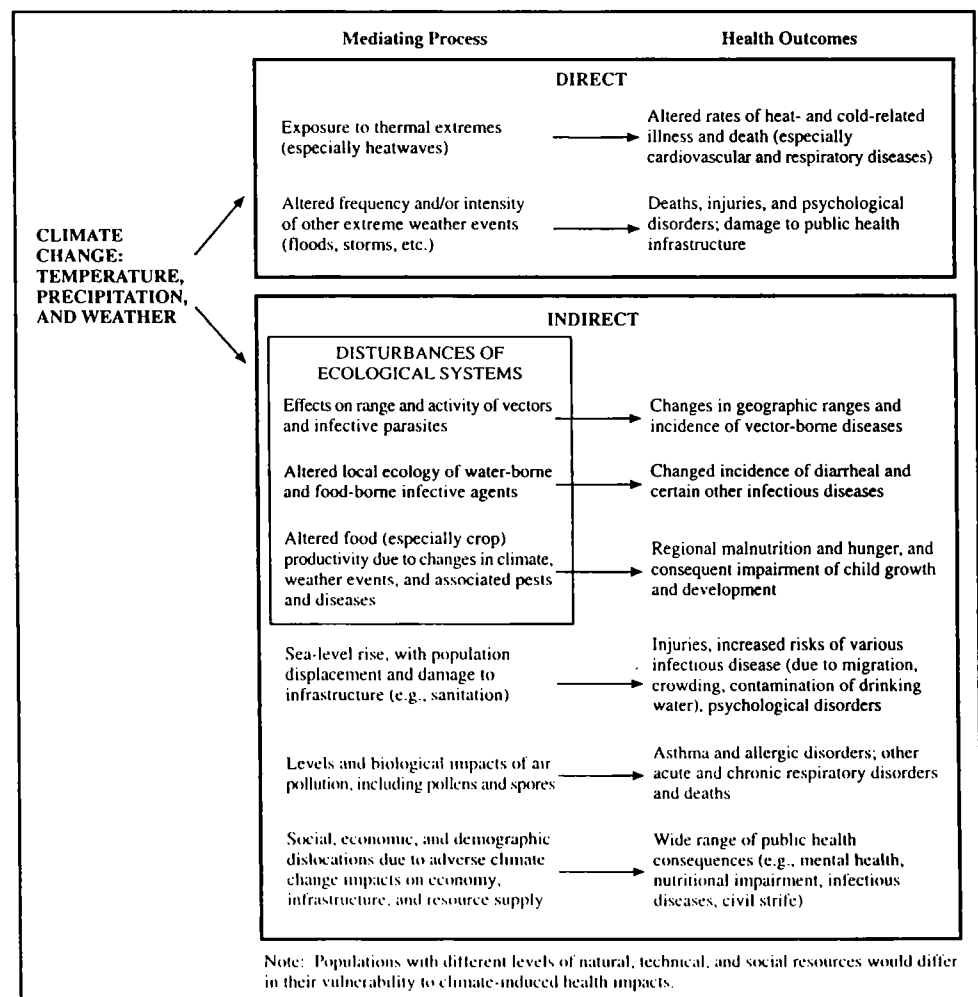


Figure 3: Ways in which climate change can affect human health.

in the intensity and duration of heat waves. Temperature increases in colder regions should result in fewer cold-related deaths. An increase in extreme weather would cause a higher incidence of death, injury, psychological disorders, and exposure to contaminated water supplies.

Indirect effects of climate change include increases in the potential transmission of vector-borne infectious diseases (e.g., malaria, dengue, yellow fever, and some viral encephalitis) resulting from extensions of the geographical range and season for vector organisms. Projections by models (that entail necessary simplifying assumptions) indicate that the geographical zone of potential malaria transmission in response to world temperature increases at the upper part of the IPCC-projected range (3–5°C by 2100) would increase from approximately 45% of the world population to approximately 60% by the latter half of the next century. This could lead to potential increases in malaria incidence (on the order of 50–80 million additional annual cases, relative to an assumed global background total of 500 million cases), primarily in tropical, subtropical, and less well-protected temperate-zone populations. Some increases in non-vector-borne infectious diseases—such as salmonellosis, cholera, and giardiasis—also could occur as a result of elevated temperatures and increased flooding.

Additional indirect effects include respiratory and allergic disorders due to climate-enhanced increases in some air pollutants, pollens, and mold spores. Exposure to air pollution and stressful weather events combine to increase the likelihood of morbidity and mortality. Some regions could experience a decline in nutritional status as a result of adverse impacts on food and fisheries productivity. Limitations on freshwater supplies also will have human health consequences.

Quantifying the projected impacts is difficult because the extent of climate-induced health disorders depends on numerous coexistent and interacting factors that characterize the vulnerability of the particular population, including environmental and socioeconomic circumstances, nutritional and immune status, population density, and access to quality health care services. Adaptive options to reduce health impacts include protective technology (e.g., housing, air conditioning, water purification, and vaccination), disaster preparedness, and appropriate health care.

4. Options to Reduce Emissions and Enhance Sinks of Greenhouse Gases

Human activities are directly increasing the atmospheric concentrations of several greenhouse gases, especially CO₂, CH₄, halocarbons, sulfur hexafluoride (SF₆), and nitrous oxide (N₂O). CO₂ is the most important of these gases, followed by CH₄. Human activities also indirectly affect concentrations of water vapor and ozone. Significant reductions in net greenhouse gas emissions are technically possible and can be economically feasible. These reductions can be achieved by utilizing an extensive array of technologies, and policy measures

that accelerate technology development, diffusion, and transfer in all sectors including the energy, industry, transportation, residential/commercial, and agricultural/forestry sectors. By the year 2100, the world's commercial energy system in effect will be replaced at least twice, offering opportunities to change the energy system without premature retirement of capital stock; significant amounts of capital stock in the industrial, commercial, residential, and agricultural/forestry sectors will also be replaced. These cycles of capital replacement provide opportunities to use new, better performing technologies. It should be noted that the analyses of Working Group II do not attempt to quantify potential macroeconomic consequences that may be associated with mitigation measures. Discussion of macroeconomic analyses is found in the IPCC Working Group III contribution to the Second Assessment Report. The degree to which technical potential and cost-effectiveness are realized is dependent on initiatives to counter lack of information and overcome cultural, institutional, legal, financial and economic barriers that can hinder diffusion of technology or behavioral changes. The pursuit of mitigation options can be carried out within the limits of sustainable development criteria. Social and environmental criteria not related to greenhouse gas emissions abatement could, however, restrict the ultimate potential of each of the options.

4.1. Energy, Industrial Process, and Human Settlement Emissions

Global energy demand has grown at an average annual rate of approximately 2% for almost 2 centuries, although energy demand growth varies considerably over time and between different regions. In the published literature, different methods and conventions are used to characterize energy consumption. These conventions differ, for example, according to their definition of sectors and their treatment of energy forms. Based on aggregated national energy balances, 385 EJ of primary energy was consumed in the world in 1990, resulting in the release of 6 Gt C as CO₂. Of this, 279 EJ was delivered to end users, accounting for 3.7 Gt C emissions as CO₂ at the point of consumption. The remaining 106 EJ was used in energy conversion and distribution, accounting for 2.3 Gt C emissions as CO₂. In 1990, the three largest sectors of energy consumption were industry (45% of total CO₂ releases), residential/commercial sector (29%), and transport (21%). Of these, transport sector energy use and related CO₂ emissions have been the most rapidly growing over the past 2 decades. For the detailed sectoral mitigation option assessment in this report, 1990 energy consumption estimates are based on a range of literature sources; a variety of conventions are used to define these sectors and their energy use, which is estimated to amount to a total of 259–282 EJ.

Figure 4 depicts total energy-related emissions by major world region. Organisation for Economic Cooperation and Development (OECD) nations have been and remain major energy users and fossil fuel CO₂ emitters, although their share of global fossil fuel carbon emissions has been declining.

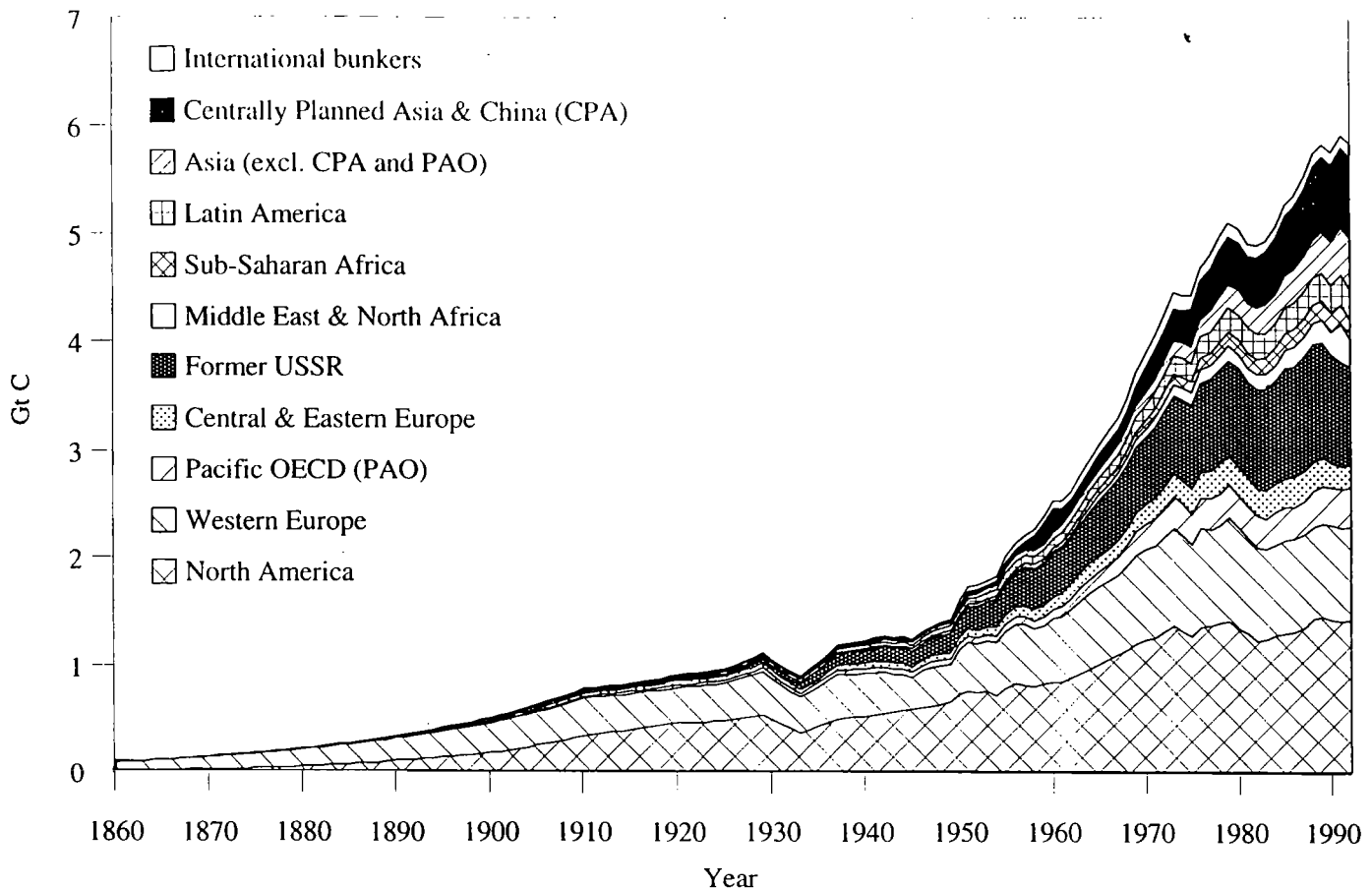


Figure 4: Global energy-related CO₂ emissions by major world region in Gt C/yr. Sources: Keeling, 1994; Marland *et al.*, 1994; Grubler and Nakicenovic, 1992; Etemad and Luciani, 1991; Fujii, 1990; UN, 1952 (see the Energy Primer for reference information).

Developing nations, taken as a group, still account for a smaller portion of total global CO₂ emissions than industrialized nations—OECD and former Soviet Union/Eastern Europe (FSU/EE)—but most projections indicate that with forecast rates of economic and population growth, the future share of developing countries will increase. Future energy demand is anticipated to continue to grow, at least through the first half of the next century. The IPCC (1992, 1994) projects that without policy intervention, there could be significant growth in emissions from the industrial, transportation, and commercial/residential buildings sectors:

4.1.1. Energy Demand

Numerous studies have indicated that 10–30% energy-efficiency gains above present levels are feasible at little or no net cost in many parts of the world through technical conservation measures and improved management practices over the next 2 to 3 decades. Using technologies that presently yield the highest output of energy services for a given input of energy, efficiency gains of 50–60% would be technically feasible in many countries over the same time period. Achieving these potentials will depend on future cost reductions, financing, and technology

transfer, as well as measures to overcome a variety of non-technical barriers. The potential for greenhouse gas emission reductions exceeds the potential for energy use efficiency because of the possibility of switching fuels and energy sources. Because energy use is growing world-wide, even replacing current technology with more efficient technology could still lead to an absolute increase in CO₂ emissions in the future.

In 1992, the IPCC produced six scenarios (IS92a-f) of future energy use and associated greenhouse gas emissions (IPCC, 1992, 1995). These scenarios provide a wide range of possible future greenhouse gas emission levels, without mitigation measures.

In the Second Assessment Report, future energy use has been reexamined on a more detailed sectoral basis, both with and without new mitigation measures, based on existing studies. Despite different assessment approaches, the resulting ranges of energy consumption increases to 2025 without new measures are broadly consistent with those of IS92. If past trends continue, greenhouse gas emissions will grow more slowly than energy use, except in the transport sector.

The following paragraphs summarize energy-efficiency improvement potentials estimated in the IPCC Second

Assessment Report. Strong policy measures would be required to achieve these potentials. Energy-related greenhouse gas emission reductions depend on the source of the energy, but reductions in energy use will in general lead to reduced greenhouse gas emissions.

Industry. Energy use in 1990 was estimated to be 98–117 EJ, and is projected to grow to 140–242 EJ in 2025 without new measures. Countries differ widely in their current industrial energy use and energy-related greenhouse gas emission trends. Industrial sector energy-related greenhouse gas emissions in most industrialized countries are expected to be stable or decreasing as a result of industrial restructuring and technological innovation, whereas industrial emissions in developing countries are projected to increase mainly as a result of industrial growth. The short-term potential for energy-efficiency improvements in the manufacturing sector of major industrial countries is estimated to be 25%. The potential for greenhouse gas emission reductions is larger. Technologies and measures for reducing energy-related emissions from this sector include improving efficiency (e.g., energy and materials savings, cogeneration, energy cascading, steam recovery, and use of more efficient motors and other electrical devices); recycling materials and switching to those with lower greenhouse gas emissions; and developing processes that use less energy and materials.

Transportation. Energy use in 1990 was estimated to be 61–65 EJ, and is projected to grow to 90–140 EJ in 2025 without new measures. Projected energy use in 2025 could be reduced by about a third to 60–100 EJ through vehicles using very efficient drive-trains, lightweight construction, and low air-resistance design, without compromising comfort and performance. Further energy-use reductions are possible through the use of smaller vehicles; altered land-use patterns, transport systems, mobility patterns, and lifestyles; and shifting to less energy-intensive transport modes. Greenhouse gas emissions per unit of energy used could be reduced through the use of alternative fuels and electricity from renewable sources. These measures, taken together, provide the opportunity for reducing global transport energy-related greenhouse gas emissions by as much as 40% of projected emissions by 2025. Actions to reduce energy-related greenhouse gas emissions from transport can simultaneously address other problems such as local air pollution.

Commercial/Residential Sector. Energy use in 1990 was estimated to be about 100 EJ, and is projected to grow to 165–205 EJ in 2025 without new measures. Projected energy use could be reduced by about a quarter to 126–170 EJ by 2025 without diminishing services through the use of energy efficient technology. The potential for greenhouse gas emission reductions is larger. Technical changes might include reduced heat transfers through building structures and more efficient space-conditioning and water supply systems, lighting, and appliances. Ambient temperatures in urban areas can be reduced through increased vegetation and greater reflectivity of building surfaces, reducing the energy required for space conditioning. Energy-related greenhouse gas emission reductions beyond

those obtained through reduced energy use could be achieved through changes in energy sources.

4.1.2. *Mitigating Industrial Process and Human Settlement Emissions*

Process-related greenhouse gases including CO₂, CH₄, N₂O, halocarbons, and SF₆ are released during manufacturing and industrial processes, such as the production of iron, steel, aluminum, ammonia, cement, and other materials. Large reductions are possible in some cases. Measures include modifying production processes, eliminating solvents, replacing feedstocks, materials substitution, increased recycling, and reduced consumption of greenhouse gas-intensive materials. Capturing and utilizing CH₄ from landfills and sewage treatment facilities and lowering the leakage rate of halocarbon refrigerants from mobile and stationary sources also can lead to significant greenhouse gas emission reductions.

4.1.3. *Energy Supply*

This assessment focuses on new technologies for capital investment and not on potential retrofitting of existing capital stock to use less carbon-intensive forms of primary energy. It is technically possible to realize deep emissions reductions in the energy supply sector in step with the normal timing of investments to replace infrastructure and equipment as it wears out or becomes obsolete. Many options for achieving these deep reductions will also decrease the emissions of sulfur dioxide, nitrogen oxides, and volatile organic compounds. Promising approaches, not ordered according to priority, are described below.

4.1.3.1. *Greenhouse gas reductions in the use of fossil fuels*

More Efficient Conversion of Fossil Fuels. New technology offers considerably increased conversion efficiencies. For example, the efficiency of power production can be increased from the present world average of about 30% to more than 60% in the longer term. Also, the use of combined heat and power production replacing separate production of power and heat—whether for process heat or space heating—offers a significant rise in fuel conversion efficiency.

Switching to Low-Carbon Fossil Fuels and Suppressing Emissions. Switching from coal to oil or natural gas, and from oil to natural gas, can reduce emissions. Natural gas has the lowest CO₂ emissions per unit of energy of all fossil fuels at about 14 kg C/GJ, compared to oil with about 20 kg C/GJ and coal with about 25 kg C/GJ. The lower carbon-containing fuels can, in general, be converted with higher efficiency than coal. Large resources of natural gas exist in many areas. New, low capital cost, highly efficient combined-cycle technology has reduced electricity costs considerably in some areas. Natural gas could potentially replace oil in the transportation sector.

Approaches exist to reduce emissions of CH₄ from natural gas pipelines and emissions of CH₄ and/or CO₂ from oil and gas wells and coal mines.

Decarbonization of Flue Gases and Fuels, and CO₂ Storage.

The removal and storage of CO₂ from fossil fuel power-station stack gases is feasible, but reduces the conversion efficiency and significantly increases the production cost of electricity. Another approach to decarbonization uses fossil fuel feedstocks to make hydrogen-rich fuels. Both approaches generate a byproduct stream of CO₂ that could be stored, for example, in depleted natural gas fields. The future availability of conversion technologies such as fuel cells that can efficiently use hydrogen would increase the relative attractiveness of the latter approach. For some longer term CO₂ storage options, the costs, environmental effects, and efficacy of such options remain largely unknown.

4.1.3.2. Switching to non-fossil fuel sources of energy

Switching to Nuclear Energy. Nuclear energy could replace baseload fossil fuel electricity generation in many parts of the world if generally acceptable responses can be found to concerns such as reactor safety, radioactive-waste transport and disposal, and nuclear proliferation.

Switching to Renewable Sources of Energy. Solar, biomass, wind, hydro, and geothermal technologies already are widely used. In 1990, renewable sources of energy contributed about 20% of the world's primary energy consumption, most of it fuelwood and hydropower. Technological advances offer new opportunities and declining costs for energy from these sources. In the longer term, renewable sources of energy could meet a major part of the world's demand for energy. Power systems can easily accommodate limited fractions of intermittent generation, and with the addition of fast-responding backup and storage units, also higher fractions. Where biomass is sustainably regrown and used to displace fossil fuels in energy production, net carbon emissions are avoided as the CO₂ released in converting the biomass to energy is again fixed in biomass through photosynthesis. If the development of biomass energy can be carried out in ways that effectively address concerns about other environmental issues and competition with other land uses, biomass could make major contributions in both the electricity and fuels markets, as well as offering prospects of increasing rural employment and income.

4.1.4. Integration of Energy System Mitigation Options

To assess the potential impact of combinations of individual measures at the energy system level, in contrast to the level of individual technologies, variants of a Low CO₂-Emitting Energy Supply System (LESS) are described. The LESS constructions are "thought experiments" exploring possible global energy systems.

The following assumptions were made: World population grows from 5.3 billion in 1990 to 9.5 billion by 2050 and 10.5

billion by 2100. GDP grows 7-fold by 2050 (5-fold and 14-fold in industrialized and developing countries, respectively) and 25-fold by 2100 (13-fold and 70-fold in industrialized and developing countries, respectively), relative to 1990. Because of emphasis on energy efficiency, primary energy consumption rises much more slowly than GDP. The energy supply constructions were made to meet energy demand in (i) projections developed for the IPCC's First Assessment Report (1990) in a low energy demand variant, where global primary commercial energy use approximately doubles, with no net change for industrialized countries but a 4.4-fold increase for developing countries from 1990 to 2100; and (ii) a higher energy demand variant, developed in the IPCC IS92a scenario where energy demand quadruples from 1990 to 2100. The energy demand levels of the LESS constructions are consistent with the energy demand mitigation chapters of this Second Assessment Report.

Figure 5 shows combinations of different energy sources to meet changing levels of demand over the next century. The analysis of these variants leads to the following conclusions:

- Deep reductions of CO₂ emissions from energy supply systems are technically possible within 50 to 100 years, using alternative strategies.
- Many combinations of the options identified in this assessment could reduce global CO₂ emissions from fossil fuels from about 6 Gt C in 1990 to about 4 Gt C/yr by 2050, and to about 2 Gt C/yr by 2100 (see Figure 6). Cumulative CO₂ emissions, from 1990 to 2100, would range from about 450 to about 470 Gt C in the alternative LESS constructions.
- Higher energy efficiency is underscored for achieving deep reductions in CO₂ emissions, for increasing the flexibility of supply side combinations, and for reducing overall energy system costs.
- Interregional trade in energy grows in the LESS constructions compared to today's levels, expanding sustainable development options for Africa, Latin America, and the Middle East during the next century.

Costs for energy services in each LESS variant relative to costs for conventional energy depend on relative future energy prices, which are uncertain within a wide range, and on the performance and cost characteristics assumed for alternative technologies. However, within the wide range of future energy prices, one or more of the variants would plausibly be capable of providing the demanded energy services at estimated costs that are approximately the same as estimated future costs for current conventional energy. It is not possible to identify a least-cost future energy system for the longer term, as the relative costs of options depend on resource constraints and technological opportunities that are imperfectly known, and on actions by governments and the private sector.

The literature provides strong support for the feasibility of achieving the performance and cost characteristics assumed for energy technologies in the LESS constructions, within the next 2 decades, though it is impossible to be certain until the research

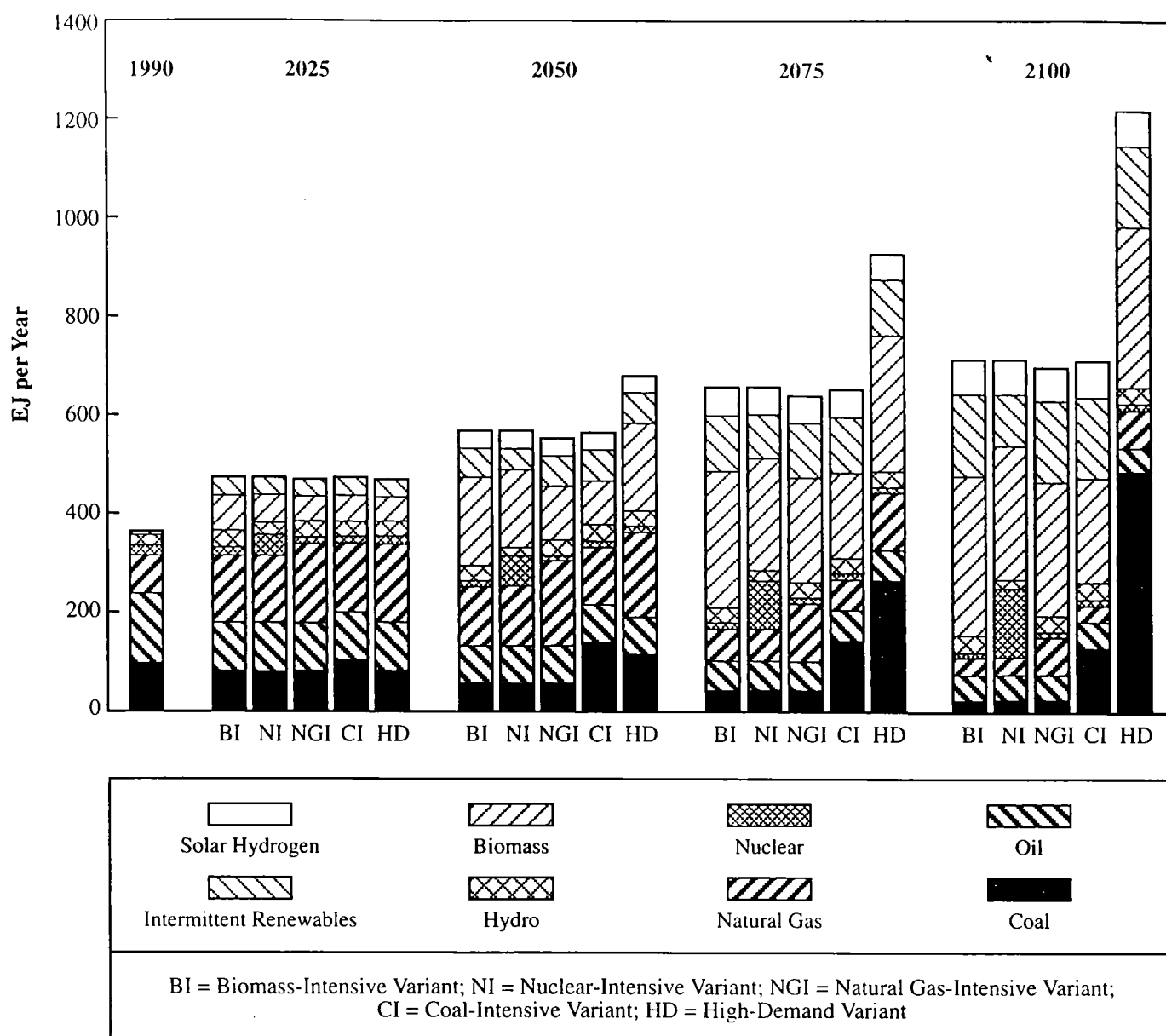


Figure 5: Global primary energy use for alternative Low CO₂-Emitting Energy Supply System (LESS) constructions: Alternatives for meeting different energy demand levels over time, using various fuel mixes.

and development is complete and the technologies have been tested in the market. Moreover, these performance and cost characteristics cannot be achieved without a strong and sustained investment in research, development, and demonstration (RD&D). Many of the technologies being developed would need initial support to enter the market, and to reach sufficient volume to lower costs to become competitive.

Market penetration and continued acceptability of different energy technologies ultimately depends on their relative cost, performance (including environmental performance), institutional arrangements, and regulations and policies. Because costs vary by location and application, the wide variety of circumstances creates initial opportunities for new technologies to enter the market. Deeper understanding of the opportunities

for emissions reductions would require more detailed analysis of options, taking into account local conditions.

Because of the large number of options, there is flexibility as to how the energy supply system could evolve, and paths of energy system development could be influenced by considerations other than climate change, including political, environmental (especially indoor and urban air pollution, acidification, and land restoration), and socioeconomic circumstances.

4.2. Agriculture, Rangelands, and Forestry

Beyond the use of biomass fuels to displace fossil fuels, the management of forests, agricultural lands, and rangelands can play an

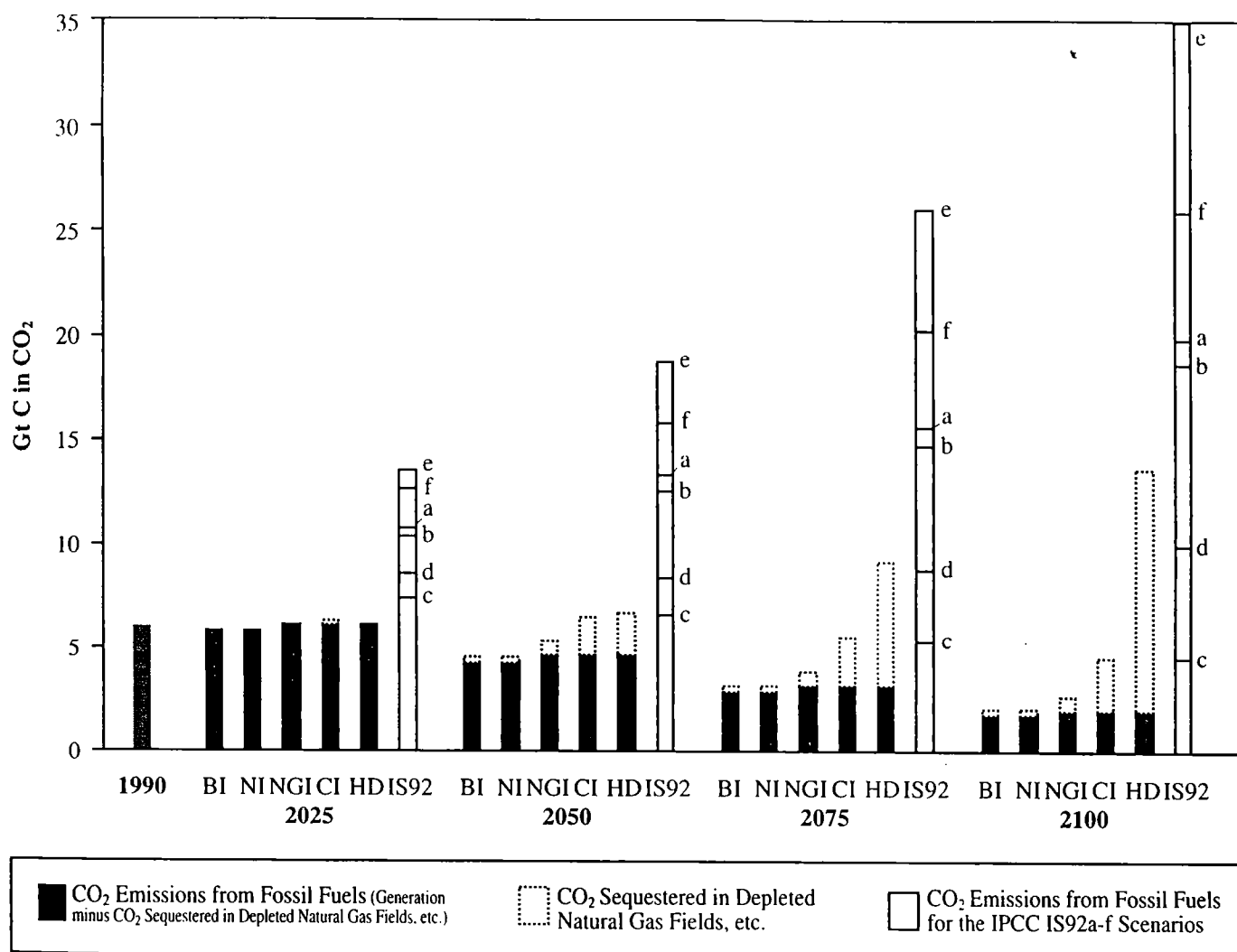


Figure 6: Annual CO₂ emissions from fossil fuels for alternative LESS constructions, with comparison to the IPCC IS92a-f scenarios (see Figure 5 for acronym definitions).

important role in reducing current emissions of CO₂, CH₄, and N₂O and in enhancing carbon sinks. A number of measures could conserve and sequester substantial amounts of carbon (approximately 60–90 Gt C in the forestry sector alone) over the next 50 years. In the forestry sector, costs for conserving and sequestering carbon in biomass and soil are estimated to range widely but can be competitive with other mitigation options. Factors affecting costs include opportunity costs of land; initial costs of planting and establishment; costs of nurseries; the cost of annual maintenance and monitoring; and transaction costs. Direct and indirect benefits will vary with national circumstances and could offset the costs. Other practices in the agriculture sector could reduce emissions of other greenhouse gases such as CH₄ and N₂O. Land-use and management measures include:

- Sustaining existing forest cover
- Slowing deforestation
- Regenerating natural forests
- Establishing tree plantations
- Promoting agroforestry
- Altering management of agricultural soils and rangelands
- Improving efficiency of fertilizer use

- Restoring degraded agricultural lands and rangelands
- Recovering CH₄ from stored manure
- Improving the diet quality of ruminants.

The net amount of carbon per unit area conserved or sequestered in living biomass under a particular forest management practice and present climate is relatively well understood. The most important uncertainties associated with estimating a global value are (i) the amount of land suitable and available for forestation, regeneration, and/or restoration programs; (ii) the rate at which tropical deforestation can actually be reduced; (iii) the long-term use (security) of these lands; and (iv) the continued suitability of some practices for particular locations given the possibility of changes in temperature, water availability, and so forth under climate change.

4.3. Cross-Sectoral Issues

Cross-sectoral assessment of different combinations of mitigation options focuses on the interactions of the full range of technologies and practices that are potentially capable of reducing

emissions of greenhouse gases or sequestering carbon. Current analysis suggests the following:

- **Competing Uses of Land, Water, and Other Natural Resources.** A growing population and expanding economy will increase the demand for land and other natural resources needed to provide, *inter alia*, food, fiber, forest products, and recreation services. Climate change will interact with the resulting intensified patterns of resource use. Land and other resources could also be required for mitigation of greenhouse gas emissions. Agricultural productivity improvements throughout the world and especially in developing countries would increase availability of land for production of biomass energy.
- **Geoengineering Options.** Some geoengineering approaches to counterbalance greenhouse gas-induced climate change have been suggested (e.g., putting solar radiation reflectors in space or injecting sulfate aerosols into the atmosphere to mimic the cooling influence of volcanic eruptions). Such approaches generally are likely to be ineffective, expensive to sustain, and/or to have serious environmental and other effects that are in many cases poorly understood.

4.4. Policy Instruments

Mitigation depends on reducing barriers to the diffusion and transfer of technology, mobilizing financial resources, supporting capacity building in developing countries, and other approaches to assist in the implementation of behavioral changes and technological opportunities in all regions of the globe. The optimum mix of policies will vary from country to country, depending upon political structure and societal receptiveness. The leadership of national governments in applying these policies will contribute to responding to adverse consequences of climate change. Governments can choose policies that facilitate the penetration of less greenhouse gas-intensive technologies and modified consumption patterns. Indeed, many countries have extensive experience with a variety of policies that can accelerate the adoption of such technologies. This experience comes from efforts over the past 20 to 30 years to achieve improved energy efficiency, reduce the environmental impacts of agricultural policies, and meet conservation and environmental goals unrelated to climate change. Policies to reduce net greenhouse gas emissions appear more easily implemented when they are designed to address other concerns that impede sustainable development (e.g., air pollution and soil erosion). A number of policies, some of which may need regional or international agreement, can facilitate the penetration of less greenhouse gas-intensive technologies and modified consumption patterns, including:

- Putting in place appropriate institutional and structural frameworks
- Energy pricing strategies (e.g., carbon or energy taxes, and reduced energy subsidies)

- Reducing or removing other subsidies (e.g., agricultural and transport subsidies) that increase greenhouse gas emissions
- Tradable emissions permits
- Voluntary programs and negotiated agreements with industry
- Utility demand-side management programs
- Regulatory programs, including minimum energy efficiency standards (e.g., for appliances and fuel economy)
- Stimulating RD&D to make new technologies available
- Market pull and demonstration programs that stimulate the development and application of advanced technologies
- Renewable energy incentives during market build-up
- Incentives such as provisions for accelerated depreciation and reduced costs for consumers
- Education and training; information and advisory measures
- Options that also support other economic and environmental goals.

Accelerated development of technologies that will reduce greenhouse gas emissions and enhance greenhouse gas sinks—as well as understanding the barriers that inhibit their diffusion into the marketplace—requires intensified research and development by governments and the private sector.

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SUMMARY FOR POLICYMAKERS

1 Introduction

Working Group III of the Intergovernmental Panel on Climate Change (IPCC) was restructured in November 1992 and charged with conducting "technical assessments of the socio-economics of impacts, adaptation, and mitigation of climate change over both the short and long term and at the regional and global levels." Working Group III responded to this charge by further stipulating in its work plan that it would place the socio-economic perspectives in the context of sustainable development, and, in accordance with the Framework Convention on Climate Change (FCCC), provide comprehensive treatment of both mitigation and adaptation options while covering all economic sectors and all relevant sources of greenhouse gases and sinks.

This report assesses a large part of the existing literature on the socioeconomics of climate change and identifies areas in which a consensus has emerged on key issues and areas where differences exist.¹ The chapters have been arranged to cover several key issues. First, frameworks for socioeconomic assessment of costs and benefits of action and inaction are described. Particular attention is given to the applicability of cost-benefit analysis, the incorporation of equity and social considerations, and consideration of intergenerational equity issues. Second, the economic and social benefits of limiting greenhouse gas emissions and enhancing sinks are reviewed. Third, the economic, social, and environmental costs of mitigating greenhouse gas emissions are assessed. Next, generic mitigation and adaptation response options are reviewed, methods for assessing the costs and effectiveness of different response options are summarized, and integrated assessment techniques are discussed. Finally, the report provides an economic assessment of policy instruments to combat climate change.

In accordance with the approved work plan, this assessment of the socioeconomic literature related to climate change focusses on economic studies; material from other social sciences is found mostly in the chapter on equity and social considerations. The report is an assessment of the state of knowledge – what we know and do not know – and not a prescription for policy implementation.

Countries can use the information in this report to help take decisions they believe are most appropriate for their specific circumstances.

2 Scope of the Assessment

Climate change presents the decision maker with a set of formidable complications: a considerable number of re-

maining uncertainties (which are inherent in the complexity of the problem), the potential for irreversible damages or costs, a very long planning horizon, long time lags between emissions and effects, wide regional variation in causes and effects, an irreducibly global scope of the problem, and the need to consider multiple greenhouse gases and aerosols. Yet another complication arises from the fact that effective protection of the climate system requires global cooperation.

Nevertheless, a number of insights that may be useful to policymakers can be drawn from the literature:

- Analyses indicate that a prudent way to deal with climate change is through a portfolio of actions aimed at mitigation, adaptation, and improvement of knowledge. The appropriate portfolio will differ for each country. The challenge is not to find the best policy today for the next 100 years, but to select a prudent strategy and to adjust it over time in the light of new information.
- Earlier mitigation action may increase flexibility in moving toward stabilization of atmospheric concentrations of greenhouse gases (U.N. Framework Convention on Climate Change, Article 2). The choice of abatement paths involves balancing the economic risks of rapid abatement now (that premature capital stock retirement will later be proved unnecessary) against the corresponding risk of delay (that more rapid reduction will then be required, necessitating premature retirement of future capital stock).
- The literature indicates that significant "no regrets"² opportunities are available in most countries and that the risk of aggregate net damage due to climate change, consideration of risk aversion, and application of the precautionary principle provide rationales for action beyond no regrets.
- The value of better information about climate change processes and impacts and society's responses to them is likely to be great. In particular, the literature accords high value to information about climate sensitivity to greenhouse gases and aerosols, climate change damage functions, and variables such as determinants of economic growth and rates of energy efficiency improvements. Better information about the costs and benefits of mitigation and adaptation measures and how they might change in coming decades also has a high value.

- Analysis of economic and social issues related to climate change, especially in developing countries where little work of this nature has been carried out, is a high priority for research. More generally, research is needed on integrated assessment and analysis of decision making related to climate change. Further, research advancing the economic understanding of nonlinearities and new theories of economic growth is also needed. Research and development related to energy efficiency technologies and nonfossil energy options also offer high potential value. In addition, there is also a need for research on the development of sustainable consumption patterns.

A portfolio of possible actions that policymakers could consider, in accordance with applicable international agreements, to implement low cost and/or cost-effective measures to reduce emissions of greenhouse gases and adapt to climate change can include:

- implementing energy efficiency measures including the removal of institutional barriers to energy efficiency improvements;
- phasing out existing distortionary policies and practices that increase greenhouse gas emissions, such as some subsidies and regulations, noninternalization of environmental costs, and distortions in transport pricing;
- implementing cost-effective fuel switching measures from more to less carbon-intensive fuels and to carbon-free fuels such as renewables;
- implementing measures to enhance sinks or reservoirs of greenhouse gases such as improving forest management and land use practices;
- implementing measures and developing new techniques for reducing methane, nitrous oxide, and other greenhouse gas emissions;
- encouraging forms of international cooperation to limit greenhouse gas emissions, such as implementing coordinated carbon/energy taxes, activities implemented jointly, and tradeable quotas;
- promoting the development and implementation of national and international energy efficiency standards;
- promoting voluntary actions to reduce greenhouse gas emissions;
- promoting education and training, implementing information and advisory measures for sustainable development and consumption patterns that will facilitate climate change mitigation and adaptation;
- planning and implementing measures to adapt to the consequences of climate change;
- undertaking research aimed at better understanding the causes and impacts of climate change and facilitating more effective adaptation to it;
- conducting technological research aimed at minimizing emissions of greenhouse gases from continued use of

fossil fuels and developing commercial nonfossil energy sources;

- developing improved institutional mechanisms, such as improved insurance arrangements, to share the risks of damages due to climate change.

Contribution of economics

- Estimates of the costs and benefits of stabilizing greenhouse gas *concentrations* are sensitive to, inter alia, the ultimate target concentration, the emissions path toward this level, the discount rate, and assumptions concerning the costs and availability of technologies and practices.
- Despite its widespread use in economic policy evaluation, Gross Domestic Product is widely recognized to be an imperfect measure of a society's well-being, largely because it fails to account for degradation of the environment and natural systems. Other methodologies exist that try to take these nonmarket values and social and ecological sustainability into account. Such methodologies would provide a more complete indication of how climate change might affect society's well-being.
- Given the interrelated nature of the global economic system, attempts to mitigate climate change through actions in one region or sector may have offsetting economic effects that risk increasing the emissions of other regions and sectors (so-called leakages). These emission leakages can be lessened through coordinated actions of groups of countries.
- The literature suggests that flexible, cost-effective policies relying on economic incentives and instruments, as well as coordinated instruments, can considerably reduce mitigation or adaptation costs, or increase the cost-effectiveness of emission reduction measures.

Equity considerations

In considering equity principles and issues related to greenhouse gas emissions, it is important for policy consideration to take into account in particular Articles 3, 4.2a, and 11.2 of the Framework Convention on Climate Change, Principle 2 of the Rio Declaration, and general principles of international law.

Scientific analyses cannot prescribe how equity should be applied in implementing the Framework Convention on Climate Change, but analysis can clarify the implications of alternative choices and their ethical basis.

- Developing countries require support for institutional and endogenous capacity building, so that they may effectively participate in climate change decision making.
- It is important that both efficiency and equity concerns be considered during the analysis of mitigation and adaptation measures. For the purposes of analysis, it is possible to separate efficiency from equity. This analyti-

cal separation presupposes that (and is valid, for policy purposes, only if) effective institutions exist or can be created for appropriate redistribution of climate change costs. It may be worthwhile to conduct analyses of the equity implications of particular measures for achieving efficiency, including social considerations and impacts.

3 Decision Making Frameworks for Addressing Climate Change

Since climate change is a global issue, comprehensive analyses of mitigation, adaptation, and research measures are needed to identify the most efficient and appropriate strategy to address climate change. International decision making related to climate change as established by the FCCC is a collective process in which a variety of concerns, such as equity, ecological protection, economics, ethics, and poverty-related issues, are of special significance for present and future generations. Treatments of decision making under uncertainty, risk aversion, technology development and diffusion processes, and distributional considerations are at present relatively poorly developed in international environmental economics, and especially in the climate change literature.

Decision making related to climate change must take into account the *unique* characteristics of the "problem": large uncertainties (scientific and economic), possible nonlinearities and irreversibilities, asymmetric distribution of impacts geographically and temporally, the very long time horizon, and the global nature of climate change with the associated potential for free riding. Beyond scientific uncertainties (discussed in Volume 1) and impact uncertainties (Volume 2), *socioeconomic uncertainties* relate to estimates of how these changes will affect human society (including direct economic and broader welfare impacts) and to the socioeconomic implications of emission abatement.

The other dimension that magnifies uncertainties and complicates decision making is *geographical*: climate change is a global problem encompassing an incredibly diverse mix of human societies, with differing histories, circumstances, and capabilities. Many developing countries are in relatively hot climates, depend more heavily on agriculture, and have less well developed infrastructures and social structures; thus, they may suffer more than average, perhaps much more. In developed countries, there may also be large climate change impacts.

The literature also emphasizes that delaying responses is itself a decision involving costs. Some studies suggest that the cost of delay is small, others emphasize that the costs could include imposition of risks on all parties (particularly the most vulnerable), greater utilization of limited atmospheric capacity, and potential deferral of desirable technical development. No consensus is reflected in the literature.

The global nature of the problem – necessitating collective action by sovereign states – and the large differences in the circumstances of different parties raise consequential as well as procedural issues. Consequential issues relate to outcomes

whereas procedural issues relate to how decisions are made. In relation to climate change, the existence of an agreed legal framework involves a collective process within a negotiated framework (the FCCC). Accordingly decision making can be considered within three different categories of frameworks, each with different implications and with distinct foci: global optimization (trying to find the globally optimal result), procedural decision making (establishing and refining rules of procedure), and collective decision making (dealing with distributional issues and processes involving the interaction of numerous independent decision makers).

Application of the literature on decision making to climate change provides elements that can be used in building collective and/or market-oriented strategies for sharing risks and realizing mutual benefits. The literature suggests that actions be sequential (temporally distributed), that countries implement a portfolio of mitigation, adaptation, and research measures, and that they adjust this portfolio continuously in response to new knowledge. The potential for transfers of financial resources and technology to developing countries may be considered as a part of any comprehensive analytical framework.

Elements of a market-related strategy concern *insurance and markets for risk*. Pooling risk does not change the risk, but it can improve economic efficiency and welfare. Although insurance capable of sharing climate change risks on a global basis currently does not exist, one of the important potential gains from cooperating in a collective framework, such as the Framework Convention on Climate Change, is that of risk sharing. Creating an insurance system to cover the risks of climate change is difficult,³ and the international community has not yet established such sophisticated instruments. This does not preclude, however, future international action to establish insurance markets sufficient for some international needs.

4 Equity and Social Considerations

Equity considerations are an important aspect of climate change policy and of the Convention. In common language equity means "the quality of being impartial" or "something that is fair and just." The FCCC, including the references to equity and equitable in Articles 3.1, 4.2.a, and 11.2, provides the context for efforts to apply equity in meeting the purposes and the objective of the Convention. International law, including relevant decisions of the International Court of Justice, may also provide guidance.

A variety of ethical principles, including the importance of meeting people's basic needs, may be relevant to addressing climate change, but the application to relations among states of principles originally developed to guide individual behaviour is complex and not straightforward. Climate change policies should not aggravate existing disparities between one region and another or attempt to redress all equity issues.

Equity involves procedural as well as consequential issues. Procedural issues relate to how decisions are made whereas consequential issues relate to outcomes. To be effective and to promote cooperation, agreements must be re-

garded as legitimate, and equity is an important element in gaining legitimacy.

Procedural equity encompasses process and participation issues. It requires that all parties be able to participate effectively in international negotiations related to climate change. Appropriate measures to enable developing country parties to participate effectively in negotiations increase the prospects for achieving effective, lasting, and equitable agreements on how best to address the threat of climate change. Concern about equity and social impacts indicates the need to build endogenous capabilities and strengthen institutional capacities, particularly in developing countries, to make and implement collective decisions in a legitimate and equitable manner.

Consequential equity has two components: the distribution of the costs of damages or adaptation and of measures to mitigate climate change. Because countries differ substantially in vulnerability, wealth, capacity, resource endowments, and other factors listed below, the costs of the damages, adaptation, and mitigation may be borne inequitably, unless the distribution of these costs is addressed explicitly.

Climate change is likely to impose costs on future generations and on regions where damages occur, including regions with low greenhouse gas emissions. Climate change impacts will be distributed unevenly.

The Convention recognizes in Article 3.1 the principle of common but differentiated responsibilities and respective capabilities. Actions beyond "no regrets" measures impose costs on the present generation. Mitigation policies unavoidably raise issues about how to share the costs. The initial emission limitation intentions of Annex I parties represent an agreed collective first step of those parties in addressing climate change.

Equity arguments can support a variety of proposals to distribute mitigation costs. Most of them seem to cluster around two main approaches: equal per capita emission allocations and allocations based on incremental departures from national baseline emissions (current or projected). Some proposals combine these approaches in an effort to incorporate equity concerns not addressed by relying exclusively on one or the other approach. The IPCC can clarify scientifically the implications of different approaches and proposals, but the choice of particular proposals is a policy judgment.

There are substantial variations among both developed and developing countries that are relevant to the application of equity principles to mitigation. These include variations in historical and cumulative emissions, current total and per capita emissions, emission intensities and economic output, and factors such as wealth, energy structures, and resource endowments. The literature is weak on the equity implications of these variations among both developed and developing countries.

In addition, the implications of climate change for developing countries are different from those for developed countries. The former often have different urgent priorities, weaker institutions, and are generally more vulnerable to climate change. It is likely, however, that developing countries' share of emissions will grow further to meet their social and developmental needs. Greenhouse gas emissions are likely to be-

come increasingly global, while substantial per capita disparities are likely to remain.

It is important that both efficiency and equity concerns should be considered during the analysis of mitigation and adaptation measures. It may be worthwhile to conduct analyses of the equity implications of particular measures for achieving efficiency, including social considerations and impacts.

5 Intertemporal Equity and Discounting

Climate policy, like many other policy issues, raises particular questions of equity among generations, because future generations are not able to influence directly the policies being chosen today that could affect their well-being, and because it might not be possible to compensate future generations for consequent reductions in their well-being.

Sustainable development is one approach to intergenerational equity. Sustainable development meets "the needs of the present without compromising the ability of future generations to meet their own needs."⁴ A consensus exists among economists that this does not imply that future generations should inherit a world with at least as much of every resource. Nevertheless, sustainable development would require that use of exhaustible natural resources and environmental degradation be appropriately offset – for example, by an increase in productive assets sufficient to enable future generations to obtain at least the same standard of living as those alive today. There are different views in the literature on the extent to which infrastructure and knowledge, on the one hand, and natural resources, such as a healthy environment, on the other hand, are substitutes. This is crucial to applying these concepts. Some analysts stress that there are exhaustible resources that are unique and cannot be substituted for. Others believe that current generations can compensate future generations for decreases in the quality or quantity of environmental resources by increases in other resources.

Discounting is the principal analytical tool economists use to compare economic effects that occur at different points in time. The choice of discount rate is of crucial technical importance for analyses of climate change policy, because the time horizon is extremely long, and mitigation costs tend to come much earlier than the benefits of avoided damages. The higher the discount rate, the less future benefits and the more current costs matter in the analysis.

Selection of a social discount rate is also a question of values since it inherently relates the costs of present measures to possible damages suffered by future generations if no action is taken.⁵ How best to choose a discount rate is, and will likely remain, an unresolved question in economics. Partly as a consequence, different discount rates are used in different countries. Analysts typically conduct sensitivity studies using various discount rates. It should also be recognized that the social discount rate presupposes that all effects are transformed to their equivalent in consumption. This makes it difficult to apply to those nonmarket impacts of climate change which for ethical reasons might not be, or for practical reasons cannot be, converted into consumption units.

The literature on the appropriate social discount rate for climate change analysis can be grouped into two broad categories. One approach discounts consumption by different generations using the "social rate of time preference," which is the sum of the rate of "pure time preference" (impatience) and the rate of increase of welfare derived from higher per capita incomes in the future. Depending on the values taken for the different parameters the discount rate tends to fall between 0.5% and 3.0% per year on a global basis – using the above approach. Although wide variations in regional discount rates exist, they may still be consistent with a particular global average.

The second approach to the discount rate considers market returns to investment, which range between 3% and 6% in real terms for long-term, risk-free public investments. Conceptually, funds could be invested in projects that earn such returns, with the proceeds being used to increase the consumption for future generations.

The choice of the social discount rate for public investment projects is a matter of policy preference but has a major impact on the economic evaluation of climate change actions.⁶ For example, in today's dollars, \$1,000 of damage 100 years from now would be valued at \$370 using a 1% discount rate (near the low end of the range for the first approach) but would be valued at \$7.60 using a 5% discount rate (near the upper end of the range for the second approach). However, in cost-effectiveness analyses of policies over short time horizons, the impact of using different discount rates is much smaller. In all areas analysts should specify the discount rate(s) they use to facilitate comparison and aggregation of results.

6 Applicability of Cost and Benefit Assessments

Many factors need to be taken into account in the evaluation of projects and public policy issues related to climate change, including the analysis of possible costs and benefits. Although costs and benefits cannot all be measured in monetary terms, various techniques exist which offer a useful framework for organizing information about the consequences of alternative actions for addressing climate change.

The family of analytical techniques for examining economic environmental policies and decisions includes traditional project level cost-benefit analysis, cost-effectiveness analysis, multicriteria analysis, and decision analysis. Traditional cost-benefit analysis attempts to compare all costs and benefits expressed in terms of a common monetary unit. Cost-effectiveness analysis seeks to find the lowest cost option to achieve an objective specified using other criteria. Multicriteria analysis is designed to deal with problems where some benefits and/or costs are measured in nonmonetary units. Decision analysis focusses specifically on making decisions under uncertainty.

In principle, this group of techniques can contribute to improving public policy decisions concerning the desirable extent of actions to mitigate global climate change, the timing of such actions, and the methods to be employed.

Traditional cost-benefit analysis is based on the concept that the level of emission control at each point in time is determined such that marginal costs equal marginal benefits. However, both costs and benefits may be hard, sometimes impossible, to assess. This may be due to large uncertainties, possible catastrophes with very small probabilities, or simply lack of consistent methodology for monetizing the effects. In some of these cases, it may be possible to apply multicriteria analysis. This provides policymakers with a broader set of information, including evaluation of relevant costs and benefits, estimated within a common framework.

Practical application of traditional cost-benefit analysis to the problem of climate change is therefore difficult because of the global, regional, and intergenerational nature of the problem. Estimates of the costs of mitigation options also vary widely. Furthermore, estimates of potential physical damages due to climate change also vary widely. In addition, confidence in monetary estimates for important consequences (especially nonmarket consequences) is low. These uncertainties and the resolution of uncertainty over time may be decisive for the choice of strategies to combat climate change. The objective of decision analysis is to deal with such problems. Furthermore, for some categories of ecological, cultural and human health impacts, widely accepted economic concepts of value are not available. To the extent that some impacts and measures cannot be valued in monetary terms, economists augment the traditional cost-benefit analysis approach with such techniques as multicriteria analysis, permitting some quantitative expression of the trade-offs to be made. These techniques do not resolve questions involving equity – for example, determining who should bear the costs. However, they provide important information on the incidence of damage, mitigation, and adaptation costs, and where cost-effective action might be taken.

Despite their many imperfections, these techniques provide a valuable framework for identifying essential questions that policymakers must face when dealing with climate change, namely:

- By how much should the emissions of greenhouse gases be reduced?
- When should emissions be reduced?
- How should emissions be reduced?

These analytical techniques assist decision makers in comparing the consequences of alternative actions, including that of no action, on a quantitative basis – and can certainly make a contribution to resolution of these questions.

7 The Social Costs of Anthropogenic Climate Change: Damages of Increased Greenhouse Gas Emissions

The literature on the subject of this section is controversial and mainly based on research done on developed countries, often extrapolated to developing countries. There is no consensus about how to value statistical lives or how to aggregate

statistical lives across countries.⁷ Monetary valuation should not obscure the human consequences of anthropogenic climate change damages, because the value of life has meaning beyond monetary considerations. It should be noted that the Rio Declaration and Agenda 21 call for human beings to remain at the centre of sustainable development. The approach taken to this valuation might affect the scale of damage reduction strategies. It may be noted that in virtually all the literature discussed in this section the developing country statistical lives have not been equally valued at the developed country value, nor are other damages in developing countries equally valued at the developed country value. Because national circumstances, including opportunity costs, differ, economists sometimes evaluate certain kinds of impacts differently amongst countries.

The benefits of limiting greenhouse gas emissions and enhancing sinks are (a) the climate change damages avoided and (b) the secondary benefits associated with the relevant policies. Secondary benefits include reductions in other pollutants jointly produced with greenhouse gases and the conservation of biological diversity. Net climate change damages include both market and nonmarket impacts as far as they can be quantified at present and, in some cases, adaptation costs. Damages are expressed in net terms to account for the fact that there are some beneficial impacts of climate change as well, which are, however, dominated by the damage costs. Nonmarket impacts, such as human health, risk of human mortality, and damage to ecosystems, form an important component of available estimates of the social costs of climate change. The literature on monetary valuation of such nonmarket effects reflects a number of divergent views and approaches. The estimates of nonmarket damages, however, are highly speculative and not comprehensive.

Nonmarket damage estimates are a source of major uncertainty in assessing the implications of global climate change for human welfare. Some regard monetary valuation of such impacts as essential to sound decision making, but others reject monetary valuation of some impacts, such as risk of human mortality, on ethical grounds. Additionally, there is a danger that entire unique cultures may be obliterated. This is not something that can be considered in monetary terms, but becomes a question of loss of human diversity, for which we have no indicators to measure economic value.

The assessed literature contains only a few estimates of the monetized damages associated with doubled CO₂ equivalent concentration scenarios. These estimates are aggregated to a global scale and illustrate the potential impacts of climate change under selected scenarios. Aggregating individual monetized damages to obtain total social welfare impacts involves difficult decisions about equity amongst countries. Global estimates are based on an aggregation of monetary damages across countries (damages which are themselves implicit aggregations across individuals) that reflects intercountry differences in wealth and income. This fundamentally influences the monetary valuation of damages. Taking income differences as given implies that an equivalent impact in two countries (such as an equal increase in human mortality) would receive very different weights in the calculation of global damages.

To enable choices between different ways of promoting human welfare to be made on a consistent basis, economists have for many years sought to express a wide range of human and environmental impacts in terms of monetary equivalents, using various techniques. The most commonly used of those techniques is an approach based on the observed willingness to pay for various nonmarket benefits.⁸ This is the approach that has been taken in most of the assessed literature.

Human life is an element outside the market, and societies may want to preserve it in an equal way. An approach that includes equal valuation of impacts on human life wherever they occur may yield different global aggregate estimates than those reported below. For example, equalizing the value of a statistical life at a global average could leave total global damage unchanged but would increase markedly the share of these damages borne by the developing world. Equalizing the value at the level typical in developed countries would increase monetized damages several times, and would further increase the share of the developing countries in the total damage estimate.

Other aggregation methods can be used to adjust for differences in the wealth or incomes of countries in calculations of monetary damages. Because estimates of monetary damage tend to be a higher percentage of national GDP for low-income countries than for high-income countries, aggregation schemes that adjust for wealth or income effects are expected to yield higher estimates of global damages than those presented in this report.

The assessed literature quantifying total damages from 2–3°C warming provides a wide range of point estimates for damages, given the presumed change in atmospheric greenhouse gas concentrations. The aggregate estimates tend to be a few percent of world GDP, with, in general, considerably higher estimates of damage to developing countries as a share of their GDP. The aggregate estimates are subject to considerable uncertainty, but the range of uncertainty cannot be gauged from the literature. The range of estimates cannot be interpreted as a confidence interval, given the widely differing assumptions and methodologies in the studies. As noted above, aggregation is likely to mask even greater uncertainties about damage components.

Regional or sectoral approaches to estimating the consequences of climate change include a much wider range of estimates of the net economic effects. For some areas, damages are estimated to be significantly greater and could negatively affect economic development. For others, climate change is estimated to increase economic production and present opportunities for economic development. For countries generally having a diversified, industrial economy and an educated and flexible labour force, the limited set of published estimates of damages are of the order one to a few percent of GDP. For countries generally having a specialized and natural resource-based economy (e.g., heavily emphasizing agriculture or forestry), and a poorly developed and land-tied labour force, estimates of damages from the few studies available are several times larger. Small islands and low-lying coastal areas are particularly vulnerable. Damages from possible large-scale catastrophes, such as major changes in ocean circulation, are

not reflected in these estimates. There is little agreement across studies about the exact magnitude of each category of damages or relative ranking of the damage categories.⁹ Climate changes of this magnitude are not expected to be realized for several decades, and damages in the interim could be smaller. Damages over a longer period of time might be greater.¹⁰

IPCC does not endorse any particular range of values for the marginal damage of CO₂ emissions, but published estimates range between \$5 and \$125 (1990 U.S.) per tonne of carbon emitted now. This range of estimates does not represent the full range of uncertainty. The estimates are also based on models that remain simplistic and are limited representations of the actual climate processes and are based on earlier IPCC scientific reports. The wide range of damage estimates reflects variations in model scenarios, discount rates, and other assumptions. It must be emphasized that the social cost estimates have a wide range of uncertainty because of limited knowledge of impacts, uncertain future technological and socioeconomic developments, and the possibility of catastrophic events or surprises.

8 Generic Assessment of Response Strategies

A wide range of technologies and practices is available for mitigating emissions of carbon dioxide, methane, nitrous oxide, and other greenhouse gases. There are also many adaptation measures available for responding to the impacts of climate change. All these technologies, practices, and measures have financial and environmental costs as well as benefits. This section surveys the range of options currently available or discussed in the literature. The optimal mix of response options will vary by country and over time as local conditions and costs change.

A review of CO₂ mitigation options suggests that:

- A large potential for cost-effective *energy conservation and efficiency improvements* in energy supply and energy use exists in many sectors. These options offer economic and environmental benefits in addition to reducing emissions of greenhouse gases. Various of these options can be deployed rapidly due to small unit size, modular design characteristics, and low lifetime costs.
- The options for *CO₂ mitigation in energy use* include alternative methods and efficiency improvements among others in the construction, residential, commercial, agriculture, and industry sectors. Not all cost-effective strategies are based on new technology; some may rely on improved information dissemination and public education, managerial strategies, pricing policies, and institutional reforms.
- Estimates of the technical potential for *switching to less carbon-intensive fuels* vary regionally and with the type of measure and economic availability of reserves of fossil and alternative fuels. These estimates must also take into account potential methane emissions from leakage of natural gas during production and distribution.

- *Renewable energy technologies* (e.g., solar, hydroelectric, wind, traditional and modern biomass, and ocean thermal energy conversion) have achieved different levels of technical development, economic maturity, and commercial readiness. The potential of these energy sources is not fully realized. Cost estimates for these technologies are sensitive to site-specific characteristics, resource variability, and the form of final energy delivered. These cost estimates vary widely.
- *Nuclear energy*¹¹ is a technology that has been deployed for several decades in many countries. However, a number of factors have slowed the expansion of nuclear power, including: (a) wary public perceptions resulting from nuclear accidents, (b) not yet fully resolved issues concerning reactor safety, proliferation of fissile material, power plant decommissioning, and long-term disposal of nuclear waste, as well as, in some instances, lower-than-anticipated levels of demand for electricity. Regulatory and siting difficulties have increased construction lead times, leading to higher capital costs for this option in some countries. If these issues, including *inter alia* the social, political, and environmental aspects mentioned above, can be resolved, nuclear energy has the potential to increase its present share in world-wide energy production.
- *CO₂ capture and disposal* may be ultimately limited for technical and environmental reasons, because not all forms of disposal ensure prevention of carbon reentering the atmosphere.
- *Forestry* options, in some circumstances, offer large potential, modest costs, low risk, and other benefits. Further, the potential modern use of biomass as a source of fuels and electricity could become attractive. Halting or slowing deforestation and increasing reforestation through increased silvicultural productivity and sustainable management programmes that increase agricultural productivity, the expansion of forest reserves, and promotion of ecotourism are among the cost-effective options for slowing the atmospheric build-up of CO₂. Forestry programmes raise important equity considerations.¹²

There is also a wide range of available technologies and practices for reducing emissions of *methane* from such sources as natural gas systems, coal mines, waste dumps, and farms. However, the issue of reduction of emissions related to the food supply may imply trade-offs with rates of food production. These trade-offs must be carefully assessed as they may affect the provision of basic needs in some countries, particularly in developing countries.

Most *nitrous oxide* emissions come from diffuse sources related to agriculture and forestry. These emissions are difficult to reduce rapidly. Industrial emissions of *nitrous oxide* and *halogenated compounds* tend to be concentrated in a few key sectors and tend to be easier to control. Measures to limit such emissions may be attractive for many countries.

The slow implementation of many of the technologically attractive and cost-effective options listed above has many

possible explanations, with both actual and perceived costs being a major factor. Among other factors, capital availability, information gaps, institutional obstacles, and market imperfections affect the rate of diffusion for these technologies. Identifying the reasons specific to a particular country is a precondition to devising sound and efficient policies to encourage their broader adoption.

Education and training as well as information and advisory measures are important aspects of various response options.

Many of the emission-reducing technologies and practices described above also provide other benefits to society. These additional benefits include improved air quality, better protection of surface and underground waters, enhanced animal productivity, reduced risk of explosions and fire, and improved use of energy resources.

Many options are also available for *adapting* to the impacts of climate change and thus reducing the damages to national economies and natural ecosystems. Adaptive options are available in many sectors, ranging from agriculture and energy to health, coastal zone management, offshore fisheries, and recreation. Some of these provide enhanced ability to cope with the current impacts of climate variability. However, possible trade-offs between implementation of mitigation and adaptation measures are important to consider in future research. A summary of sectoral options for adaptation is presented in Volume 2.

The optimal response strategy for each country will depend on the special circumstances and conditions which that country must face. Nonetheless, many recent studies and empirical observations suggest that some of the most cost-effective options can be most successfully implemented on a joint or co-operative basis among nations.

9 Costs of Response Options

It must be emphasized that the text in this section is an assessment of the technical literature and does not make recommendations on policy matters. The available literature is primarily from developed countries.

Cost concepts

From the perspective of this section on assessing mitigation or adaptation costs, what matters is the net cost (total cost less secondary benefits and costs). These net costs exclude the social costs of climate change, which are discussed in Section 7. The assessed literature yields a very wide range of estimates of the costs of response options. The wide range largely reflects significant differences in assumptions about the efficiency of energy and other markets, and about the ability of government institutions to address perceived market failures or imperfections.

Measures to reduce greenhouse gas emissions may yield additional economic impacts (for example, through technological externalities associated with fostering research and development programmes) and/or environmental impacts (such as reduced emissions of acid rain and urban smog precursors).

Studies suggest that the secondary environmental benefits may be substantial but are likely to differ from country to country.

Specific results

Estimates of the cost of greenhouse gas emission reduction depend critically on assumptions about the levels of energy efficiency improvements in the baseline scenario (that is, in the absence of climate policy) and on a wide range of factors such as consumption patterns, resource and technology availability, the desired level and timing of abatement, and the choice of policy instruments. Policymakers should not place too much confidence in the specific numerical results from any one analysis. For example, mitigation cost analyses reveal the costs of mitigation relative to a given baseline, but neither the baseline nor the intervention scenarios should be interpreted as representing likely future conditions. The focus should be on the general insights regarding the underlying determinants of costs.

The costs of stabilizing atmospheric concentrations of greenhouse gases at levels and within a time frame that will prevent dangerous anthropogenic interference with the climate system (the ultimate objective of the FCCC) will be critically dependent on the choice of emission timepath. The cost of the abatement programme will be influenced by the rate of capital replacement, the discount rate, and the effect of research and development.

Failure to adopt policies as early as possible to encourage efficient replacement investments at the end of the economic life of a plant and equipment (i.e., at the point of capital stock turnover) imposes an economic cost to society. Implementing emission reductions at rates that can be absorbed in the course of normal stock turnover is likely to be cheaper than enforcing premature retirement now.

The choice of abatement paths thus involves balancing the economic risks of rapid abatement now (that premature capital stock retirement will later be proved unnecessary) against the corresponding risk of delay (that more rapid reduction will then be required, necessitating premature retirement of future capital stock).

Appropriate long-run signals are required to allow producers and consumers to adapt cost-effectively to constraints on greenhouse gas emissions and to encourage research and development. Benefits associated with the implementation of any "no regret" policies will offset, at least in part, the costs of a full portfolio of mitigation measures. This will also increase the time available to learn about climate risks and to bring new technologies into the marketplace.

Despite significant differences in views, there is agreement that energy efficiency gains of perhaps 10 to 30% above baseline trends over the next two to three decades can be realized at negative to zero net cost (negative net cost means an economic benefit). With longer time horizons, which allow a more complete turnover of capital stocks, and which give research and development and market transformation policies a chance to impact multiple replacement cycles, this potential is much higher. The magnitude of such "no regret" potentials

depends on the existence of substantial market or institutional imperfections that prevent cost-effective emission reduction measures from occurring. The key question is then the extent to which such imperfections and barriers can be removed cost-effectively by policy initiatives such as efficiency standards, incentives, removal of subsidies, information programmes, and funding of technology transfer.

Progress has been made in a number of countries in cost-effectively reducing imperfections and institutional barriers in markets through policy instruments based on voluntary agreements, energy efficiency incentives, product efficiency standards, and energy efficiency procurement programmes involving manufacturers, as well as utility regulatory reforms. Where empirical evaluations have been made, many have found the benefit-cost ratio of increasing energy efficiency to be favourable, suggesting the practical feasibility of realizing "no regret" potentials at negative net cost. More information is needed on similar and improved programmes in a wider range of countries.

Infrastructure decisions are critical in determining long-term emissions and abatement costs because they can enhance or restrict the number and type of future options. Infrastructure decisions determine development patterns in transportation, urban settlement, and land use and influence energy system development and deforestation patterns. This issue is of particular importance to developing countries and many economies in transition where major infrastructure decisions will be made in the near term.

If a carbon or carbon-energy tax is used as a policy instrument for reducing emissions, the taxes could raise substantial revenues, and how the revenues are distributed could dramatically affect the cost of mitigation. If the revenues are distributed by reducing distortionary taxes in the existing system, they will help reduce the excess burden of the existing tax system, potentially yielding an additional economic benefit (double dividend). For example, those European studies which are more optimistic regarding the potential for tax recycling show lower and, in some instances, slightly negative costs. Conversely, inefficient recycling of the tax revenues could increase costs. For example, if the tax revenues are used to finance government programmes that yield a lower return than the private sector investments forgone because of the tax, then overall costs will increase.

There are large differences in the costs of reducing greenhouse gas emissions among countries because of their state of economic development, infrastructure choices, and natural resource base. This indicates that international cooperation could significantly reduce the global cost of reducing emissions. Research suggests that, in principle, substantial savings would be possible if emissions are reduced where it is cheapest to do so. In practice, this requires international mechanisms ensuring appropriate capital flows and technology transfers between countries. Conversely, a failure to achieve international cooperation could compromise unilateral attempts by a country or a group of countries to limit greenhouse gas emissions. However, estimates of so called leakage effects vary so widely that they provide little guidance to policymakers.

BOX S.1: TOP-DOWN AND BOTTOM-UP MODELS

Top-down models are aggregate models of the entire macroeconomy that draw on analysis of historical trends and relationships to predict the large-scale interactions between the sectors of the economy, especially the interactions between the energy sector and the rest of the economy. Top-down models typically incorporate relatively little detail on energy consumption and technological change, compared with bottom-up models.

In contrast, bottom-up models incorporate detailed studies of engineering costs of a wide range of available and forecast technologies, and describe energy consumption in great detail. However, compared with top-down models, they typically incorporate relatively little detail on nonenergy consumer behaviour and interactions with other sectors of the economy.

This simple characterization of top-down and bottom-up models is increasingly misleading as more recent versions of each approach have tended to provide greater detail in the aspects that were less developed in the past. As a result of this convergence in model structure, model results are tending to converge, and the remaining differences reflect differences in assumptions about how rapidly and effectively market institutions adopt cost-effective new technologies or can be induced to adopt them by policy interventions.

Many existing models are not well suited to study economies in transition or those of developing countries. More work is needed to develop the appropriate methodologies, data, and models and to build the local institutional capacity to undertake analyses.

There has been more analysis to date of emission reduction potentials and costs for developed countries than for other parts of the world. Moreover, many existing models are not well suited to study economies in transition or economies of developing countries. Much work is needed to develop and apply models for use outside developed countries (for example, to represent more explicitly market imperfections, institutional barriers, and traditional and informal economic sectors). In addition, the discussion below and the bulk of the underlying report deal with costs of response options at the national or regional level in terms of effect on GDP. Further analysis is required concerning effects of response options on employment, inflation, trade competitiveness, and other public issues.

A large number of studies using both top-down and bottom-up approaches (see box for definitions) were reviewed. Estimates of the costs of limiting fossil fuel carbon dioxide emissions (expressed as carbon) vary widely and depend on choice of methodologies, underlying assumptions, emission scenarios, policy instruments, reporting year, and other criteria. For specific results of individual studies, see Chapter 9.

OECD Countries. Although it is difficult to generalize, top-down analyses suggest that the costs of substantial reductions below 1990 levels could be as high as several percent of GDP. In the specific case of stabilizing emissions at 1990 levels, most studies estimate that annual costs in the range of -0.5% of GDP (equivalent to a gain of about \$60 billion in total for OECD countries at today's GDP levels) to 2% of GDP (equivalent to a loss of about \$240 billion) could be reached over the next several decades. However, studies also show that appropriate timing of abatement measures and the availability of low-cost alternatives may substantially reduce the size of the overall bill.

Bottom-up studies are more optimistic about the potential for low- or negative-cost emission reductions, and the capacity to implement that potential. Such studies show that the costs of reducing emissions by 20% in developed countries within two to three decades are negligible to negative. Other bottom-up studies suggest that there exists a potential for absolute reductions in excess of 50% in the longer term, without increasing, and perhaps even reducing, total energy system costs.

The results of top-down and bottom-up analyses differ because of such factors as higher estimates of no-regrets potential and technological progress, and earlier saturation in energy services per unit GDP. In the most favourable assessments, savings of $10\text{--}20\%$ in the total cost of energy services can be achieved.

Economies in transition. The potential for cost-effective reductions in energy use is apt to be considerable, but the realizable potential will depend on what economic and technological development path is chosen, as well as the availability of capital to pursue different paths. A critical issue is the future of structural changes in these countries that are apt to change dramatically the level of baseline emissions and the emission reduction costs.

Developing countries. Analyses suggest that there may be substantial low-cost fossil fuel carbon dioxide emission reduction opportunities for developing countries. Development pathways that increase energy efficiency, promote alternative energy technologies, reduce deforestation, and enhance agricultural productivity and biomass energy production can be economically beneficial. To embark upon this pathway may require significant international cooperation and financial and technology transfers. However, these are likely to be insufficient to offset rapidly increasing emissions baselines, associated with increased economic growth and overall welfare. Stabilization of carbon dioxide emissions is likely to be costly.

It should be noted that analyses of costs to economies in transition and developing countries typically neglect the general equilibrium effects of unilateral actions taken by developed countries. These effects may be either positive or negative and their magnitude is difficult to quantify.

It should also be noted that estimates of costs or benefits of the order of a few percent of GDP may represent small differences in GDP growth rates, but are nevertheless substantial in absolute terms.

Preservation and augmentation of carbon sinks offer a substantial and often cost-effective component of a greenhouse

gas mitigation strategy. Studies suggest that as much as $15\text{--}30\%$ of 1990 global energy-related emissions could be offset by carbon sequestration in forests for a period of 50 to 100 years. The costs of carbon sequestration, which are competitive with source control options, may differ among regions of the world.

Control of emissions of other greenhouse gases, especially methane and nitrous oxide, can provide significant cost-effective opportunities in some countries. About 10% of anthropogenic methane emissions could be reduced at negative or low cost using available mitigation options for such methane sources as natural gas systems, waste management, and agriculture.

10 Integrated Assessment

Integrated assessment models combine knowledge from a wide range of disciplines to provide insights that would not be observed through traditional disciplinary research. They are used to explore possible states of human and natural systems, analyze key questions related to policy formulation, and help set research priorities. Integration helps coordinate assumptions from different disciplines and allows feedbacks and interactions absent from individual disciplines to be analyzed. However, the results of such analyses are no better than the information drawn from the underlying economic, atmospheric and biological sciences. Integrated assessment models are limited by both the underlying knowledge base on which they draw and the relatively limited experiential base.

Most current integrated assessment models do not reflect the specific social and economic dynamics of the developing and transition economies well; for example, none of the existing models addresses most market imperfections, institutional barriers, or the operation of the informal sector in these countries. This can lead to biases in global assessments when mitigation options and impacts on developing or transition economies are valued as if their economies operate like those in the developed countries.

Although relatively new, integrated assessment models of climate change have evolved rapidly. Integrated assessment models tend to fall into two categories: *policy evaluation* and *policy optimization* models. Policy evaluation models are rich in physical detail and have been used to analyze the potential for deforestation as a consequence of interactions between demographics, agricultural productivity, and economic growth, and the relationship between climate change and the extent of potentially malarial regions. Policy optimization models optimize over key variables (e.g., emissions rates, carbon taxes) to achieve formulated policy goals (e.g., cost minimization or welfare optimization).

Key uncertainties in current integrated assessments include the sensitivity of the climate system to changes in greenhouse gas concentrations, the specification and valuation of impacts where there are no markets, changes in national and regional demographics, the choice of discount rates, and assumptions regarding the cost, availability, and diffusion of technologies.

11 An Economic Assessment of Policy Instruments for Combating Climate Change

Governments may have different sets of criteria for assessing international as well as domestic greenhouse policy instruments. Among these criteria are efficiency and cost-effectiveness, effectiveness in achieving stated environmental targets, distributional (including intergenerational) equity, flexibility in the face of new knowledge, understandability to the general public, and consistency with national priorities, policies, institutions, and traditions. The choice of instruments may also partly reflect a desire on the part of governments to achieve other objectives such as sustainable economic development, meeting social development goals and fiscal targets, or influencing pollution levels that are indirectly related to greenhouse gas emissions. A further concern of governments may lie with the effect of policies on competitiveness.

The world economy and indeed some individual national economies suffer from a number of price distortions which increase greenhouse gas emissions, such as some agricultural and fuel subsidies and distortions in transport pricing. A number of studies of this issue indicate that global emissions reductions of 4–18%, together with increases in real incomes, are possible from phasing out fuel subsidies. For the most part, reducing such distortions could lower emissions and increase economic efficiency. However, subsidies are often introduced and price distortions maintained for social and distributional reasons, and may be difficult to remove.

Policy instruments may be identified at two different levels: those that might be used by a group of countries and those that might be used by individual nations unilaterally or to achieve compliance with a multilateral agreement.

A group¹³ of countries may choose from policy measures and instruments including encouragement of voluntary actions and further research, tradable quotas, joint implementation (specifically activities implemented jointly under the pilot phase¹⁴), harmonized domestic carbon taxes, international carbon taxes, nontradable quotas, and various international standards. If the group did not include all major greenhouse gas emitters, then there might be a tendency for fossil fuel use to increase in countries not participating in this group. This outcome might reduce the international competitiveness of some industries in participating countries as well as the environmental effectiveness of the countries' efforts.

At both the international and national levels, the economic literature indicates that instruments that provide economic incentives, such as taxes and tradable quotas/permits, are likely to be more cost-effective than other approaches. Uniform standards among groups of countries participating in an international agreement are likely to be difficult to achieve. However, for one group of countries there has been agreement on the application of some uniform standards.

At the international level, all the potentially efficient market-based instruments could be examined during the course of future negotiations. A tradable quota system has the disadvantage of making the marginal cost of emissions uncertain, whereas a carbon tax (and related instruments)

has the disadvantage of leaving uncertain the effect on the level at which emissions are controlled. The weight given to the importance of reducing these different types of uncertainty would be one crucial factor in further evaluating these alternative instruments. Because of the lack of appropriate scientific knowledge, there would remain a high degree of uncertainty about the results of limiting emissions at specific levels. The adoption of either a tradable quota scheme or international taxes would have implications for the international distribution of wealth. The distributional consequences would be the subject of negotiation. To ensure the practicability of such instruments, there is a need for additional studies on the possible design of tradable quotas and harmonized taxes and on the institutional framework in which they might operate.

Individual countries that seek to implement mitigation policies can choose from among a large set of potential policies and instruments, including carbon taxes, tradable permits, deposit refund systems (and related instruments), and subsidies, as well as technology standards, performance standards, product bans, direct government investment, and voluntary agreements. Public education on the sustainable use of resources could play an important part in modifying consumption patterns and other human behaviour. The choice of measures at the domestic level may reflect objectives other than cost-effectiveness such as meeting fiscal targets. Revenue from carbon taxes or auctioned tradable permits could be used to replace existing distortionary taxes. The choice of instruments may also reflect other environmental objectives, such as reducing nongreenhouse pollution emissions, or increasing forest cover, or other concerns such as specific impacts on particular regions or communities.

Endnotes

1. The Framework Convention on Climate Change defines "climate change" as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The question as to whether such changes are potential or can already be identified is analyzed in Volume 1 of this IPCC Second Assessment Report (SAR).
2. "No regrets" measures are those whose benefits, such as reduced energy costs and reduced emissions of local/regional pollutants equal or exceed their cost to society, *excluding* the benefits of climate change mitigation. They are sometimes known as "measures worth doing anyway."
3. Without knowing the extent of potential impacts, the ability of private markets to insure against losses associated with climate change is unknown.
4. A related (somewhat stronger) concept is that each generation is entitled to inherit a planet and cultural resource base at least as good as that of previous generations.
5. A social discount rate is a discount rate appropriate for use by governments in the evaluation of public policy.
6. Despite the differences in the value of the discount rate, policies developed on the basis of the two approaches may lead to similar results.

7. The value of a statistical life is defined as the value people assign to a change in the risk of death among a population.
 8. The concept of willingness to pay is indicative, based on expressed desires, available resources, and information of a human being's preferences at a certain moment in time. The values may change over time. Also, other concepts (such as willingness to accept compensation for damage) have been advanced, but not yet widely applied, in the literature, and the interpretation and application of willingness to pay and other concepts to the climate problem may evolve.
 9. Due to time lags between findings in the natural sciences, their use in determination of potential physical and biological impacts, and subsequent incorporation into economic analyses of climate change, the estimates of climate change damage are based mainly on the scientific results from the 1990 and 1992 IPCC reports.
 10. See Volumes 1 and 2, the reports of Working Groups I and II.
 11. For more information on the technical aspects of nuclear power, see Volume 2.
 12. These are addressed in Section 4 above and in Chapter 3.
 13. The group could contain only a few, quite a number, or even all countries.
 14. See decision 5/CP.1 of the first Conference of the Parties (COP1) to the FCCC.
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