UNITED NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/SBSTA/2002/INF.17
27 September 2002

ENGLISH ONLY

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
Seventeenth session
New Delhi, 23–29 October 2002
Item 8 of the provisional agenda

RESEARCH AND SYSTEMATIC OBSERVATION

Third Assessment Report of the Intergovernmental Panel on Climate Change: Synthesis of information submitted by Parties on priority areas of research and questions for the scientific community

Note by the secretariat

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I. INTRODUCTION

A. Mandate

1. At its sixteenth session, the Subsidiary Body for Scientific and Technological Advice (SBSTA), under the agenda item on the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), noted the robust findings, key uncertainties and priorities for future research and systematic observation reported in the TAR. It also noted that possible items for consideration by the scientific community could include assessment of the effects of the implementation of the Kyoto Protocol, quantification and reduction of uncertainty, climate sensitivity, and improved climate and economic modelling, (FCCC/2002/SBSTA/6, para. 15(d) (i)).

2. The SBSTA invited Parties to submit, by 20 August 2002, their views, for compilation into a miscellaneous document, on priority areas of research and questions for the scientific community relevant to the Convention, as referred to in paragraph 1 above. The SBSTA requested the secretariat to prepare a synthesis of the submissions to facilitate further consideration of these issues at its seventeenth session (FCCC/2002/SBSTA/6, para 15(h)).

B. Scope of the note

3. This document contains a synthesis of the views submitted by Parties on priority research areas and questions to the scientific community relevant to the Convention. The annex presents a compilation of the views as submitted by Parties, but grouped under different headings. The views of Parties are contained in document FCCC/SBSTA/2002/MISC.15.

C. Possible action by the SBSTA

4. The SBSTA may wish to take note of the information provided in this document and in document FCCC/SBSTA/2002/MISC.15. It may wish to determine what specific role it could play with regard to climate change research, how it wishes to interact and cooperate with international research programmes, whether there are areas of research that require its particular attention and how to communicate research questions to the scientific community.

II. BACKGROUND

A. Information submitted

5. Fourteen Parties provided submissions to the secretariat: Australia, Azerbaijan, Bolivia, Canada, China, Colombia, Denmark on behalf of the European Community and of Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia, Japan, Myanmar, New Zealand, Norway, the Russian Federation, the United States of America and Uzbekistan.

6. In addition to views on priority research areas and key issues relevant to the Convention, one submission also contained specific questions to the scientific community relating to the scientific basis of climate change. Some Parties (Australia, Canada, Denmark, Japan, New Zealand, Norway, the Russian Federation and the United States) submitted views on some other matters relating to research under the Convention such as: a process to identify and communicate information needs of the Convention to the research community, IPCC and policy makers, and the role of the international research community, and of the Convention secretariat, in this process; future work of the IPCC; research and observational activities in developing countries and collaboration between developed and developing countries in this area; relevance of the scientific information summarized in the TAR to the work of the Convention; and suggestions for the special side event with the scientific community at SBSTA 17.

7. Almost all Parties highlighted the need to improve climate related systematic observation and, in particular, a global climate observing system for climate related research. The importance of on-going work of the SBSTA relating to the Global Climate Observing System was acknowledged in this regard.

B. Approach to the synthesis of information

8. Parties provided information in different formats and with various levels of detail, referring both to global issues and to their local and national circumstances and priorities. To facilitate the consideration, the information was grouped under four headings: the scientific basis of climate change; impacts vulnerability and adaptation; mitigation; and cross-cutting issues. It should be noted that some of the information is summarized under the headings that differ from those presented in the submissions. In such cases the secretariat used its best judgement to synthesize the information in a more coherent manner. In some cases the information from submissions which refers to more than one research area is repeated under different headings.

III. SYNTHESIS OF THE PRIORITY AREAS OF RESEARCH AND KEY QUESTIONS RELEVANT TO THE CONVENTION

A. The scientific basis of climate change

1. Observed climate and monitoring of the climate system

9. Ten Parties (Australia, Azerbaijan, Bolivia, China, Columbia, Japan, New Zealand, Norway, Uzbekistan and the United States) highlighted the importance of improving observations of the climate system for advancing climate models, predicting climate change, monitoring and predicting climate change impacts and assessing the effects of mitigation activities. The Parties generally stressed the need for:

(a) Improved observations and detection of changes in the climate system on a global scale. This requires improved worldwide networks, as well as high quality data, and better measurements and monitoring systems. There is a need to improve monitoring of changes and their indicators for all components of the climate system, such as terrestrial ecosystems and oceans; and to improve observations of greenhouse gas concentrations and changes in atmospheric chemistry. Improved detection of climate change trends and estimates of the rate of change require further improvements in historical reconstructions, and analysis of the instrumental record, including more rigorous consideration of the effects of urbanization on the global temperature trend;

(b) Improved monitoring and observations of regional climate variability and impacts. Some Parties specified particular regions of interest, such as the Caribbean and Pacific coastal zones and marine ecosystems, and mountainous and non-coastal areas of the South American, the Caucasus and the Central Asia regions. Parties also noted the need to improve monitoring and understanding of extreme and unique climate events, for example the El Niño Southern Oscillation and to develop regional indicators to detect climate change impacts.

2. Processes, driving forces and feedbacks in and sensitivity of the climate system

10. Eight Parties (Australia, Canada, China, Denmark, Japan, New Zealand, the Russian Federation and the United States) addressed the issue of further reducing uncertainty in key components of and processes in the climate system with respect to the needs of the Convention, and particularly its ultimate objective. The following research areas were highlighted in the submissions:

(a) Climate forcing due to natural and human-induced factors. Specific topics include the role of clouds, water vapour, CO_2 and other greenhouse gases, tropospheric ozone and aerosols (e.g. black carbon and sulphate-based), and their interactions;

(b) Sensitivity of and feedbacks within the climate system, on both local and global scales, and their interaction. Specific topics for research include responses in large- and small-scale cloud systems; the global water cycle and climate–ecosystem interactions; the coupling between climatic variables and land-use change; and the effects of marine, biological, physical and chemical processes on concentration of atmospheric CO_2, other greenhouse gases, tropospheric ozone and aerosols;

(c) Attribution of climate change at different time and spatial scales. This includes analysis of key factors that have induced climate change during the past 100 years, and of the role of long-term factors and paleo-climate dynamics.

3. Climate change modelling

11. Almost all Parties noted a need to improve models and to promote modelling activities, including testing, validation and comparison. There is a need to improve the representation of key processes in climate models, as specified in paragraph 10 above. Parties highlighted the need for better understanding of:

(a) Magnitude and rate of climate change under different emission scenarios;

(b) Regional and subregional manifestations of global climate change, including its link to climate variability and the frequency and intensity of extreme weather events. Some Parties specified regions (e.g. South America or the Arctic), elements of climate system (e.g. sea level), and particular extreme events (droughts, floods, storms, etc.) that should be given priority;

(c) Long-term climate changes (beyond 2100) and probabilities for abrupt changes in the climate system, including the risk of the possible amplification (or amelioration) of anthropogenic climate change, and taking into account the inertia of the climate system;

(d) Climate change impacts, projections of emissions, and integrated economic effects associated with adaptation and mitigation.

B. Impacts, vulnerability and adaptation

12. Further research on impacts, vulnerability and adaptation was seen as a priority by nine Parties (Australia, Canada, Columbia, Denmark, Japan, New Zealand, Norway, the United States and Uzbekistan). Related topics included:

(a) Integrated analysis of climate change impacts and vulnerabilities, including impacts of extreme events and climate variability at regional and smaller geographical scale. Studies, including related modelling activities, should focus on effects on physical, biological and human systems. They should incorporate the analysis of the additional stress induced by other, non-climatic factors, such as demographic shifts and land-use changes, and migration responses to climate change. This research is particularly needed for developing countries, indigenous communities and marginalized unique ecosystems. Several Parties identified some specific regions (e.g. South America, Andes region, polar regions, small island states) and sectors/systems (e.g. agriculture, forest, health, human being) as their priorities;

(b) Economic assessment of the adverse effects of climate change at global and regional scales;

(c) Regional and global climate change impacts and their likelihood by region, system and sector associated with different greenhouse gas stabilization levels and pathways;

(d) Likelihood, magnitude and time scale of significant impacts and abrupt, or irreversible events, such as changes in the thermohaline circulation of the oceans;

(e) Methodologies, technologies, timing and costs of adaptation;

(f) Adaptation strategies and their link to sustainable development and equity issues with specific focus on developing countries. This should incorporate local strategies aimed at enhancing adaptive capacities to withstand impacts and resilience to potential adverse effects of climate change.

C. Mitigation

13. Eight Parties (Australia, Canada, Denmark, Japan, New Zealand, Norway, the United States and Uzbekistan) stressed the need to improve understanding of and, in some cases methodologies, for assessing:

(a) Economic, environmental and social costs and benefits and the technological potential associated with different stabilization levels and emissions reduction pathways;

(b) The effectiveness of measures and implications of different strategies at the regional and national levels. This includes analysis of the ancillary benefits, the costs of damages, impacts of response measures, and constraints and opportunities for the adoption of low GHG emitting technologies;

(c) Mitigation options, their costs and barriers to implementation using "bottom-up" and "top-down" approaches;

(d) Means to enhance innovation in greenhouse gas abatement technologies, the development and deployment of low GHG emitting technologies and determinants of the rate of technological change;

(e) Geographic distribution of renewable sources, including their cost-effectiveness;

(f) Potential of biological carbon storage;

(g) Land use, land-use change and forestry and related accounting and reporting.

D. Cross-cutting issues

1. Effects of the implementation of the Kyoto Protocol

14. Three Parties (China, Columbia and Japan) consider the assessment of the effectiveness of the implementation of the Kyoto Protocol and the effects of its measures on global climate as a first priority task. The important issues include assessing the probability of adverse effects of implementation of the Protocol on economies in transition and on developing countries dependent on exports of fossil fuels and the quantification of such adverse effects in terms of Gross Domestic Product (GDP), employment prospects, exports, imports, market opportunities, and possible oil supply failures.

2. Dangerous anthropogenic interference with the climate system

15. Six Parties (Australia, Canada, Denmark, Japan, Norway and the Russian Federation) suggest that research to assist Parties in defining critical thresholds of greenhouse gas concentration to achieve the ultimate objective of the Convention should be a high priority. This research would include assessing different stabilization scenarios and quantifying the associated climate change impacts for the different regions of the world. It would also incorporate assessments of the greenhouse gas emission reductions required at different times in order to obtain these stabilization scenarios, and an analysis of costs and benefits of the mitigation and adaptation efforts. Studies would be linked to improved knowledge of the climate system, its sensitivity, and feedbacks.

3. Integrated approaches to adaptation and mitigation, in the framework of strategies for sustainable development

16. Seven Parties (Australia, Canada, Denmark, Japan, New Zealand, the United States and Uzbekistan) consider further exploration of integrated approaches to adaptation and mitigation as a means to minimize the economic and environmental consequences of climate change. In this regard, better assessments are required of the full range of benefits and costs of adaptation and mitigation across sectors and the impacts on the GDP, investment patterns, consumption levels and employment. Studies should include consideration of how regional and national development strategies can meet development priorities and address climate change. This implies the development of methodologies for defining and assessing the economic, social and environmental mitigative and adaptive capacity of nations and regions, and identifying synergies and barriers.

4. Frameworks for comprehensive risk assessment and risk management approaches for climate change policy-making under general scientific uncertainty

17. Development of a framework for assessing the risk of climate change, taking into account scientific uncertainty, and socio-economic and environmental risks in policy-making related to climate change, was seen as a priority by two Parties (Australia and New Zealand).

5. Future mitigation commitments

18. The submission from New Zealand identified the research needs related to future mitigation commitments under the Convention, including the assessment of previous, current and future contributions of nations and regions to anthropogenic climate change, such as Brazilian proposal. It also presented options and criteria for determining future mitigation commitments for all Parties, taking into account their historical and/or current greenhouse gas emissions and absorption by sinks on the basis of, inter alia, regional, national and per capita emissions.

Annex*

COMPILATION OF VIEWS OF PARTIES ON PRIORITY AREAS OF RESEARCH AND QUESTIONS TO THE SCIENTIFIC COMMUNITY RELEVANT TO THE CONVENTION

A. Science of climate change

1. Observed climate and monitoring

Australia

Monitoring and observed climate

- improved systematic and sustained monitoring of climate, including climate variables and indicators such as temperature, rainfall, ocean circulation/overturning, snowfall, riverflow, flowering times, species distribution);

- further historical reconstruction and analysis of climate variables and indicators to enable detection of trends and rates of change, for verifying and attributing future change and to allow benchmarking to assess effectiveness of mitigation strategies.

Azerbaijan

To the Global Climate Network must be jointed one station of Major Caucasus.

Bolivia

Increasing understanding and monitoring of climate variability in non-coastal areas.

- Non-coastal areas are also prompted to be impacted by climate change and climate variability events and the intensification and distortion of regional and global hydrological cycle.
- Countries without coastal areas need to enhance drastically systematic observations of precipitation and temperature patterns and build capacities for El Niño – La Niña forecasting and monitoring.
- The Government of Bolivia recognize the difficulties to differentiate climate change effects on climate variability events, even the intensification of positives anomalies related with “el Niño” since the 80´s show strong correlation with the intensification and disruption of the global hydrological cycle.
- The Government of Bolivia further recognize and urge the international community to provide the necessary help to create systematic observation capacities within the regions that can be shared among countries following the principle of equity.
- We urge the international community to recognize that some countries are more vulnerable to climate events because they depend on forecasting and research done in other countries with enhanced systematic observation capacities.

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* This compilation was made by extracting fragments from the texts as submitted by Parties (see UNFCCC/SBSTA/2002/MISC.15), by eliminating highlights and original numbering, but without formal editing.

Developing indicators and systematic observation of climate change impacts and vulnerability.

- The Government of Bolivia urge the international scientific community to enhance systematic observations on mountain regions, in particular to understand regional hydrology, ecology and land use patterns in mountain regions.
- The Government of Bolivia further request the international research community to enhance cooperation with developing countries to observe carbon cycle in Forest and develop indicators to monitor the causality of deforestation.

China

Detection and attribution of natural and anthropogenic changes

Efforts are needed to improve the observation of climate system, both in current time and in the distant past. For climate change during the instrumental period, more attention should be given to the effects of urbanization and land use on global and regional temperature. Marine data set needs to be improved.

Colombia

a) Future research could focus on certain regional ecosystems that have not been the object of extensive studies. Such is the case of mountain ecosystems and high plateaus, in particular the Andean *paramo*, not commonly perceived as being highly vulnerable to climate change.

Given that local data is scarce and predictions inaccurate, research is needed in order to:

(i) Gather observations to better understand the pressures these ecosystems are undergoing due to associated climate change effects

(ii) Provide quantitative information on the response of these systems to climate change additional to the existing qualitative data – continue research on ecosystem biology to better predict possible responses.

b) With regards to coastal zones and marine ecosystems (which have been studied in more detail) partial data at local scale on natural and anthropogenic threats needs to be completed. Detailed cartography and unified coastal lines need to be developed at a local/regional scale, as well as studies on local coastal and delta geomorphology.

Specifically, further knowledge is required at a local dimension with regards to:

(i) Current state of aquifers in the Caribbean and Pacific coastal zones
(ii) Evaluation and measurement of saline intrusion
(iii) Land use change as a result of flooding and saline intrusion
(iv) Coastal erosion and accretion processes – location, historical changes, magnitude, causes and possible consequences
(v) Effects of sea level rise (flooding, erosion and saline intrusion) on natural resource use

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

Improving the quantification of the anthropogenic component of observed changes in climate, and improving the estimates of possible natural influences and natural variability.

Japan

Promotion of systematic observation

(a) Reversing the decline of observational networks

The international community should support countries' efforts, particularly those of developing countries, to remedy deficiencies in their monitoring systems. Climate change studies require accurate, long-term, consistent and reliable data from national observational networks. New technologies are emerging for the integration of various data from different sources, including satellites, using assimilation methods. There is a strong need to encourage wider use of these technologies as new, cost-effective solutions to satisfy observational needs for climate change studies.

Global observing systems have an important role in the maintenance and improvement of observational networks. There is a strong need to support the efforts of these global observing systems such as GAW, WWW/GOS, GOOS, GTOS and GCOS.

(b) Observational foundation for climate studies

Integrated global observations

Since climate change is a global phenomenon, observations for climate studies must be organised on a global scale. In this effort, satellite data should be used effectively to cover areas where ground systems do not exist. At the same time, it is extremely important to integrate satellite-based observing systems with ground-based networks, so that satellite data can be verified using ground-based observational data.

Since Earth observation on a global scale exceeds the capacity of a single government or international organization, international strategic planning of observations is essential to avoid duplication and to fill gaps in observational networks. To achieve this, it is necessary to strengthen the cooperation and coordination among global observing systems and research programmes for integrated global observations. At the same time, relevant international organizations, especially the United Nations specialized agencies, should jointly plan and implement a strategy for integrated global observations to monitor the Earth's atmosphere. In this regard, the Integrated Global Observing Strategy (IGOS) Partnership has an essential role to facilitate the implementation of the integrated global observations. Governments and relevant international partner organizations should support efforts to achieve global observations which aim to satisfy IGOS requirements. As an important partner of the IGOS Partnership, GCOS should submit to SBSTA for further review reports on the progress of the IGOS activities.

Data and information systems

Priority should be given to the improvement of the coordination among numerous different data providers for the generation of accurate, long-term and consistent data. Therefore, it is required to promote initiatives for the following actions through international cooperation:

i. establish interchange format and quality control method for the international compatibility of observational data;

ii. establish data archiving system for improved compilation of data;

iii. promote the common use of the data archives and networks that store and access data;

iv. develop information system and services for active exchange of data obtained.

(c) Observation of the spatial distribution of greenhouse gases and aerosols

Strengthening systematic observation is essential for identifying the occurrence of climate change and improving the accuracy of climate models. In particular, it is important to observe the carbon cycle, including sequestrations and emissions of CO_2 by terrestrial ecosystems and oceans. It is also important to observe GHGs, as well as other climate forcing agents such as aerosols and clouds, and changes in precipitation patterns.

Besides observation of the carbon cycle, it is imperative to observe the global water cycle. Since water vapor is the largest forcing agent, the water cycle and global warming greatly affect each other. Changes in the water cycle also induce changes in precipitation patterns and extreme weather events.

In order to monitor the impacts of climate change which have already appeared in various areas, the following research activities are necessary

- development of monitoring methodologies and establishment of monitoring systems using those methodologies and international networks

- inter alia, establishment of monitoring systems in small island countries and other vulnerable developing counties.

New Zealand

In addition to specific research, an ongoing internationally coordinated programme of systematic observations is vital, so that scientists can address these research questions and test predictions of changes and impacts, and monitor the effects of mitigation activities.

Norway

Systematic observations

In the TAR it is stated that there is a particular need for additional systematic and sustained observations, modelling and process studies, and that a serious concern is the decline of observational networks.

The TAR identifies gaps in knowledge regarding the simulation of regional impacts of climate change. This is the case for average weather conditions in general, and changes in extreme events in particular. In our view, further work should be done to improve the regional forecasts towards higher accuracy and finer spatial scale. These efforts should be co-ordinated with strengthened systematic observation – especially in the poorly mapped developing world.

Uzbekistan

Uzbekistan would underline the importance of development of separate directions in the future report on research and additional data for integrated assessment of climate change impact to sustainable development, as such as the water resources security and strengthening of degradation lands processes and also their interaction.

USA

Climate Observing System

- A long-term global climate observing system that provides a more definitive observational foundation to evaluate decadal-to-century-scale variability and change remains critical to future projections of climate change. Such a system must include observations of key state variables such as temperature, precipitation, humidity, pressure, clouds, sea ice and snow cover, sea level, sea-surface and ocean temperatures, and soil moisture. Improved measurements of water vapor (particularly the vertical profile) and clouds are especially important. Forcing agents and their fluxes must also be observed and quantified, including for example aerosol, methane, and ozone abundances, and carbon fluxes. Comprehensive monitoring systems need to incorporate the following attributes:

    (1) Development of "climate quality" data, with stable measurement methods, consistent exposures, good inter-comparison between data sets, and back- and forward-standardization of long-term data records;
    (2) Provisions for high quality data assimilation methods, combined with efficient archiving and retrieval methods, to facilitate research, analysis, and forecasting applications;
    (3) Creative capture of relevant information from the myriad of special research projects conducted throughout the world in recent decades to optimize the information available for scientific analysis and computer model evaluations of global change and climate change; and
    (4) Development of new and complex observations and monitoring systems needed to analyze terrestrial and aquatic ecosystem variability.

- It is also important that a comprehensive monitoring system have a strategy for integrated global observations, as called for in the IPCC TAR. The challenge is to develop one agreed, coherent observation plan for the atmosphere, ocean, and land that integrates space-based and in situ observations across the three elements. SBSTA-16 urged Parties to give priority to the increasing contribution of new and emerging technologies, such as space-based systems. The Global Climate Observing System (GCOS), Global Ocean Observing System (GOOS), and Global Terrestrial Observing System (GTOS), together with the other Integrated Global Observing Strategy (IGOS) Partners, are working to develop international consensus on overall needs. GCOS has included a broader range of experts, including those from the IPCC, in preparation of the second "Report on the Adequacy of Observing Systems for Climate." SBSTA also stressed the importance of taking an integrated approach to this assessment, including the use of new and emerging methods of observation. Scientists need to develop increased expertise in using integrated datasets from satellites and in-situ instruments to develop new multi-faceted approaches relevant to help address significant scientific questions.

2. Processes, driving forces and feedbacks in and sensitivity of the climate system

Australia

Climate system modelling and processes.

- improved understanding of the climate system, e.g. the oceans role, sources and sinks of greenhouse gases

- improved understanding of feedbacks in the climate system, eg. radiation, cloud processes, aerosols, water vapour, terrestrial carbon dynamics

- improved methods of detection and attribution of climate change at global and regional scales

- development and assessment of alternative approaches to understanding and projecting the regional impacts of climate change, in a risk assessment framework using the full range of available climate models

- improved projections of climate change, climate variability and extremes, at both global and regional scales, including probabilities where possible.

Canada

There are undoubtedly a number of scientific and technical uncertainties to the climate change response which further research by the scientific community would reduce, i.e. with respect to the projected magnitude and rate of climate changes under different emissions scenarios; a better understanding of the role of the carbon cycle and biological carbon storage building on the work of the IPCC Special Report on Land-use, Land-use Change and Forestry.

China

Climate sensitivity and the projection of atmospheric CO_2 concentration

In order to significantly improve our understanding of present and future climate changes, scientific community has to pay more attention to the study of processes and feedbacks within climate system. Special efforts should be given to: The establishment of a believable emission scenarios of greenhouse gases and aerosol. Effects of marine biological, physical and chemical processes on atmospheric CO_2 concentration; Impacts of land use/land cover change and terrestrial ecosystem change on global carbon cycle; The response and feedback of cloud, moisture and mineral aerosol to climate change; Palaeo-climate dynamics on time scales of decade to millennia.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

- Reducing the uncertainty in the sensitivity of the climate system to greenhouse gases and other forcings. Improving the quantification of the anthropogenic component of observed changes in climate, and improving the estimates of possible natural influences and natural variability.

- Assessment of global and regional impacts and risks associated with various greenhouse gas stabilisation levels and pathways. This should also include better estimates of thresholds and probabilities for abrupt, or irreversible events, and assessment of the risk of the possible amplification (or amelioration) of anthropogenic climate change.

Japan

Further development of climate models and reduction of scientific uncertainties

(a) The future design of measures to tackle climate change must be based on more reliable projections of the future climate system. Research on the following subjects is of great importance for improving climate models and enabling us to make more reliable projections.

- effects of aerosols and clouds on the dynamics as well as the thermodynamics of the

- effects of climate forcing agents other than aerosols and clouds;
  change and feedback in the carbon cycle in terrestrial ecosystems and oceans;

- changes in precipitation patterns and extreme events induced by water cycle variations through climate change

(b) The impact of climate change varies from region to region. It is necessary to develop methods to obtain climate change projections with smaller geographical scales. It should be recognized that further improvement of global to regional scale projections is indispensable for downscaling.

(c) Further research is needed on the inertia of climate change, including possible large-scale and long-term changes in polar regions.

(d) Further research is needed on large-scale, high impact, non-linear and potentially abrupt changes in physical and biological systems, including changes in the thermohaline circulation of the oceans.

(e) A mechanism should be developed to ensure that the outcome of research on climate models can be used as quickly as possible for research on the effects of climate change.

(f) Intensive and comprehensive research is needed to understand the global carbon cycle, including observation and synthesis of terrestrial and oceanic carbon sources and sinks, data assimilation into models, and integration of the biophysical and human dimensions.

New Zealand

The efforts of the Parties to decide on the degree and balance between mitigation and adaptation, and global distribution of efforts and responsibilities, would be helped by the following scientific information and assessments:

- reduction of uncertainty of the climate sensitivity factor;
- better identification of thresholds for low-probability, high-impact large-scale events, which would assist determining levels of greenhouse gas concentrations that may be deemed non-dangerous compared to natural pressures on resources.

Norway

Large-scale abrupt changes

The prospect of surprises due to the non-linear nature of the climate system is dealt with in the TAR. Advances in knowledge are needed to better understand the physical mechanisms, likelihood, magnitude, time scale and reversibility associated with such phenomena. Areas of focus could be studies of the thermohaline circulation, effects due to changes in ice sheets and carbon cycle feedbacks in the terrestrial biosphere and release of greenhouse gases from permafrost regions and hydrates.

Long-term changes

In relation to projected climate changes, the TAR correctly focuses primarily on changes in 2100. We would welcome further research related to longer term climatic changes. From the TAR we know that some impacts of current emissions of greenhouse gases may be too slow to become apparent and some could be irreversible if emissions and related climate changes are not limited in both rate and magnitude before associated thresholds are crossed (i.e. inertia). Thus we see the need for further research on this, including the possible thresholds and their levels.

Russian Federation

The SBSTA also noted a need for more scientific research on greenhouse atmospheric concentration and forcing agents, which can influence the climate system.

USA

Knowledge Base on Aerosols, Driving Forces and Feedback Loops

- It would be particularly useful if the scientific and technical community could provide more information on the relative contributions to climate change of atmospheric forcing factors, as well as land cover and land use change. To improve and quantify confidence in future projections of climate change, uncertainties need to be reduced in at least three key areas:

  (1) Human-induced factors such as atmospheric concentrations of greenhouse gases and aerosols, and land cover change;
  (2) Natural factors, such as changes in solar radiation and aerosols; and
  (3) Feedbacks within the climate system that determine the sensitivity of the climate system to changes in forcing.

- The relative importance of carbon-based (black carbon) aerosols, sulfate-based aerosols, and carbon dioxide/other greenhouse gas emissions and tropospheric ozone in influencing climate requires further scientific attention as each is related to different control strategies. Additionally, more comprehensive measurements of greenhouse gases and aerosols would provide critical information about their local and regional source and sink strengths.
- Feedbacks and interactions are critical to climate sensitivity, on both local and global scales. In the case of local feedbacks, understanding is currently limited, and a great deal of research is needed. This submission cannot cover the full range of research needs, but the United States wishes to note some examples, not in priority order:

  (1) The relationship between both local and global forcing (including aerosols in particular) and responses in large and small-scale cloud systems;
  (2) Global water cycles, including the inability of general circulation models to successfully represent water vapor transport (particularly in the equatorial regions) as well as Arctic ice and snow cover;
  (3) Climate-ecosystem interactions, including dynamic vegetation and disturbance processes that reflect climate drivers;
  (4) Land use/land cover influences on climate, and the coupling between other climatic variables and land use change; and
  (5) The poor regional performance of current general circulation models, which severely restricts the examination of potential global change influences on key regional ecosystems and water sources such as bays, estuaries, snowpack, rainfall patterns, and inland watersheds.

B. Modelling

Australia

Climate system modeling and processes

- improved understanding of the climate system, e.g. the oceans role, sources and sinks of greenhouse gases

- improved understanding of feedbacks in the climate system, eg. radiation, cloud processes, aerosols, water vapour, terrestrial carbon dynamics

- improved methods of detection and attribution of climate change at global and regional scales

- development and assessment of alternative approaches to understanding and projecting the regional impacts of climate change, in a risk assessment framework using the full range of available climate models

- improved projections of climate change, climate variability and extremes, at both global and regional scales, including probabilities where possible.

Azerbaijan

It is possible to prepare an assistance program for preparation the regional climate scenarios.

Bolivia

Increasing the accuracy of Global Circulation Models and developing Regional Circulation Models for South America to understand in deep temperature and precipitation changes.

- The government of Bolivia recognize the need to increasing the accuracy of Global Circulation Models and developing Regional Circulation Models to understand in deep temperature and precipitation changes.
- Current Global Circulation Models lack an sufficient accuracy to understand which are the changes in Temperature and Precipitation in regions with complex Physiographies like mountain chains.
- Regional Circulation Models with enhanced spatial resolution can fill this gaps and provide a basis for vulnerability and adaptation studies to understand vulnerability and adaptation in different sectors and regions.
- The government of Bolivia support the initiatives to develop Regional Circulation Models and urge SBSTA to put special attention to develop climate models for mountain ecosystems. In the context of international cooperation SBSTA should put special attention to develop Regional Circulation Models for the whole Andes Region.

Canada

- Priority should be given to improved climate and socio-economic models that reflect more detailed regional and local features.
- There is also a need for improved modeling approaches that focus specifically on development drivers and possibilities for alternative development paths in non-Annex I countries.
- There are undoubtedly a number of scientific and technical uncertainties to the climate change response which further research by the scientific community would reduce, i.e. projected magnitude and rate of climate changes under different emissions scenarios.

China

Detection and attribution of natural and anthropogenic changes

- The improvement of climate model and development of methodology is needed in order to distinguish the anthropogenic change from natural variability on different time and spatial scales, especially to confirm the key elements which induce the climate change during last 100 years.

Development, test and projection of climate models

More sophisticated climate system models and regional climate models should be developed. Comparison of different models and palaeo-climate modeling should be encouraged for evaluating the models' performance and for modifying the models. Models' ability to simulate the extreme weather events and abrupt climate change should be increased, and estimation of possibilities of their occurrence could be made. The modeling prediction of possible change in the future and its uncertainty should be described scientifically.

Colombia

Correlation between climate change, extreme weather phenomena and increased climate vulnerability

- The links between climate change, extreme weather phenomena and increased climate vulnerability should be further studied, especially at the regional level, in order to fully understand the range of impacts associated to climate change and the inertia that characterizes it.

- One concrete request would deal with research regarding possible increases in storms, river and delta flooding and other natural phenomenon due to sea live rise.

Reduction of uncertainties in projected changes linked to global climate change

- There is a need for higher levels of certainty regarding the frequency, intensity, occurrence, distribution and impacts of expected climate change-related alterations.

- A specific task could be the promotion of modelling activities aimed at improving predictions on the magnitude of sea level rise, the probabilities of its occurrence, and the actual rate of the rise.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

- Improvements in modelling regional and subregional climate change, for integrated assessment of impacts, vulnerability and adaptation, including the size and frequency of extreme events (storms, floods, droughts, etc).

- Assessment of global and regional impacts and risks associated with various greenhouse gas stabilisation levels and pathways. This should also include better estimates of thresholds and probabilities for abrupt, or irreversible events, and assessment of the risk of the possible amplification (or amelioration) of anthropogenic climate change.

- Improving the quantification of the anthropogenic component of observed changes in climate, and improving the estimates of possible natural influences and natural variability.

- Assessment of the economic, environmental and social costs and benefits associated with different stabilisation levels and pathways and the technological scenarios associated with each, including improved understanding of factors affecting inertia to change and learning processes.

Japan

Further development of climate models and reduction of scientific uncertainties

State-of-the art global climate models still have some inconsistency in simulating the mean climate and its variability. To reduce uncertainties in projections, it is essential to identify what causes the inconsistency and to improve the model simulations.

(a) The future design of measures to tackle climate change must be based on more reliable projections of the future climate system. Research on the following subjects is of great importance for improving climate models and enabling us to make more reliable projections.

- effects of aerosols and clouds on the dynamics as well as the thermodynamics of the climate system
- effects of climate forcing agents other than aerosols and clouds
- change and feedback in the carbon cycle in terrestrial ecosystems and oceans
- changes in precipitation patterns and extreme events induced by water cycle variations through climate change

(b) The impact of climate change varies from region to region. It is necessary to develop methods to obtain climate change projections with smaller geographical scales. It should be recognized that further improvement of global to regional scale projections is indispensable for downscaling.

(c) Further research is needed on the inertia of climate change, including possible large-scale and long-term changes in polar regions.

(d) Further research is needed on large-scale, high impact, non-linear and potentially abrupt changes in physical and biological systems, including changes in the thermohaline circulation of the oceans.

(e) A mechanism should be developed to ensure that the outcome of research on climate models can be used as quickly as possible for research on the effects of climate change.

(f) Intensive and comprehensive research is needed to understand the global carbon cycle, including observation and synthesis of terrestrial and oceanic carbon sources and sinks, data assimilation into models, and integration of the biophysical and human dimensions.

Further research on emission scenarios

(a) Difference in emission scenarios as well as uncertainties in climate models arises in the wide range in climate change projections. Although it is scientifically impossible to predict the accurate future ways of development in the world, it is necessary to improve individual scenarios as well as consider the probability of the scenarios by enhancing consistency among sectors and regions.

(b) It is also necessary to project the future emissions of groups of countries such as developed countries, countries that are undergoing the process of transition to a market economy and developing countries in each scenario.

(c) The existing scenarios mainly focus on emissions from energy sectors and CO_2 emissions. The other scenarios such as those focusing on land use change should be further improved.

- Policy assessment should be made including the effects of the implementation of the Kyoto Protocol in the first commitment period, in conjunction with climate change impact assessment, to find outeffective integrated mitigation and adaptation measures. Emission-climate-impact integrated models could be a useful tool for such assessment.

New Zealand

The efforts of the Parties to decide on the degree and balance between mitigation and adaptation, and global distribution of efforts and responsibilities, would be helped by the following scientific information and assessments:

- reduction of uncertainty of the climate sensitivity factor;
- improvement in regional and local climate change projections and their uncertainties, and better understanding and communication of model differences leading to various projections;
- reduction of uncertainty in predictions of changes in the frequency and intensity of extreme events and their regional variations;
- better identification of thresholds for low-probability, high-impact large-scale events, which would assist determining levels of greenhouse gas concentrations that may be deemed non-dangerous compared to natural pressures on resources.

Norway

Climate extremes

The TAR indicates that the effects caused by extreme weather and climate events might be more severe than the results of the expected change in average conditions. There is still a lot of work to be done in relation to the predictability regarding the localisation, frequency and intensity of such events. Additional data gathering, modelling studies and simulation capacity are needed to achieve a better understanding of extreme events in terms of likelihood, frequency and spatial distribution. The TAR reveals that the gaps in knowledge might be particularly large for non-temperature extreme weather phenomena associated with precipitation, drying and wind. With regard to precipitation, we believe that both heavy rain- and snowfall, including the risk of avalanches and land slides, should be further studied. Research on climate extremes should be strengthened in general, to increase predictability and to find low-cost mitigation measures.

Regional changes

The TAR identifies gaps in knowledge regarding the simulation of regional impacts of climate change. This is the case for average weather conditions in general, and changes in extreme events in particular. In our view, further work should be done to improve the regional forecasts towards higher accuracy and finer spatial scale. These efforts should be co-ordinated with strengthened systematic observation – especially in the poorly mapped developing world.

Further work is also needed to improve the understanding of the potential consequences of climate change on a regional scale. These studies should focus on effects on both physical, biological and human systems, and should include the additional stress induced by other factors such as demographic shifts and land-use changes. This research is particularly needed for developing regions, indigenous communities

and marginalised unique ecosystems. This work should also deal with the current and short-term regional effects of climate change. Areas of interest could for example be the possible role of climate change and recent extreme weather events, and the effects from such events on resources, demography and political stability.

Large-scale abrupt changes

The prospect of surprises due to the non-linear nature of the climate system is dealt with in the TAR. Advances in knowledge are needed to better understand the physical mechanisms, likelihood, magnitude, time scale and reversibility associated with such phenomena. Areas of focus could be studies of the thermohaline circulation, effects due to changes in ice sheets and carbon cycle feedbacks in the terrestrial biosphere and release of greenhouse gases from permafrost regions and hydrates.

Long-term changes

In relation to projected climate changes, the TAR correctly focuses primarily on changes in 2100. We would welcome further research related to longer term climatic changes. From the TAR we know that some impacts of current emissions of greenhouse gases may be too slow to become apparent and some could be irreversible if emissions and related climate changes are not limited in both rate and magnitude before associated thresholds are crossed (i.e. inertia). Thus w see the need for further research on this, including the possible thresholds and their levels.

USA

Climate Change Modeling

Reliance on models demands careful attention to their associated limitations and assumptions. In particular, great attention has been paid to global mean surface temperatures, even though some results are based solely on simple models that do not fully incorporate other major climate change variables (for example, those associated with the hydrological cycle). We also note that there remain significant uncertainties concerning the local and regional response of climatic phenomena. It is clear that more robust indicators that reflect regional and local climate change and variability have important policy implications and need to be developed. Focus on research and development of relevant tools and technologies by the scientific and technological community to reduce the uncertainties in these analyses and projections will be required.

C. Impacts, vulnerability and adaptation

Australia

Climate change impacts

- improved understanding of the thresholds that might produce sudden or irreversible change and the potential impacts of such changes, eg. weakening or cessation of the thermohaline circulation of the ocean and its impacts on climate and human systems

- integrated assessment of regional impacts across various industries, activities, societies and ecosystems, including socio-economic outcomes

- special attention to the effects of long time scales and inertia in the climate system, and indeed also in the socio-economic system, which affects the urgency and time scales of adaptation and mitigation actions.

Adaptation and Mitigation

- improved understanding of both short-term and long-term mitigation and adaptation options that maximise achievement of sustainable development

- assessment of relative effectiveness of different mitigation and adaptation responses

- region-specific studies of integrated adaptation and mitigation options which identify opportunities and barriers within a risk assessment framework and considering cost-benefit analyses

- development of frameworks for taking into account uncertainty, and socio-economic and environmental risk in policy making related to climate change – this requires quantification of the risk associated with various impacts

Canada

More research is needed to understand the vulnerabilities, impact of and adaptation to Arctic climate changes.

Colombia

1) Vulnerability assessment and differential climate change impacts

As a key step to improve local adaptation capabilities to respond to the adverse effects of climate change, we consider it a priority for the scientific community to further study the vulnerability of regional ecosystems to the projected alterations linked with global climate change.

a) Future research could focus on certain regional ecosystems that have not been the object of extensive studies. Such is the case of mountain ecosystems and high plateaus, in particular the Andean *paramo*, not commonly perceived as being highly vulnerable to climate change.
b) With regards to coastal zones and marine ecosystems (which have been studied in more detail) partial data at local scale on natural and anthropogenic threats needs to be completed. Detailed cartography and unified coastal lines need to be developed at a local/regional scale, as well as studies on local coastal and delta geomorphology.

Specifically, further knowledge is required at a local dimension with regards to:

(i) Current state of aquifers in the Caribbean and Pacific coastal zones
(ii) Evaluation and measurement of saline intrusion
(iii) Land use change as a result of flooding and saline intrusion
Coastal erosion and accretion processes – location, historical changes, magnitude, causes and possible consequences
Effects of sea level rise (flooding, erosion and saline intrusion) on natural resource use.

2) Further research is needed regarding local strategies aimed at creating greater resilience to face potential climate-related harm. These strategies must take into account poverty and inequality issues, governance factors and effective territorial planning options that address climate change. In this regard, the scientific community could help guide policymakers on the effects of and links between territorial planning and adaptive capacities.

3) Vulnerability, climate change and agriculture

Not withstanding the fact that agriculture is a multifactored system, investigation efforts should strive for greater linkage between climatic and socioeconomic scenarios to determine the vulnerability of agricultural zones and sectors to climate change, in terms of: Gross Domestic Product, employment prospects, chemical substance use, exports and imports, market opportunities, among others. Specifically, research regarding agriculture and vulnerability could focus on:

a) Evaluating information regarding minimum and optimal climatic conditions for the development of agricultural crops such as: temperatures, rainfall, solar radiation, water needs, among others

b) Defining and identifying strategic crops and agricultural areas most negatively affected by climate change impacts

c) Specific studies on the expected changes in geographical distribution and productivity of the main crops already identified in the TAR (maize, wheat, rice) as well as others, possibly due to climate change effects and increased climate variability

d) Links between indirect effects of climate change, such as reduction in cultivated areas, and peasant migration phenomena

e) Scarcity of freshwater resources due to climate change and possible rise in production costs

f) Research on crop improvement in order to yield harvest more tolerant to drought and more resistant to plagues and diseases, as well as having shorter cultivation cycles that allow greater flexibility in conditions of climate change.

Migration responses to climate change

Climate change may potentially lead to emigration in highly vulnerable areas. The scientific community relevant to the Convention should therefore take the issue of environmental refugees into account as an additional pressure on societies and regions less vulnerable to climate change.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

Improvements in modelling regional and subregional climate change, for integrated assessment of impacts, vulnerability and adaptation, including the size and frequency of extreme events (storms, floods, droughts, etc).

Assessment of global and regional impacts and risks associated with various greenhouse gas stabilisation levels and pathways. This should also include better estimates of thresholds and probabilities for abrupt, or irreversible events, and assessment of the risk of the possible amplification (or amelioration) of anthropogenic climate change.

Research on methodologies, technologies, timing and costs of adaptation.

Japan

Further development of climate models and reduction of scientific uncertainties

- The impact of climate change varies from region to region. It is necessary to develop methods to obtain climate change projections with smaller geographical scales. It should be recognized that further improvement of global to regional scale projections is indispensable for downscaling.

- Further research is needed on the inertia of climate change, including possible large-scale and long-term changes in polar regions.

- Further research is needed on large-scale, high impact, non-linear and potentially abrupt changes in physical and biological systems, including changes in the thermohaline circulation of the oceans.

- A mechanism should be developed to ensure that the outcome of research on climate models can be used as quickly as possible for research on the effects of climate change.

Further research on existing impacts, prediction of future impacts and possibility of adaptation

(a) In order to monitor the impacts of climate change which have already appeared in various areas, the following research activities are necessary.
  - development of monitoring methodologies and establishment of monitoring systems using those methodologies and international networks
  - inter alia, establishment of monitoring systems in small island countries and other vulnerable developing countries.

(b) The prediction of future impacts of projected climate change should be improved by focusing on the following issues

  - prediction of regional impacts with smaller geographical scales

  - environmental and socio-economic impacts associated with changes in precipitation patterns and extreme events such as floods, droughts, tropical cyclones and ENSO

  - comprehensive risk assessment of climate change impacts including quantitative inter-sectoral risk comparison and integration of various risks

  - prediction of climate change impacts according to different development scenarios

(c) Potential and costs of adaptation measures should be further examined region by region.

New Zealand

The efforts of the Parties to decide on the degree and balance between mitigation and adaptation, and global distribution of efforts and responsibilities, would be helped by the following scientific information and assessments:

- improved links between responses to climate change impacts and “normal” sustainable management and use of natural resources, and methodologies to quantify costs, co-benefits and synergies of adaptation measures;

- reduction of uncertainty in predictions of changes in the frequency and intensity of extreme events and their regional variations;

- better identification of thresholds for low-probability, high-impact large-scale events, which would assist determining levels of greenhouse gas concentrations that may be deemed non-dangerous compared to natural pressures on resources.

Norway

Mitigation and Adaptation

Research on adaptation strategies should also be highlighted, with regional and local focus. As described in the TAR, the projected impacts of extreme events might affect both natural systems, infrastructure and social aspects. Developed countries might be relatively well prepared with respect to technical adaptability, but more information is needed e.g. on effects on human well-being and health, as well as on the vulnerability of (marginalised) eco-systems, with a special focus on the situation in developing countries.

Climate extremes

The TAR indicates that the effects caused by extreme weather and climate events might be more severe than the results of the expected change in average conditions. There is still a lot of work to be done in relation to the predictability regarding the localisation, frequency and intensity of such events. Additional data gathering, modelling studies and simulation capacity are needed to achieve a better understanding of extreme events in terms of likelihood, frequency and spatial distribution. The TAR reveals that the gaps in knowledge might be particularly large for non-temperature extreme weather phenomena associated with precipitation, drying and wind. With regard to precipitation, we believe that both heavy rain- and snowfall, including the risk of avalanches and land slides, should be further studied. Research on climate extremes should be strengthened in general, to increase predictability and to find low-cost mitigation measures.

Regional changes

The TAR identifies gaps in knowledge regarding the simulation of regional impacts of climate change. This is the case for average weather conditions in general, and changes in extreme events in particular. In our view, further work should be done to improve the regional forecasts towards higher accuracy and finer spatial scale. These efforts should be co-ordinated with strengthened systematic observation – especially in the poorly mapped developing world.

Further work is also needed to improve the understanding of the potential consequences of climate change on a regional scale. These studies should focus on effects on both physical, biological and human systems, and should include the additional stress induced by other factors such as demographic shifts and land-use changes. This research is particularly needed for developing regions, indigenous communities and marginalised unique ecosystems. This work should also deal with the current and short-term regional effects of climate change. Areas of interest could for example be the possible role of climate change and recent extreme weather events, and the effects from such events on resources, demography and political stability.

Large-scale abrupt changes

The prospect of surprises due to the non-linear nature of the climate system is dealt with in the TAR. Advances in knowledge are needed to better understand the physical mechanisms, likelihood, magnitude, time scale and reversibility associated with such phenomena. Areas of focus could be studies of the thermohaline circulation, effects due to changes in ice sheets and carbon cycle feedbacks in the terrestrial biosphere and release of greenhouse gases from permafrost regions and hydrates.

USA

Reducing Uncertainties Regarding Potential Impacts

There is some evidence from both observational and modeling studies that recent climate changes have affected physical and biological systems, although factors such as land-use change, resource use and pollution also act on these systems, making attribution difficult. The TAR Working Group II report identified many outstanding uncertainties, including the reliability of local or regional details in projections of climate change. Reducing uncertainties will require extensive research and observational efforts.

Several key research issues that require attention are:

(1) The likelihood of changes in temperature, precipitation and other climate indicators at specific points in time and space (*i.e.*, provide likelihoods, as opposed to a range);
(2) The likelihood of impacts (by region, sector, etc.) of climate change at different points in time for a range of forcing scenarios especially as reflected in disturbance responses such as drought, flood, wildfire and pathogen epidemics;
(3) The potential changes in rates of climate change over the next few decades, as well as associated impacts and vulnerability; and
(4) Projected changes in the hydrological cycle in response to global and regional climate change.

Integrated Assessment of Alternatives

The United States believes that adaptive responses and amelioration of adverse effects of climate change are important areas for further investigation of potential responses evaluation of their effectiveness, and estimation of their costs. Further, the application of integrated assessment and decision analytical frameworks, which take into account economic, social, and biophysical data could allow for the prioritization of adaptive responses, as well as the relative emphasis on adaptation and mitigation.

D. Mitigation

Australia

Adaptation and Mitigation

- improved understanding of both short-term and long-term mitigation and adaptation options that maximise achievement of sustainable development

- assessment of relative effectiveness of different mitigation and adaptation responses

- region-specific studies of integrated adaptation and mitigation options which identify opportunities and barriers within a risk assessment framework and considering cost-benefit analyses

- development of frameworks for taking into account uncertainty, and socio-economic and environmental risk in policy making related to climate change – this requires quantification of the risk associated with various impacts

- further analysis of likely emissions pathways, and associated economic, social and environmental implications. An important aspect of this would be to assess the costs and benefits of mitigation options, timeliness, projected impacts and necessary adaptation measures for various mitigation scenarios

- assessment of how best to enhance innovation in greenhouse gas abatement technologies
- expanded focus on methodological issues in relation to emissions reporting, especially for carbon sequestration measures relating to forests, agricultural lands and other terrestrial ecosystems.

Canada

There are undoubtedly a number of scientific and technical uncertainties to the climate change response which further research by the scientific community would reduce, i.e. with respect a better understanding of the role of the carbon cycle and biological carbon storage building on the work of the IPCC Special Report on Land-use, Land-use Change and Forestry; the synergies and trade-offs among land use, land-use change, adaptation, mitigation and vulnerability issues; further examination of the relationship between adaptation and mitigation , including how timing of emission reductions affects the optimal balance of adaptation and mitigation; the effectiveness of measures; the potential for non-CO_2 greenhouse gas reductions; and more information (both monetary and non-monetary) about ancillary benefits and the costs of damages. Further assessment of the technological potential for different emissions reduction pathways, in both the short term and long term and on both a detailed regional and sub-regional basis, would reduce uncertainties with regards to what options are open and what they will cost.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

Assessment of the economic, environmental and social costs and benefits associated with different stabilisation levels and pathways and the technological scenarios associated with each, including improved understanding of factors affecting inertia to change and learning processes.

Assessments of the constraints and opportunities for adoption of low GHG emitting technologies.

Japan

Further research on mitigation measures:

(a) Potentials, barriers and costs of mitigation measures should be examined in terms of emission scenario, region, country and sector.

(b) Effects (including ancillary benefits) of mitigation measures and their implication with sustainable development should be further examined.

(c) The further investigation should be made for opportunities of individual technologies and measures to mitigate climate change. Such technologies and measures should include (i) mitigation and prevention technologies such as separation, recovery, sequestration and utilization of carbon and green house gases, (ii) renewable and alternative energy technologies, resources and products, as well as energy efficiency measures and technologies, and (iii) green house gas sinks.

New Zealand

The efforts of the Parties to decide on the degree and balance between mitigation and adaptation, and global distribution of efforts and responsibilities, would be helped by the following scientific information and assessments:

- improvements in bottom-up and top-down assessments of mitigation costs and barriers to implementation, and consistent treatment of ancillary benefits and negative cost options, revenue recycling, and transaction costs.

Norway

Mitigation and Adaptation

It is very important to continue the research on mitigation options and related costs and benefits. In this regard, analyses of barriers for implementation of the mitigation strategies as well as policy instruments are essential and should be given priority. Important research areas include options within the energy and transport sectors, where there are large potentials for reductions. Furthermore, “no regret” options (as defined in the TAR) as well as co-benefits of measures should be focused.

Uzbekistan

Fourth Assessment Report necessary will develop items related with methodologies on economic assessment of negative consequences of climate change and cost of mitigating measures, especially, for the countries with transition economy. The analysis and regional economic assessment of potential damage due no establishing of responsible measures is highly important, because there is break between the implementation of mitigation policy and scientific recommendations.

Presently, very important items also are the economic analysis of expenses and benefits ratio in the most successful transfer of technology projects, the increasing of energy efficiency in technological processes and the use of renewed sources energy.

USA

Technological Change, Diffusion and Cost

Further discussion and review of least-cost pathways for meeting a particular stabilization goal are needed beyond those studies identified in Chapter 8 of the Working Group III TAR. These studies indicate that such pathways tend to depart gradually from the baseline in early years with more rapid reductions later on. This minimizes premature retirement of capital stock and permits sufficient time for the development and deployment of low-GHG emitting technologies.

Many of the differences between model projections of costs to address climate change stem from different assumptions regarding technological change. Certain aspects of technology diffusion, including the rates of change that are possible, remain poorly understood and merit further research and assessment, as well.

Alternative Mitigation Strategies

Further research and assessment are needed on the implications of different strategies with respect to CO_2 and non-CO_2 gases, as well as carbonaceous aerosols, and actions (*e.g.*, sequestration), on the

nature, timing and cost of climate change mitigation. The potential of carbon capture, separation and sequestration technologies as well as associated environmental benefits and risks are sufficiently promising that they merit focused and systematic study. The time scales of forcing, responses, and costs associated with a range of different policy choices merit investigation with such an approach.

Renewable Energy Resource Distribution

Past studies have characterized renewable energy technologies, but not their cost-effective geographic distribution. Information on the magnitude and distribution of renewable energy resources and technology distribution would facilitate country-specific development efforts on those technologies with the greatest potential to replace CO_2-producing energy sources.

Biological Mitigation

It is also important to further explore biological mitigation, including:

(1) Conservation of existing pools of sequestered carbon;
(2) Augmentation of existing pools; and
(3) Substitution of biomass and other materials for fossil fuels.

Working Group III notes the importance of biological mitigation, and identifies questions about the uncertainty regarding the potential magnitude of biological mitigation and the lack of comparability between costs associated with various mitigation strategies. It is particularly important to address both the measurement of, and the costs and benefits associated with, preventing deforestation, especially in the tropics. As noted by Working Group III, improving the accuracy of global estimates of carbon emissions from deforestation remains an urgent and challenging task.

E. Cross-cutting issues

1. Effectiveness and effects of the implementation of the Kyoto Protocol

China

Estimation of effectiveness of the Kyoto Protocol implementation

The Convention prescribes that the developed countries will firstly take action to reduce the emission of greenhouse gases. So it is an urgent task for IPCC to assess the effectiveness of the implementation of Kyoto Protocol to globe climate change in the future.

Colombia

Probable adverse effects of response measures under the Kyoto Protocol on fossil fuel exports

a) Quantification of such adverse effects in terms of Gross Domestic Product, employment prospects, exports and imports, market opportunities, among others;
b) Effects of possible oil supply failure (in the mid to long term) on projected emissions scenarios and climate change predictions.

Japan

Policy assessment should be made including the effects of the implementation of the Kyoto Protocol in the first commitment period, in conjunction with climate change impact assessment, to find outeffective

integrated mitigation and adaptation measures. Emission-climate-impact integrated models could be a useful tool for such assessment.

2. Assessing dangerous anthropogenic interference with the climate system

Australia

An important part of the research agenda includes developing the scientific basis for policies to achieve the ultimate objective of the UNFCCC, as expressed in Article 2. The TAR provides useful information to the Parties that is relevant to the long-term stabilisation of greenhouse gases in this context. A future focus for research could therefore build on the work of the TAR in meeting the objective of the Convention through further examination of the impacts of differing stabilisation levels, the capacity for adaptation to respond to these impacts, including explicit analysis of any irreversible impacts. Further analysis of abatement pathways, including timing of a portfolio of mitigation actions required to reach particular stabilisation levels would also be useful.

Canada

The TAR suggests that decisions on what constitutes critical GHG levels will be intricately linked with further monitoring and research on: detecting, attributing, and projecting climate change and the impacts of climate change; the vulnerabilities of natural and human systems and the adaptive and mitigative capacities of communities from the local to global scale; and the effectiveness of adaptation and mitigation options. International research agencies should be encouraged to focus attention on the conclusions of the TAR on further research and information needs.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

Regarding key research issues, the EU has already made its views known in the submission "Third Assessment Report of the Intergovernmental Panel on Climate Change", which is reproduced in FCCC/SBSTA/2002/MISC5. It would underline the importance of further work on assessing the parameters required to address the ultimate objective of the Convention, improving the assessment of the anthropogenic component of climate change and reducing the uncertainty in the sensitivity of the climate system to increasing greenhouse gas concentrations. It would also encourage cross cutting work to look at the question of stabilisation, which it will discuss in more detail in its next submission.

Japan

Improving scientific knowledge related to the ultimate objective of the Convention

As described in the TAR the decision on the ultimate objective of the convention requires value judgment. On the other hand, the best scientific knowledge should be provided for the policy decision. Although a lot of new information was compiled in the TAR, further improvement of scientific knowledge is needed. In this regard the research on the subjects described above from 1 to 5 as well as integrated research activities which bridge emission scenario, climate model, impact analysis and response measures are important. They will provide scientific knowledge for better decision making on the ultimate objective of the Convention. Nevertheless, we should recognize that a set of scientific information enabling the complete quantification of the ultimate objective may not be obtained in the near future. Therefore, practical approaches to address climate change under certain level of uncertainty should also be explored.

Norway

It is Norway's view that research, which may assist Parties in achieving the ultimate objective of the Convention should be a high priority of the SBSTA. We see a need to decide on specific stabilisation targets for greenhouse gases in the atmosphere and develop possible paths towards this ultimate objective. The SBSTA should start assessing different stabilisation scenarios and the climatic impacts associated with them for the different regions of the world. It would be advantageous if these regional impacts could be quantified as detailed as possible. Information on different time frames of reductions required in order to obtain these stabilisation levels, and under what conditions, should be made available. Analyses of costs and benefits of the mitigation efforts needed would be important input in such a process.

The TAR and the Scenario-report (SRES) contain information that would be helpful in the assessment. Further information will be available in the coming years, and close cooperation between the SBSTA and the IPCC is necessary.

Russian Federation

Russian Federation believes that researches on levels of greenhouse gas atmospheric concentrations that may cause dangerous influence on climate system of the Earth is a priority condition for achieving the above tasks. TAR indicated their importance for reaching ultimate objective, principles and provisions of the Convention and justification of commitments, policies, and measures on reduction greenhouse gas emissions that were taken by the Annex I Parties in accordance with Kyoto Protocol. The SBSTA also noted a need for more scientific research on greenhouse gas atmospheric concentration and forcing agents, which can influence the climate system (paragraph 4 (a), document FCCC/SBSTA/2002/CRP.3/REV.1).

Russian Federation proposes to prepare a Technical Paper on permissible levels of greenhouse gas atmospheric concentrations and other forcing agents that do not cause dangerous interference with the climate system. The Technical Paper should summarize the latest scientific knowledge of the dynamics of greenhouse gasses and aerosol accumulation and interaction in the atmosphere, together with their transformation and impact on global climate.

3. Integrated approach to adaptation and mitigation in the framework of strategies for sustainable development

Australia

Adaptation and Mitigation

- improved understanding of both short-term and long-term mitigation and adaptation options that maximise achievement of sustainable development
- assessment of relative effectiveness of different mitigation and adaptation responses
- region-specific studies of integrated adaptation and mitigation options which identify opportunities and barriers within a risk assessment framework and considering cost-benefit analyses.

Canada

The TAR also points to the fact that a portfolio of both adaptation and mitigation measures will prove to be the most effective response to climate change, and the SBSTA should begin to explore policy frameworks that take into account these synergies.

There are undoubtedly a number of scientific and technical uncertainties to the climate change response which further research by the scientific community would reduce, i.e. the synergies and trade-offs among land use, land-use change, adaptation, mitigation and vulnerability issues; further examination of the relationship between adaptation and mitigation, including how timing of emission reductions affects the optimal balance of adaptation and mitigation.

Denmark on behalf of the European Community and Bulgaria, Croatia, Czech Republic, Hungary, Lithuania, Poland, Slovakia and Slovenia

- Assessing integrated approaches to adaptation and mitigation in the framework of strategies for sustainable development.

- Assessing how regional/national development strategies can simultaneously meet development priorities and address climate change.

Japan

- Policy assessment should be made including the effects of the implementation of the Kyoto Protocol in the first commitment period, in conjunction with climate change impact assessment, to find out effective integrated mitigation and adaptation measures. Emission-climate-impact integrated models could be a useful tool for such assessment.

New Zealand

The efforts of the Parties to decide on the degree and balance between mitigation and adaptation, and global distribution of efforts and responsibilities, would be helped by the following scientific information and assessments:

- methodological frameworks for defining and assessing economic, social and environmental mitigative and adaptive capacity of nations and regions and identify cross-cutting issues (synergies and barriers).

Uzbekistan

Uzbekistan, as the country not having the large financial opportunities, is very interested also in expansion of IPCC activities directed on development of the recommendations and economic assessments on comparative efficiency and cost of separate kinds of activity on GHG emission reduction, which could allow to choose by countries the most effective strategy of a mitigation and adaptation. Presently, very important items also are the economic analysis of expenses and benefits ratio in the most successful transfer of technology projects, the increasing of energy efficiency in technological processes and the use of renewed sources energy.

USA

Integrated Analysis of Mitigation and Adaptation Options

The question of an economically efficient transition to a future that minimizes the economic and environmental consequences of climate change cannot be answered without simultaneous consideration of adaptation and mitigation. Developing the capacity to address climate change now and in the future will require substantial effort, institution building, and innovation. This should be a priority for the scientific and technical community. In this regard, a major concern is the inadequacy of decision models to capture both the benefits and costs associated with climate change and relevant mitigation strategies. The importance of a better assessment of accounting to reflect the full range of benefits and costs across sectors and the impacts on a nation's GDP, investment patterns, consumption levels, and jobs throughout the economy merit investigation.

Integrated Assessment of Alternatives

The United States believes that adaptive responses and amelioration of adverse effects of climate change are important areas for further investigation of potential responses evaluation of their effectiveness, and estimation of their costs. Further, the application of integrated assessment and decision analytical frameworks, which take into account economic, social, and biophysical data could allow for the prioritization of adaptive responses, as well as the relative emphasis on adaptation and mitigation.

4. Methodology/framework for comprehensive risk assessment and risk management approach for climate change policy making under general scientific uncertainty

Australia

- development of frameworks for taking into account uncertainty, and socio-economic and environmental risk in policy making related to climate change – this requires quantification of the risk associated with various impacts

New Zealand

- development of comprehensive risk management approaches to dealing with uncertainty, incorporating:
    - probability distributions for climate sensitivity
    - thresholds for damages in ecological and socio-economic sectors, and the relevance of rate-of-change versus absolute change
    - financial and non-market appraisals of adaptation strategies
    - methodologies for determining possible thresholds and decision points in the evolution of emission pathways in developing and developed countries, with the goal of better understanding drivers and probability distributions of emission scenarios used in the scientific literature
    - treatment and communication of subjective and objective uncertainties
    - consistent treatment and communication of the concepts of probability, uncertainty, impact, and risk, in climate change assessments.

5. Future mitigation commitments

New Zealand

- peer review of current and future scientific work undertaken by SBSTA to determine current, previous and future contributions of nations and regions to anthropogenic climate change, including sensitivities to assumptions and required data (such as the proposal by Brazil);
- assessment of options to determine future mitigation commitments by all Parties on the basis of historical and/or current greenhouse gas emissions, and absorptions by sinks, on the basis of, inter alia, regional, national, per capita, per GDP, or per unit energy net emissions, with regard to:
    - data requirements
    - data availability
    - feasibility of projections
    - measurement frameworks for mitigative and adaptive capacity.

F. Questions related to the Convention for the scientific community

China

Facts and causes of the past climate change

Key scientific questions to be tackled include: what changes have happened to the global and regional temperatures, the rate of precipitation and extreme weather or climate events over the last 100 or 1000 years or for an even longer period? How about the changes in solar radiations, volcanic aerosol, tropospheric aerosols and land use/cover during the corresponding periods? What are the causes for the observed changes in major elements of climate? And how could we detect the anthropogenic global and regional changes of climate in case of the remarkable and multi-scale natural climate changes?

The TAR concludes that there is new and stronger evidence that human-induced increase in atmospheric CO_2 concentration is the main cause for the observed changes in the climate over the past 50 years. We should realize, however, that this conclusion is tentative and might be subject to major modification. Presently, we still don't know the exact position of today's climate in the past 1000 years or longer time due to proxy problems of data and its coverage. So it is necessary for further research. Problems still exist because urbanization effects on terrestrial records might have not been removed completely from the current temperature series. The disparity between surface and aloft temperatures in the last 20-30 year should also be explained more rationally. It should be pointed out that the scientists lack reliable time series data of long-term solar radiation, natural and anthropogenic aerosols for investigating the causes of climate change. The ability of climate models to simulate the low-frequency climate change is considered to be low at present, and their role in studying climate change detection and attribution will be enhanced only if they are significantly improved.

Key processes and feedbacks in climate system

There are many important questions in this respect which accurate answers should be given: what are the magnitudes and rates of terrestrial and ocean carbon emissions and sequestration? How to accurately estimate the future change in concentration of the atmospheric greenhouse gases? What is the sensitivity of climate system to varied forcing including greenhouse gases? What is the mechanism for the documented rapid climate changes in the past time?

Our understanding of these questions is limited, and much work is needed in observation and research in the future. Efforts should be given to the processes of bio-geo-chemical cycles of the key earth elements including carbon, the response and feedback of clouds and moisture to climate change, the interactions among ecosystems, cryosphere and climate change, and the palaeo-processes relevant to the understanding of modern climate change. Only if substantial progress be made in these areas, could we be more confident to estimate the sensitivity of the earth climate system.

Climate models and the prediction of the future climate trend

The scientific questions which need to be studied and assessed include: how to reduce the error bars for predicted future concentration of atmospheric greenhouse gases and for the radiation magnitudes of the gases and aerosols? How to test and improve the ability of hierarchy of climate models? And how to use these models to predict the global and regional climate change probably induced by the increased concentration of atmospheric carbon dioxide and other trace gases, and to depict the confidence or uncertainty especially for the prediction of regional details?

The climate models in use today couldn't simulate with satisfaction the current regional precipitation and extreme weather events, and the palaeo-climate changes. Even for the surface temperature changes, models usually output radically different results for the same region. Large uncertainty is obvious in estimating the radiation forcing of the main species of greenhouse gases and aerosols, particularly in estimating the indirect effect of aerosols. The role played by black carbon from continents should also be further investigated.

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