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Research and systematic observation

Research needs and priorities relating to the Convention

Note by the secretariat

Summary

This synthesis report on research needs and priorities relating to the Convention provides background information and a summary of the priorities for research identified by Parties, of issues relating to capacity-building and of other issues relating to research under the Convention. It also describes the process of research and its coordination at international, regional and national levels. The document identifies several questions that the Subsidiary Body for Scientific and Technological Advice may wish to consider in relation to research needs and priorities relating to the Convention.

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Introduction

Mandate

The Conference of the Parties (COP), by its decision 9/CP.11, requested the Subsidiary Body for Scientific and Technological Advice (SBSTA) to regularly consider research needs relating to the Convention in order to inform Parties about ongoing and planned activities of regional and international climate change research programmes, and to communicate Parties' views on research needs and priorities to the scientific community.

The SBSTA, at its twenty-second session,¹ invited Parties to submit to the secretariat, by 15 January 2006, information on identified research needs and priorities relating to the Convention, including information relating to the enhancement of the capacity of developing countries to contribute to and participate in climate change research. The SBSTA requested the secretariat to prepare a synthesis report on the research needs and priorities relating to the Convention, identified in documents FCCC/SBSTA/2002/INF.17 and FCCC/SBSTA/2005/3, in the submissions by Parties referred to above, in national communications, and in the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC), and to make this synthesis report available to Parties and to relevant regional and international climate change research programmes before the twenty-fourth session of the SBSTA. The SBSTA further requested the secretariat to organize a special side event during its twenty-fourth session with the objective of enhancing communication between climate change research organizations and the SBSTA.²

Scope of the note

This note provides a synthesis of views of Parties on research priorities. It also contains a summary of the activities of research organizations as well as some information on how the needs identified by the Parties are met and/or are planned to be met. The inclusion of this information is deemed to be useful for consideration of the issues relating to research by the SBSTA and at the side event referred to in paragraph 2 above.

Possible action by the Subsidiary Body for Scientific and Technological Advice

The SBSTA may wish, taking into account the results of the initial consideration of this matter at SBSTA 20 and 22, to focus on the following issues:

- (a) The specific role the SBSTA could play in stimulating climate change research and promoting research relating to the Convention;
- (b) Approaches to stimulate research in areas not addressed by the global change research programmes, such as mitigation technology and adaptation planning and measures;
- (c) Interaction and cooperation with international research programmes;
- (d) Promoting the establishment and strengthening of regional cooperative research networks.

¹ FCCC/SBSTA/2005/4, paragraphs 77 and 78.

² FCCC/SBSTA/2005/4, paragraph 80.

Sources of information and approach to the synthesis

Research needs and priorities and other issues relating to research under the Convention

In accordance with the mandate, the following main sources were used for the synthesis:

- (a) Documents FCCC/SBSTA/2002/INF.17 which drew on the submissions of 14 Parties in 2002, and FCCC/SBSTA/2005/3 which was based on the views of 5 Parties; both documents included submissions from the European Community and its member States
- (b) Document FCCC/SBSTA/2006/MISC.3 and Add.1 which includes recent submissions from seven Parties (Australia, China, the European Community on behalf of its member States, Japan, Mexico, Switzerland, and the United States of America)
- (c) The Third Assessment Report of the IPCC.

In their recent submissions presented in document FCCC/SBSTA/2006/MISC.3 and Add.1, Parties noted that many of the issues raised in the previous submission on research priorities in 2002 are still a priority, although some progress has been made. In addition, several Parties explicitly stated that their 2005 submissions supplemented the earlier report and did not repeat views that they had provided in 2002 or following the 2004 research event. Accordingly, the approach taken was to synthesize what was presented in earlier documents and to provide an update from the latest documents in more detail where possible.

Parties submitted information in different formats and with various levels of detail. To facilitate the analysis, the information was grouped under four headings: the scientific basis of climate change; impacts, vulnerability and adaptation; mitigation; and integrated approaches to adaptation and mitigation. The synthesis of views from Parties on enhancement of capacity-building presented in section III.B, and on other issues relating to research (including those in FCCC/SBSTA/2005/3) is presented in section III.C, together with an update from more recent submissions where relevant.

Research activities and coordination

Information on research activities was obtained from publicly available sources, primarily websites. The secretariat has also informally solicited information from major regional and international climate change research programmes, and received input from, inter alia, the Asia-Pacific Network for Global Change Research (APN), the Inter-American Institute for Global Change Research (IAI), the World Climate Research Programme (WCRP) and DIVERSITAS.

Information on relevant national research activities was obtained from compilation and synthesis reports of national communications prepared by the secretariat (FCCC/SBI/2003/7 and Add. 1 and FCCC/SBI/2005/18 and Add.4).

Synthesis of needs, priorities and issues relating to research under the Convention

Research topics and priorities

The scientific basis of climate change

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 was highlighted in the previous synthesis reports, including:

- (a) Improving observations and detection of changes in the climate system on a global scale;
- (b) Improving monitoring and observations of regional climate variability and impacts.

In recent submissions Parties confirmed the importance of this area and noted that, although progress has been made since 2002, more emphasis is needed.

In this regard Japan and the United States of America highlighted two key priorities: enhancing global research capacity and expanding coverage of Earth observations. Continued support for existing international global change research programmes and scientific activities is required.

Parties also highlighted capacity-building as an essential tool for increasing capability for climate monitoring and for analysing climate observations. Enhancing the links among geospatial, oceanic and terrestrial data sets is critical for decision-making at global, regional and national levels. The Global Climate Observing System (GCOS) cooperative mechanism and the Global Earth Observation System of Systems (GEOSS) provide strategies for more coordinated approaches to these issues.

In its recent submission, the United States stressed that the wealth of research results and data produced now and in the future must be made available to decision makers at local, national, regional and international levels. Australia and the United States also noted that observations are the foundation for all research, and that improving access to existing data is critical for all countries, and especially developing countries, for enhancing their ability to benefit from and better participate in global change research. Australia also noted the GCOS Implementation Plan as a major step forward in the need for quality systematic observation.

The importance of **improved understanding of radiative forcing, processes and coupling** in the climate system was highlighted in the previous synthesis reports and confirmed in recent submissions, in particular in the areas of:

- (a) Climate forcing due to natural and human-induced factors;
- (b) Sensitivity of and feedbacks within the climate system, on both local and global scales, and their interaction;
- (c) Attribution of climate change at different time and spatial scales.

In their recent submissions Parties identified further priorities for the scientific community, including:

- (a) Improved characterization of important unresolved processes and feedbacks, both physical and biogeochemical, in the climate system, specifically the role of carbonaceous aerosols;
- (b) Assessment of the risk of the possible amplification (or amelioration) of anthropogenic climate change due to coupling in the climate system.

Other research topics noted include an **improved understanding of the potential implications of different atmospheric concentrations of greenhouse gases (GHG)**, including evaluation of the uncertainties associated with climate scenarios, sensitivity of key systems and adaptive capacity.

In their submissions in 2002, Parties stressed the need for climate change modelling to gain a 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;
- (c) Long-term climate changes (beyond 2100) and probabilities for abrupt changes in the climate system;
- (d) Climate change impacts, projections of emissions and integrated economic effects associated with adaptation and mitigation.

In their recent submissions Parties confirmed the need to continue to improve the representation of key processes in the climate models, as well as the models themselves, in order to better quantify uncertainties of climate projections and scenarios. This includes integrating climate models of different spatial and time resolution to improve the simulation of climate variability, regional climate changes and extreme events, as well as integrating the models of the physical climate and the biogeochemical system, enhanced with descriptions of human activities.

Impacts, vulnerability and adaptation

Research on impacts, vulnerability and adaptation was indicated as a priority by many Parties in 2002. Important topics include:

- (a) Integrated analysis of climate change impacts and vulnerabilities, including impacts of extreme events and climate variability at regional and smaller geographical scales, as well as the analysis of the additional stress induced by non-climatic factors, and migration responses to climate change;
- (b) Economic assessment of the adverse effects of climate change at global and regional scales;
- (c) Regional and global climate change impacts associated with different GHG stabilization levels and pathways and their likelihood by region, system and sector;
- (d) Likelihood, magnitude and timescale of large impacts and abrupt or irreversible events;
- (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.

All Parties in their recent submissions generally confirmed the above priorities, and recommended that the assessment of global and regional impacts and risks associated with various GHG stabilization levels and emission pathways should take adaptation into account. Enhanced research is needed on improvements in modelling regional and subregional climate change, for integrated assessment of impacts, vulnerability and adaptation, including the size and frequency of extreme events, as well as for specific regions, phenomena and impacts (such as ice coverage, ocean acidity and related impacts on ecosystems). Parties also put greater focus on consideration of the human dimension in the assessment of adaptation, adaptive capacity, sensitivity and vulnerability, including the need for improved tools for integrated assessment to assess policy options.

Mitigation

In the previous synthesis reports, some Parties stressed the need to improve understanding of, and in some cases to assess:

- (a) The effectiveness of measures and implications of different strategies at the regional and national levels, including 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;
- (b) Mitigation options, their costs and the barriers to their implementation;
- (c) Means to enhance innovation in GHG abatement technologies and determinants of the rate of technological change;
- (d) Geographic distribution of renewable sources and analysis of their cost-effectiveness;
- (e) Potential of biological carbon storage;
- (f) Land use, land-use change and forestry, and related accounting and reporting.

In their recent submissions Parties highlighted the need for research and development of applicable technologies for mitigation, including hydrogen-energy technology, and noted the need to assess the economic, environmental and social costs and benefits associated with different stabilization levels and emission pathways and the technological and adaptation scenarios associated with each. The importance of improved understanding of factors affecting resistance to change and learning processes, as well as investigation of technological and social innovation options for mitigation, was also highlighted. Some Parties proposed several research areas in the field of mitigation including urban planning and climate change mitigation, sustainable transport, and studies to develop specific national GHG emission factors.

Integrated approaches to adaptation and mitigation and integration to the sustainable development

In their previous and recent submissions Parties addressed a cross-cutting issue relating to integrated approaches to adaptation and mitigation in the national strategies for sustainable development. Australia and China highlighted the importance of research in the area of assessment of mitigation options in the context of development, sustainability and equity. Japan considered that it is important to coordinate activities in climate change monitoring, advanced climate modelling, and impact and adaptation studies, so that information from different research areas can be made mutually supportive.

The European Community and Mexico suggested that more research is needed on the costs and benefits of mitigation and adaptation under various scenarios so as to assess how regional/national sustainable development strategies can simultaneously meet development priorities and address climate change. China highlighted the need for research and methods of assessment of impacts of mitigation on sustainable development.

Enhancement of the capacity of developing countries to contribute to and participate in climate change research

All Parties in both their previous and latest submissions highlighted the importance of the enhancement of the capacity of developing countries to contribute to, and participate in, global climate change research efforts, including participation in studies undertaken under global and regional programmes. Capacity-building is an essential tool for increasing capability for climate monitoring and analysing climate observations.

Parties provided information about the participation of Parties in, and support for, a number of global and regional initiatives on enhancing capacity of developing countries, such as activities of the System for Analysis Research and Training (START), APN, IAI, the International Research Institute for Climate Prediction (IRI) and the Consultative Group on International Agricultural Research (CGIAR); the programmes of these organizations include substantial components directed at enhancing the capabilities of scientists from developing countries to participate in such regional research and contribute to global-scale studies. Parties also noted the effort of the IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA) towards examining ways to address poor data access, lack of appropriate, regionally oriented data products and information for decision-making, and training.

Parties stressed the need for countries to work more closely with existing groups, such as START, IAI, APN and TGICA, to identify specific projects to enhance research capacity, including data access and development of data products appropriate to the limited computational and data management resources in developing and transition economy countries. Infrastructure development to improve access to existing data is critical and of particular use to developing countries and their ability to benefit from and better participate in global change research. Equally important are efforts by developing countries to share their climate data.

In its recent submission, Australia noted the role of the international organizations, such as the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC), through a number of programmes and networks (such as START), in capacity-building that focuses on enhancing the capabilities of member nations in their respective disciplines. China highlighted several areas for capacity-building, including engagement of scientists and research institutions from developing countries in internationally cooperative climate change research programmes, setting up and strengthening institutions for training, capacity-building for participation in Kyoto Protocol mechanisms, and technology transfer.

The European Community reported that several of its member States have programmes to assist institutions in developing countries in conducting climate-related studies and to assist students from developing countries through scholarships and training. Mexico suggested identifying "Regional Adaptation Centres" from existing institutions, in order to strengthen efforts by regional cooperative networks and funds to adapt to climate change. In this context a suggestion was made to maximize the use of existing institutions in different regions, such as IAI and APN. The United States described its activities on the international climate change agenda, which are undertaken through the establishment of results-oriented "action plans" with many bilateral and regional partners. The United States also observed that the representation of developing countries in international climate change research would be enhanced by improving observation systems, by the efforts of more developing countries to share their climate data and through encouragement and incorporation of such research into their sustainable development planning.

Other issues relating to research under the Convention

In addition to the research topics and capacity-building issues, Parties in their earlier and recent submissions addressed the following cross-cutting issues:

- (a) The need under the UNFCCC process to assess the adequacy of research activities and their international coordination to meet the needs of the Convention
- (b) The importance of social as well as natural sciences, and the interaction between the two, in responding to the research needs arising from the assessment reports of the IPCC
- (c) The importance of improving communication of research findings to policymakers.

On the first issue, Parties highlighted the critical role of the IPCC in assessing the state of the science and identifying gaps and priorities in different areas relating to climate change research. They also confirmed the importance of considering needs and priorities for research under the UNFCCC process and communicating these needs to the research community. Parties expressed different views on the specific role of the SBSTA and its involvement in the assessment and international coordination of research activities.

In its latest submission, Australia noted that the research priorities identified by Parties and communicated to the research programmes and organizations could be a useful supplement to those of the IPCC to highlight information needs of policymakers. The European Community suggested that a key priority would be to initiate an international programme or framework that would assess global and regional impacts and risks as well as the economic, environmental and social costs and benefits associated with various GHG stabilization levels and emission pathways, and the technological and adaptation scenarios associated with each. The United States suggested that the SBSTA should recognize the value of international science priorities that evolve “bottom-up”, from the research communities themselves. Research priorities should focus on specific scientific concerns and address the key uncertainties identified in the IPCC Third Assessment Report.

In order to promote communication about research priorities and activities, Switzerland proposed the establishment of an informal joint group of relevant international bodies active on climate research, observation and assessment, namely IPCC, GCOS, WMO and the Earth System Science Partnership (ESSP), with provision of relevant information through the UNFCCC website.

On the social and natural sciences and the interaction between them, Parties highlighted the efforts of individual Parties towards interdisciplinary work and effective integration of the social and natural sciences comprising a variety of activities as reflected in document FCCC/SBSTA/2005/3. In their latest submissions, Mexico stressed the need to enhance consideration of human dimension in climate change research, especially in the area of impacts, vulnerability and adaptation studies, and the United States highlighted the importance of incorporating economic, social and biophysical data into decision support tools for the prioritization of adaptive responses.

On the issue of improving communication of research findings to policymakers at different levels, Japan suggested that improved information on climate observations, projections and climate change impacts might help decision-making and is critical to support adaptation planning, adaptive management and mitigation policymaking. Mexico stressed the importance of research on the development of efficient methods and tools for climate change communication strategies to be used for different stakeholders (policymakers at the federal, state and local levels). In this regard Mexico suggested that the development of research projects, in the framework of the Joint Liaison Group, that involve synergy with other conventions for adopting mitigation and adaptation actions to climate change would be very useful. The United States stressed that the development of improved science-based resources to aid in decision-making is critical to support planning, adaptive management and policymaking.

International, regional and national research coordination

International and regional research coordination

Civil society, governments and the science community, as well as industry and business, face unprecedented challenges, which can only be addressed through collaboration, including research collaboration. Given the various requirements of climate change issues, actors and research fields, coordination at many levels is essential. This coordination is being pursued through activities of different international and regional programmes and organizations as well as through national efforts.

1. Coordination within and between the international research programmes

International governmental and non-governmental organizations such as the International Council for Science (ICSU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), WMO and the Organisation for Economic Co-operation and Development (OECD) provide planning and coordination mechanisms that promote internationally focused research while avoiding duplication of effort. As an example, ICSU, the international, non-governmental umbrella organization for science worldwide, has launched four large scientific research programmes, namely WCRP, the International Geosphere–Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and DIVERSITAS (see annex I). More than 20,000 scientists worldwide contribute to the science of these programmes which are funded primarily through OECD governments, with about EUR 2 billion annually. ICSU is also one of the sponsors of the global observing systems to provide the necessary data base, and of international assessments such as the Millennium Ecosystem Assessment.

Coordination tasks of the four above-mentioned international programmes include the following:

- (a) Developing common international frameworks for collaborative research; forming research networks to tackle focused scientific questions
- (b) Promoting standardized methodologies guiding and facilitating construction of global databases
- (c) Validating and comparing models
- (d) Facilitating efficient patterns of resource allocation; undertaking analysis, synthesis and integration activities on broad Earth system themes.

These tasks are organized through core projects, working groups and task teams in order to deliver optimized research outputs. Numerous scientific steering committees overview ongoing research activities and redirect programme elements when new needs emerge. They continuously address major issues of importance to identified users, including the needs of the Convention. To make direct links to societal needs, the programmes also sponsor joint activities in the framework of the ESSP (see annex I for more detailed examples), in particular, projects on carbon, water, food security and human health. The challenge for the science community, university structures and funding bodies is thus to enable full and collaborative participation of scientists from the natural, human and social, engineering and health sciences.

Scientists and projects of the international research programmes contribute to the assembly of Earth system and climate observations necessary for the detection and attribution of climate change. They lead the provision of climate information that is assessed by the IPCC Working Group I (WGI) and provide the model projections of future climate change exploited by IPCC WGII and WGIII. The IPCC's assessment reports describe the current state of knowledge and provide the best available knowledge generated through internationally coordinated scientific research to the international multilateral agreements.

It is important to note that the programming of research by these bodies does not automatically result in the availability of resources. Researchers need to seek funding from regional and national funding mechanisms.

2. International coordination between national research funding organisations

As climate change research often tackles global issues, effective national programmes require efficient inter-agency and other coordination within a country as well as coordination with other countries. To

foster the latter, the International Group of Funding Agencies for Global Change Research (IGFA) was established as a forum through which national agencies identify issues of mutual interest including:

- (a) Information exchange about national global change research programmes;
- (b) Approaches to the integration and implementation of global change research in the light of available resources;
- (c) Optimization of funding allocations for global change research and its international coordination; infrastructural topics of mutual interest, including data accessibility and observation systems;
- (d) Ways to improve the interaction between science and policy.

3. Coordination within the regions and capacity-building

Regionally coordinated programmes with a strong focus on capacity-building play important roles. They are usually tightly linked with national and international activities, but add considerable value to research results on matters specific to regions. The most relevant networks and institutions for the Convention are: START, co-sponsored by the IGBP, WCRP, and IHDP, which seeks to establish and foster regional networks of collaborating scientists and institutions in developing countries of nine regions; IAI covering the Americas; and APN covering the Asia-Pacific region. There is no equivalent of such regional networks specifically for the African region, although START covers some activities in the region, and there is an ongoing effort of the scientists from Africa, coordinated by the Pan-African secretariat, for creation of a regional network to provide a regional platform for the study of global environmental change, including climate change.

In the European region, mechanisms to foster international cooperation have been developed by the European Science Foundation (EuroCores), the European Community (Integrated Projects, Networks of Excellence, ERA-NETs) and the European Union's Framework Programme for Research and Technological Development, which is mainly a tool to support the creation of the European Research Area. These instruments are particularly effective as they combine both the research proposals and the funding mechanisms.

As mentioned in chapter III, Parties repeatedly emphasized that capacity-building elements are integrated in their research programmes. There is frequent collaboration with, and provision of training to, researchers in developing countries and in countries undergoing the process of transition to a market economy within cooperative programmes in the areas relating to the scientific basis of climate change, impacts and adaptation, and mitigation studies. Japan and Mexico specifically highlighted the need for better coordination of activities in impact and adaptation studies and increased use of regional cooperative networks such as IAI and APN.

National research coordination

National research coordination in Parties included in Annex I to the Convention and in Parties not included in Annex I to the Convention as reported in their national communications

Reporting from **Annex I Parties** (FCCC/SBI/2003/7 and Add. 1) demonstrated that in many cases there are special national research plans and long-term strategies in different areas of climate change research; in others, research activities are coordinated by a high-level research committee or council. In most countries research is carried out by government-funded research institutions and by universities. In countries with major research activities, special funds are established for climate change research. In a few countries with economies in transition, climate change research is carried out with international and/or bilateral support.

Many countries have ongoing international research activities in identified priority areas for national climate change research; they participate in projects of the WCRP, IGBP and IHDP. Furthermore, there are bi- or multilateral research activities within such organizations as APN or the DIVERSITAS programme, and cooperative modelling initiatives or research carried out at international agencies (e.g. IEA).

Most countries participate in and support the work and assessment of the IPCC, and their research on the scientific basis, impacts, adaptation and mitigation contributes greatly to the IPCC reports.

Special reports on systematic observation show that many countries have national plans or national policy guidance on systematic observation, and have instituted internal mechanisms to ensure the coordination of climate activities, linking their observational programmes more directly to their national needs. Data are frequently exchanged in different areas of observation, following international agreements. Many of the GCOS data sets are exchanged and, in particular, supplied to international data centres. A few barriers exist, however, to the exchange of data, such as financial restrictions and the need for technical assistance and capacity-building. Parties report that they run programme elements in support of developing countries, including support to observing networks, and equipment, training and assistance in the preparation of workshops.

In most Parties not included in Annex I to the Convention (**non-Annex I Parties**) (FCCC/SBI/2005/18 and Add.4), especially in developing countries, research projects and systematic observation initiatives relating to climate change are currently ongoing or under development. These activities serve to fill gaps in the knowledge required by Parties to improve the understanding of the possible impacts of climate change and to prepare them for developing sound climate change strategies. A major part of national research focuses on identified priority areas for national climate change research. National research plans and long-term strategies in different areas of climate change research initiatives have been established in some cases. Research is nationally coordinated by government ministries, government-funded research institutions, and national meteorological services, or by universities and research councils. In many countries ministries responsible for the environment, energy and agriculture conduct sector-specific research.

There is a general lack of research funding. This constrains climate change research activities and leads to limited technical support and human capacity, and restricts the expansion of existing networks to increase their coverage nationally.

Many projects are conducted in collaboration with international and regional bodies. Research results often contribute to the work of the IPCC and researchers take active part in IPCC writing teams.

Teams of national researchers participate in international efforts on global observing systems relating to climate change through collaboration and cooperation with regional and international organizations. These programmes include GCOS and the Global Ocean Observing System (GOOS). There is also technical cooperation between neighbouring countries (for example, between Argentina and Brazil, China and India, and Botswana and South Africa).

General trends and developments in national research programmes and links to international activities

In most countries research into climate-related issues retains a strong focus of national programmes, including studies of the scientific basis of climate change, of impact and adaptation studies, and mitigation issues; funding levels are in general relatively stable. In some countries there is a tendency to shift priorities from mitigation towards adaptation issues. Several countries put special emphasis on more regionally oriented research. For example, within Europe there is a supranational collaboration of the 25 member States of the European Union (EU) and other European countries, towards the EU

framework research programme, which will help to address many questions relating to past and possible future climate changes in the region. There is a continuously strong move towards an interdisciplinary approach, as many of today's research challenges lie at the boundaries of the traditional disciplines. Research also often incorporates issues of sustainable development.

In a broad sense global change research is driven primarily by scientific needs, as mutually agreed upon by the science community, and increasingly by decision makers' needs for science-based information and tools. Thus, there is also a tendency to carry out more applied research, including the commercial sector. Business (especially insurance and re-insurance companies) show increased interest in climate and global change science. This interest is largely driven by perceived changes in the frequency and scale of extreme climate and weather events.

Ratification of the Kyoto Protocol has changed the research agendas of several countries; this also holds true for the United Nations Millennium Development Goals as they pertain to global change issues. Both these events have generally increased awareness of the importance of global change research. Most countries continuously support and push international cooperation, within which climate change science, research and observational programmes are planned and implemented, including support for observing systems and free access to high quality data.

Many countries and regions have established programmes or mechanisms for coordinated research activities, established by funding agencies through advisory groups and calls for proposals, and overseen by review teams (see annex I). The "top-down" design of those programmes follows societal needs and produces policy-relevant results. Many of the individual climate change research projects running at national university and non-university research institutes, at centres of excellence and research associations are also part of and coordinated by international programmes. A huge number of individual projects, however, follow pure scientific rules of excellence; they may or may not be coordinated at a national or international level but fill gaps that are potentially important for future developments. Due to differences between national research infrastructures and research funding mechanisms, the instruments, structure and form of national programmes are very diverse.

Some considerations on progress in research efforts in the areas of identified priorities and gaps

In their recent submissions Parties noted that, although progress has been made since 2002, work needs to continue on improving:

- (a) Quantifying of the anthropogenic component of observed changes in climate and estimates of natural influences and natural variability;
- (b) Understanding the mechanisms and factors, both anthropogenic and natural, leading to changes in radiative forcing, and reducing uncertainties;
- (c) Climate related systematic observation and, in particular, a global climate observing system for climate related research.

The United States also observed that the representation of developing countries in international climate change research would be enhanced by improving observation systems, by the efforts of more developing countries to share their climate data and through encouragement and incorporation of such research into their sustainable development planning.

Parties have also noted several specific subjects where more work is needed to meet the needs of the Convention. These subjects include:

- (a) Improvement of methods to quantify uncertainties of climate projections and scenarios, including long-term ensemble simulations using complex models;
- (b) Improvements in the integrated hierarchy of global and regional climate models with a focus on the simulation of climate variability, regional climate changes and extreme events;
- (c) More effective links between models of the physical climate and the biogeochemical system, and incorporating the consideration of the human dimension into climate change research.

In order to coordinate activities in climate change monitoring, advanced climate modelling, and impact and adaptation studies, Japan considers necessary the establishment of a database system where data obtained from observations, climate change projection models, and impact and adaptation studies are integrated so that information from different research areas can be made accessible and more applicable to mitigation policies.

International and regional research programmes attempted to identify remaining gaps in research and observations and specify directions in the research to address these gaps. For example, the WCRP, as one of the lead organizations in promoting, prioritizing and coordinating essential research on the climate system, has formulated a number of remaining priority areas for addressing deficiencies in research on climate systems, including:

- (a) Ensuring necessary quality of the climate observing system, in particular for improving monitoring of extreme events;
- (b) Reducing the uncertainty in radiative forcing in climate predictions by improving in modelling and observations and reducing in the uncertainty in the climate forcing due to aerosol-cloud interactions;
- (c) Placing greater emphasis on reducing uncertainties on feedbacks relevant to climate change by establishing the key processes for climate change;
- (d) Developing a detailed multinational plan for providing regional projections of climate change at the scale necessary for local risk analysis and adaptation purposes;
- (e) Ensuring that multiple simulations of climate change are completed and determining the uncertainties of these projections;
- (f) Ensuring the validity of mitigation measures by research into tracking climate forcing agents and their precursors in the atmosphere and using this information to determine the reliability of the reporting of their sources, and determining the impact of mitigation measures on limiting climate change;
- (g) Improving the interaction of social and natural sciences by linking the standard emissions scenarios and the socio-economic scenarios.

At the regional level, the projects under the IAI Collaborative Research Network have also identified gaps in current knowledge and advance the IAI's mission to provide regional analyses to global change problems, and to work towards adaptation and mitigation. Taking into account the priorities of IAI member countries, the following current research needs are still to be addressed under the projects of this programme:

- (a) Climate change and variability (human and political dimensions);

- (b) Integrated assessments of climate variability, its impacts, and scenarios of climate risks applied to health, agriculture, fisheries, water, tourism and energy;
- (c) Climate change effects on glaciers and water resources;
- (d) Use of general circulation models on a regional scale;
- (e) Vulnerability of coastal zones to climate change.

Initial comparison of the research needs and priorities identified by Parties, and gaps and remaining research needs identified by the programmes on international and regional levels, seem to be converging in many areas. More detailed analysis might be needed to show the specifics in research efforts in the areas of identified priorities and remaining gaps. The core projects implemented under international research programmes and the regional networks are currently contributing to the necessary research to address many of the mentioned gaps and deficiencies. More detailed information on the research is provided in annex I.

Annex I**Examples and scope of work of some international and regional programmes with major research components relating to the Convention****A. International global change and climate change research programmes**

1. The international scientific research programmes build on interdisciplinarity, networking and integration. They address scientific questions where an international approach is the best way to provide results relevant for society. They add value to a large number of individual, national and regional research projects through integrating activities to achieve enhanced scientific understanding.

1. World Climate Research Programme

2. The objectives of the World Climate Research Programme (WCRP) are to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate. WCRP has formulated a broad-based multidisciplinary science strategy offering the widest possible scope for investigation of all physical aspects of climate and climate change. Capitalizing on 25 years of successful research, the WCRP strategy promotes the creation of a comprehensive, reliable, end-to-end global climate modelling and observing system for the dual purpose of describing the structure and variability of the climate system and generating a physically consistent description of the state of the coupled climate system for future projection of climate. This requires the identification of gaps and deficiencies in the existing observing systems; repeated reanalysis of in situ and space-based observations; and new and improved models as synthesis tools which enable better and more detailed prediction of the climate system.

3. Specifically, the strategic aim of WCRP for 2005–2015 is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.

4. It is now possible for WCRP to address the seamless prediction of the climate system from weekly weather to seasonal, interannual, decadal and centennial climate variations and anthropogenic climate change. Advances in understanding and in new technology for observations and computing also make it possible to address the broader questions of Earth system modelling and the use of comprehensive Earth system models for investigating the habitability of our planet, and contributing to the socio-economic welfare and the sustainability of modern societies.

5. WCRP has established two overarching panels through which it implements its strategy – one on modelling and the other on observations and assimilation. The WCRP Modelling Panel (WMP) has as its prime role promoting, coordinating and integrating modelling activities across WCRP with the purpose of meeting the objectives of WCRP and end-users. The WCRP Observations and Assimilation Panel (WOAP) is complementary to, and closely interactive with, the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS) and also with the Global Earth Observing System of Systems (GEOSS).

6. This multidisciplinary strategy is reflected in the ongoing WCRP core projects, which are described below.

Climate and Cryosphere

7. Climate and Cryosphere (CliC) is a project that addresses the entire cryosphere (i.e., snow cover, sea-, lake- and river-ice, glaciers, ice sheets, ice caps and ice shelves, and frozen ground including permafrost) and its relation to climate. CliC aims to improve understanding of the cryosphere and its interactions with the global climate system, and to enhance the ability to use parts of the cryosphere for detection of climate change. The principal goal of CliC is to assess and quantify the impacts of climatic variability and change on components of the cryosphere and their consequences for the climate system, and to determine the stability of the global cryosphere. In order to achieve this goal CliC has the supporting objectives of: enhancing the observation and monitoring of the cryosphere in support of process studies, model evaluation, and change detection; improving understanding of the physical processes and feedbacks through which the cryosphere interacts within the climate system; and improving the representation of cryospheric processes in models to reduce uncertainties in simulations of climate and predictions of climate change.

Climate Variability and Predictability

8. Climate Variability and Predictability (CLIVAR) is the main focus in WCRP for studies of climate variability, extending effective predictions of climate variation and refining the estimates of anthropogenic climate change. CLIVAR is attempting particularly to exploit the “memory” in the slowly changing oceans and to develop understanding of the coupled behaviour of the rapidly changing atmosphere and slowly varying land surface, oceans and ice masses as they respond to natural processes, human influences and changes in the Earth’s chemistry and biota. CLIVAR was in particular designed in order:

- (a) To describe and understand the physical processes responsible for climate variability and predictability on seasonal, inter-annual, decadal, and centennial time-scales;
- (b) To extend the record of climate variability over the timescales of interest through the assembly of quality-controlled paleoclimatic and instrumental data sets;
- (c) To extend the range and accuracy of seasonal and inter-annual climate prediction through the development of global coupled predictive models;
- (d) To understand and predict the response of the climate system to increases of radiatively active gases and aerosols and to compare these predictions to the observed climate record in order to detect the anthropogenic modification of the natural climate signal.

The Global Energy and Water Cycle Experiment

9. The Global Energy and Water Cycle Experiment (GEWEX) focuses on studies of atmospheric and thermodynamic processes that determine the global hydrological cycle and water budget and their adjustment to global changes such as the increase in greenhouse gases (GHGs). GEWEX is addressing the following principal scientific questions:

- (a) Are the Earth's energy budget and water cycle changing?
- (b) How do processes contribute to feedback and causes of natural variability?
- (c) Can we predict these changes on up to seasonal to inter-annual timescales?
- (d) What are the impacts of these changes on water resources?

Stratospheric Processes and their Role in Climate

10. Stratospheric Processes and their Role in Climate (SPARC) concentrates on the interaction of dynamic, radiative and chemical processes. Activities organized by SPARC focus on climatology for the stratosphere and the improvement of understanding of trends in temperature, and ozone and water vapour concentrations in the stratosphere. New SPARC initiatives include studies on climate chemistry interactions, detection, attribution, and prediction of stratospheric change and stratosphere–troposphere dynamic coupling.

Surface Ocean-Lower Atmosphere Study

11. The Surface Ocean-Lower Atmosphere Study is a core-project jointly carried out with the International Geosphere-Biosphere Programme (IGBP), is listed below under the IGBP heading.

Working Group on Coupled Modelling

12. The Working Group on Coupled Modelling (WGCM) is drawing on the expertise of IGBP projects as appropriate, takes the lead for providing the scientific basis and material for Intergovernmental Panel on Climate Change (IPCC) and other international assessments through sensitivity studies, climate hindcasts and projections of future change.

Working Group on Numerical Experimentation

13. The Working Group on Numerical Experimentation (WGNE) has the responsibility for fostering the development of atmospheric circulation models for use in weather prediction and climate studies on all timescales, and for diagnosing shortcomings.

International Geosphere Biosphere Programme

14. The International Geosphere Biosphere Programme (IGBP) is an international scientific research programme on global change. Its objectives are to describe and understand Earth system dynamics, focusing on the interactive biological, chemical and physical processes, the changes that are occurring in these dynamics, and the role of human activities in these changes. In the next 10 years IGBP will work within a more systematic structure with six projects that are centred on the three major earth system compartments – atmosphere, land and ocean – and the interfaces between them – land–atmosphere, atmosphere–ocean, land–ocean. The following projects are currently running under the programme.

15. Two projects – Past Global Changes (PAGES) and Analysis, Integration and Modelling of the Earth System (AIMES) focus on a whole system perspective from the past into the future. PAGES research helps to integrate the IGBP programme by providing a longer time context for the dynamics of the Earth system as a whole, as well as for parts of it. Part of the basis for understanding, even predicting, the course of future change lies in a growing knowledge of past variability, and its spatial and temporal expression, causes and consequences. PAGES is currently in a restructuring and adjustment phase of its scope and organizational structure, in order to adapt to the shifting requirements of international research on past global change. The revised set of questions addressed by this project are:

- (a) Climate sensitivity: What is the history of the main climate forcing factors (insolation, GHGs, solar and volcanic forcing, aerosols) and the sensitivity of the climate system to these forcings? What are the causes of natural GHG and aerosol variations? In what precise sequence have changes in forcing, surface climate, and ecological systems occurred?

- (b) Climate variability: How have the global climate and the Earth's natural environment changed in the past? What are the main modes of variability, and how do they relate to each other and to the mean state of the climate system?
- (c) Climate system dynamics: How have different parts of the Earth system interacted to produce climate feedbacks on regional and global scales? What are the causes and thresholds of rapid transitions between quasi-stable climatic and environmental states, in particular on timescales that are relevant to society? How reversible are these changes?
- (d) Anthropogenic versus natural change: To what extent, and since when, has human activity modified climate and the global/regional environment? How can anthropogenically induced change be disentangled from natural responses to external forcing mechanisms and internal system dynamics?

16. AIMES is a new IGBP project that studies global change in a more holistic and integrated way. Crucial to the emergence of this perspective is the increasing awareness of two aspects of Earth system functioning. First, that the Earth itself is a single system within which the biosphere is an active, essential component. Second, that human activities are now so pervasive and profound in their consequences that they affect the Earth at a global scale in complex, interactive and apparently accelerating ways. The overall challenge for AIMES is to achieve a deeper and more quantitative understanding of the role of human perturbations to the biogeochemical cycles in altering the coupled physical climate system. The overarching goal will be to understand and quantify the influence of human choice on environmental change and subsequent feedbacks. In order to understand human perturbations, it is important to foster and improve our baseline understanding of Earth system dynamics and its components.

International Global Atmospheric Chemistry

17. The International Global Atmospheric Chemistry (IGAC) carried out a complete restructuring of its scientific framework and project infrastructure to meet the demands of the more integrated Earth system science approach of IGBP's second decade of research. The project addresses several key questions, including:

- (a) What is the role of atmospheric chemistry in amplifying or damping climate change? What are the relative roles of stratosphere-troposphere exchange, anthropogenic and natural precursor emissions, and in situ photochemical processes in controlling ozone and its effect on climate change?
- (b) What are the sources, sinks, distributions and properties of aerosol particles and their direct radiative effects on climate?
- (c) What are the effects of aerosol particles on clouds, precipitation and regional hydrological cycles?
- (d) How will changing emissions and depositions of gases and aerosol particles affect spatial patterns of climate forcings?
- (e) Within the Earth system, what effects do changing regional emissions and depositions, long-range transport, and chemical transformations have on air quality and the chemical composition of the planetary boundary layer?
- (f) What are the export fluxes of oxidants, aerosol particles and their precursors from continents (e.g., mega-cities, biomass burning, desert dust) in the global atmosphere?

- (g) What are the impacts of intercontinental transport on surface air quality? How will human activities transform the cleansing capacity of the future atmosphere?

Global Land Project

18. The Global Land Project (GLP) focuses on the interactions of people, biota and natural resources of terrestrial and aquatic systems. The GLP strategy emphasizes changes in the coupled human–environmental system at local to regional scales. The GLP will bring together researchers from the social and natural sciences, as well as from the humanities. The objectives of the GLP are:

- (a) To identify the agents, structures, and nature of change in land systems and to quantify their impacts on land systems;
- (b) To assess how the provision of ecosystem services is affected by land change;
- (c) To identify the character and dynamics of vulnerable and sustainable land systems to interacting perturbations, including climate change.

Ocean Research

19. A partnership comprising the Global Ocean Ecosystem Dynamics (GLOBEC) and the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) is currently undertaking ocean research that will result in a single integrated ocean project by 2009. The ocean is a vital component in the dynamics of the Earth and an important player in global change. Its vast store of heat and gases has decisive impacts on climate. The ocean usually has greater inertia in comparison to land or the atmosphere. However, paleo-oceanographic research and modelling have shown that abrupt changes in critical ocean processes can occur and trigger vast changes in the state of the Earth and its climate.

20. In collaboration, the two projects address the questions:

- (a) What are the critical components in the ocean?
- (b) What are the major feedbacks between the ocean and other Earth system components? What are the ocean regions most vulnerable to global change?
- (c) What critical components of the ocean system are most sensitive to human action and have greatest impact on humans?
- (d) What states of the ocean system could occur which are not compatible with human health and survival?
- (e) What are the options and caveats for geo-engineering in the ocean?
- (f) What structure of institutions is required for an effective and efficient management of marine resources and for the protection of marine environments and marine-based human communities?

Integrated Land Ecosystem – Atmosphere Processes Study

21. The Integrated Land Ecosystem – Atmosphere Processes Study (iLEAPS) deals with the transport and transformation of energy and matter across the land–atmosphere interface which play a major role in controlling atmospheric composition. Processes in both the atmosphere and terrestrial ecosystems drive this transport and transformation, with biological processes playing an especially important role in the terrestrial component of the system. iLEAPS is designed to provide understanding of how interacting physical, chemical and biological processes transport and transform energy and matter

through the land–atmosphere interface. The project specifically addresses the implications of these processes for the dynamics of the Earth system as a whole, and the role that the human component of the Earth system plays in modifying these processes.

Surface Ocean–Lower Atmosphere Study

22. The Surface Ocean–Lower Atmosphere Study (SOLAS) is a new international research initiative, co-sponsored by WCRP, to carry out research at the interface between the oceans and the atmosphere. SOLAS aims at developing a quantitative understanding of processes responsible for air–sea exchange of mass, momentum and energy to permit accurate calculation of regional and global fluxes. This requires establishing the dependence of these interfacial transfer mechanisms on physical, biological, and chemical factors within the boundary layers and the horizontal and vertical transport and transformation processes that determine these exchanges.

Land–Ocean Interactions in the Coastal Zone

23. The Land–Ocean Interactions in the Coastal Zone (LOICZ) has developed scientific knowledge and tools that address global change in the coastal zone, focusing on material flux and human dimensions at regional and global scales. The International Human Dimension Programme (IHDP) co-sponsors the project. In the future LOICZ will continue to address key biogeochemical processes and focus more strongly on human interactions.

International Human Dimension Programme (IHDP)

24. IHDP is an international, interdisciplinary, non-governmental science programme dedicated to promoting, catalyzing and coordinating research on the human dimensions of global environmental change. IHDP takes a social science perspective on global change and investigates the human causes and consequences of change, as well as the societal responses to mitigate and adapt to global environmental change. Its core projects are described below.

Global Environmental Change and Human Security

25. Global Environmental Change and Human Security (GECHS) studies the relationships between global environmental change and human security which involve issues of perception, adaptation, vulnerability, interaction, response, and thresholds. Research questions are:

- (a) When and how does global environmental change threaten human security? Why are some regions and communities more vulnerable to global environmental change? Can future insecurities be predicted?
- (b) What strategies would reduce the potential effects of global environmental change on human security? What facilitates the implementation of some strategies and how can obstacles be overcome?

Institutional Dimensions of Global Environmental Change

26. Institutional Dimensions of Global Environmental Change (IDGEC) centres on the examination of the role of social institutions in causing, exacerbating and solving large-scale environmental problems. It focuses on three themes: ocean governance, forest use and carbon management. The circumpolar North and Southeast Asia are regional foci. The analytic themes include:

- (a) The problem of fit: are prevailing institutional arrangements well matched to the properties of the biophysical systems to which they relate?

- (b) The problem of interplay: do distinct institutional arrangements interact with others either horizontally or vertically in ways that influence the outcomes?
- (c) The problem of scale: to what extent can findings about the roles institutions play be generalized across levels in spatial, temporal, and jurisdictional scales?

Industrial Transformation

27. Industrial Transformation (IT) is an international, multidisciplinary research initiative aimed at understanding complex society–environment interactions; identifying driving forces for change; and exploring development trajectories that have a much smaller burden on the environment on a global scale. Its overarching goal is to explore pathways towards decoupling of economic growth from the related degradation of the environment.

Urbanization and Global Environmental Change

28. Urbanization and Global Environmental Change is a new core project whose focus is the interaction between global environmental change and urban processes.

Land–Ocean Interactions in the Coastal Zone

29. The Land–Ocean Interactions in the Coastal Zone (LOICZ), a core project jointly carried out with the IGBP, is described above under the IGBP heading.

Global Land Project

30. The Global Land Project (GLP), a core project jointly carried out with the IGBP, is described above under the IGBP heading.

DIVERSITAS

31. DIVERSITAS – an integrative approach to biodiversity science – brings together biological, ecological and social sciences to address key questions that underlie our limited understanding of the current situation. It comprises three programmes:

- (a) bioDISCOVERY aims at identifying existing biodiversity and understanding how it is changing and why. The project is designed to advance efforts to measure and describe biodiversity at the level of genes, species and ecosystems. This is a fundamental step in the broader goals of improving our capacity to recognize change and loss, and to find out why it is occurring;
- (b) ecoSERVICES_aims at understanding relationships between biodiversity and ecosystem functioning and services. With a particular focus on the relationship between biodiversity and ecosystem functioning, ecoSERVICES seeks to establish a robust understanding of the ecological, economic and cultural consequences of biodiversity loss and change;
- (c) bioSUSTAINABILITY_develops new knowledge to guide policy- and decision-making in order to encourage more sustainable use of biodiversity. To achieve this, activities and initiatives are directed towards establishing a more complete understanding of the ecological, economic and social aspects involved. The project ultimately seeks to determine how humans can be motivated to conserve biodiversity and to use it in sustainable ways. The most pressing need is to establish the scientific foundations for appropriate future social actions aimed at maintaining an acceptable level of biodiversity on the planet.

Earth System Science Partnership (ESSP)

32. ESSP is a joint initiative of DIVERSITAS, IGBP, IHDP, and WCRP. It brings together researchers from diverse fields, and from across the globe, to undertake an integrated study of the Earth system: its structure and functioning; the changes occurring to the system; and the implications of those changes for global sustainability. The core of ESSP activities lies in in-depth analysis and advanced modelling of the Earth system as a whole, incorporating data and information from the diverse fields represented by the four global change programmes: IGBP, WCRP, IHDP and DIVERSITAS. The first such effort on Earth system modelling is already under way, built on collaboration between AIMES and WGCM. The next step is to integrate human dimensions into Earth system analysis and modelling. There are four initial subprojects:

- (a) Global Carbon Project (GCP) investigates carbon cycles and energy systems;
- (b) Global Environmental Change and Food Systems (GECAFS) develops strategies to assess the environmental and socio-economic consequences of adaptive responses aimed at improving food security;
- (c) Global Water System Project (GWSP) examines how humans are changing the global water cycle and what the implications are for societies;
- (d) Global Change and Human Health.

Natural sciences major programme of UNESCO

33. This programme contains a number of subprogrammes in research areas relevant to climate change issues as described below.

International Hydrological Programme

34. The International Hydrological Programme (IHP) is UNESCO's intergovernmental scientific cooperative programme in hydrologic research, water resources management and education. The IHP is a vehicle through which Member States can upgrade their knowledge of the water cycle and thereby increase their capacity to better manage and develop their water resources; thus it is highly relevant for climate change issues. The IHP aims at the improvement of the scientific and technological basis such that the methods for the rational management of water resources are continuously developed worldwide, including the protection of the environment. It strives to minimize the risks to water resources systems, taking fully into account social challenges and interactions and developing appropriate approaches for sound water management. The IHP is structured into phases of six years; the period 2002–2007 is the IHP's sixth phase. IHP structures its work according to five themes: global changes and water resources; integrated watershed and aquifer dynamics; land habitat hydrology; water and society; water education and training. The transition from the global scale to the watershed scale is the main conceptual parallel in all five themes for understanding the complex relationships between water and society and the overall need for knowledge, information and technology transfer.

35. The cross-cutting programmes FRIEND (Flow Regimes from International Experimental and Network Data) and HELP (Hydrology for Environment, Life and Policy) through their operational concept intersect the five themes.

Man and the Biosphere Programme

36. The Man and the Biosphere Programme (MAB) carries out interdisciplinary research and capacity-building measures with the goal of defining and establishing sustainable ways for people to live within their environment globally. MAB aims at the understanding and conservation of valuable and

endangered ecosystems and it targets the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss. Its predominant instrument is the world network of biosphere reserves. Biosphere reserves act as vehicles for knowledge-sharing, research and monitoring, education and training, and participatory decision-making. The main aims of MAB, in particular the biosphere reserves, are to reduce biodiversity loss, improve livelihoods, and enhance social, economic and cultural conditions for environmental sustainability, and thus contribute to the pursuit of the Millennium Development Goals (MDG), in particular MDG 7 on environmental sustainability.

Intergovernmental Oceanographic Commission

37. The Intergovernmental Oceanographic Commission (IOC) of UNESCO provides Member States with an essential mechanism for global cooperation in the study of the oceans. The IOC assists governments to address their individual and collective ocean and coastal problems through the sharing of knowledge, information and technology and through the coordination of national programmes.

38. Among the IOC's many programmes, lines of action and panels, all of which are at least partially relevant for climate change, some are particularly relevant and carried out in cooperation with other United Nations agencies, including the Global Ocean Observing System advisory panel on ocean CO₂; the Joint WMO/IOC Commission for Oceanography and Marine Meteorology; the IOC-GEF/WB Working Group on Coral Bleaching and Local Ecological Responses; GLOSS, the Global Sea Level Observing System; the Global Temperature-Salinity Profile Program; and the Ocean Observations Panel for Climate (OOPC), a scientific expert advisory group charged with making recommendations for a sustained global ocean observing system for climate in support of the goals of its sponsors (GOOS, GCOS and WCRP).

B. Examples of some regional research activities and networks

1. European research framework programme

39. Within the European Union's 6th Research Framework Programme (2002–2006), thematic priority no. 6 "Sustainable development, global change and ecosystems" addresses climate change issues. Its main objectives are: strengthening the scientific capacities needed for Europe to be able to implement a sustainable development model in the short and in the long term, integrating its social, economic and environmental dimensions; and contributing to international efforts to mitigate adverse trends in global change. Relevant programme elements are: impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks; water cycle including soil-related aspects; biodiversity and ecosystems; mechanisms of desertification and natural disasters; strategies for sustainable land management, including coastal zones, agricultural land and forests; operational forecasting and modelling; complementary research (risk assessment methodologies; emerging human diseases); and cross cutting issues (sustainable development concepts and tools).

40. The European Commission has recently adopted a proposal for the 7th Research Framework Programme (2007–2013). In one of the four specific programmes "Cooperation", support will be provided to transnational cooperation at every scale across the European Union and beyond, in a number of thematic areas corresponding to major fields of the progress of knowledge and technology, where research must be supported and strengthened to address European social, economic, public health, environmental and industrial challenges. The overarching aim is to contribute to sustainable development within the context of promoting research at the highest level of excellence. Thematic area "Environment – including climate change" includes the following elements: integrated research on the functioning of the climate and the earth system in order to enable the development of effective adaptation and mitigation measures to climate change and its impacts; multidisciplinary research on interaction of environmental risk factors and human health; multirisk approach and improved knowledge, methods and

integrated framework for the assessment of hazards, vulnerability and risks; improved knowledge basis and advanced models and tools for the conservation and sustainable management of natural and man-made resources; and improved understanding of impacts of human activities on the ocean and seas.

41. The EU as a member of the Group on Earth Observations (GEO) is working towards an unprecedented level of coordination and harmonization of Earth observation systems, aimed at the creation of the Global Earth Observation System of Systems (GEOSS).

2. System for Analysis, Research, and Training (START)

42. START, which is cosponsored by the IGBP, WCRP and IHDP, seeks to establish and foster regional networks of collaborating scientists and institutions in developing countries. These networks conduct research on regional aspects of environmental change, assess impacts and vulnerabilities to such changes, and provide information to policymakers. START acts to enhance the scientific capacity of developing countries to address the complex processes of environmental change and degradation through a wide variety of training and career development programmes. START concentrates on the following regional networks: Temperate East Asia Regional Network; Pan-Africa Regional Network; Southeast Asia Regional Network; South Asia Regional Network; Oceania Regional Network; Mediterranean Regional Network; Central Asia Regional Network; and Central and Eastern Europe Regional Network.

43. The fundamental objectives of these networks are to mobilize scientific manpower and resources to address regional scientific questions concerned with global change; and to provide a framework to support regional synthesis and scientific assessments relevant to policy development.

3. Inter-American Institute (IAI)

44. The second round of the IAI's Collaborative Research Network (CRN) programme is designed to create networks of scientists throughout the Americas who will work collaboratively on global change problems of importance to the region. The first round of CRN has led to a stronger and more cohesive science community.

45. The individual CRN projects are expected to contribute to the development and strengthening of the regional capacity to deal with global environmental change issues and their socio-economic impacts. The approach will be integrative, involving the natural and social sciences in a collaborative way, and the programme seeks to provide sound scientific understanding in support of sustainable development in the region. The CRN projects will provide the best possible scientific basis for documenting, understanding and projecting changes in the Earth's life-support system and for facilitating full use of scientific information in policy- and decision-making on possible response strategies for adaptation and mitigation.

4. Asia-Pacific Network for Global Change Research (APN)

46. The APN is an international network of governments whose mission is to enable investigation of change in the Earth's life support systems as it occurs in the Asia-Pacific region. APN's current activities are guided by its Second Strategic Plan (2005-2010), which is based on input from stakeholders and extensive scientific and institutional reviews of its first 10 years. This plan describes the three "agendas" that the APN is currently addressing: science, policy and institutional matters. Its newly formulated science agenda has the following general themes: climate, ecosystems, biodiversity and land use, changes in the atmospheric, terrestrial and marine domains, and use of resources and pathways for sustainable development. Under its policy agenda, the APN is dedicating particular attention to promoting interactions between science and policy processes.

Annex II**Abbreviations**

AIMES	Analysis, Integration and Modelling of the Earth System
APN	Asia–Pacific Network for Global Change Research
CGIAR	Consultative Group on International Agricultural Research
CLiC	Climate and Cryosphere
CLIVAR	Climate Variability and Predictability Study
CRN	Cooperative Research Network
DIVERSITAS	(an international programme of biodiversity science)
ESSP	Earth System Science Partnership
FRIEND	Flow Regimes for International Experimental and Network Data
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GECAFS	Global Environmental Change and Food Systems
GECHS	Global Environmental Change and Human Security
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water Cycle Experiment
GLOBEC	Global Ocean Ecosystem Dynamics
GLOSS	Global Sea Level Observing System
GLP	Global Land Project
GOOS	Global Ocean Observing System
GTOS	Global Terrestrial Observing System
GWSP	Global Water System Project
HELP	Hydrology for Environment, Life and Policy
IAI	Inter-American Institute for Global Change Research
ISCU	International Council for Science
IDGEC	Institutional Dimensions of Global Environmental Change
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere–Biosphere Program
IGFA	International Group of Funding Agencies for Global Change Research
IHDP	International Human Dimension Programme
iLEAPS	Integrated Land Ecosystem–Atmosphere Process Study
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research
IHP	International Hydrological Programme
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate Prediction
IT	Industrial Transformation
LOICZ	Land–Ocean Interactions in the Coastal Zone
MAB	Man and the Biosphere Programme
MDG	Millennium Development Goals
OECD	Organisation for Economic Co-operation and Development

OOPC	Ocean Observations Panel for Climate
PAGES	Past Global Changes
SOLAS	Surface Ocean–Lower Atmosphere Study
SPARC	Stratospheric Processes and their Role in Climate
START	System for Analysis Research and Training
TAR	Third Assessment Report
TGICA	Task Group on Data and Scenario Support for Impact and Climate Analysis
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WCRP	World Climate Research Programme
WGCM	Working Group on Coupled Modelling
WGI	IPCC Working Group I
WGNE	Working Group on Numerical Experimentation
WMO	World Meteorological Organization
WMP	WCRP Modelling Panel
WOAP	WCRP Observation and Assimilation Panel
