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Subsidiary Body for Scientific and Technological Advice

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Item 6 of the provisional agenda

Research and systematic observation

Update on developments in research activities relevant to the needs of the Convention

Submissions from regional and international climate change research programmes and organizations

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its thirty-second session, welcomed the updated information on developments in research activities and emerging scientific findings relevant to the needs of the Convention provided by regional and international climate change research programmes and organizations (hereinafter referred to as research programmes and organizations) in the context of the research dialogue under the SBSTA (FCCC/SBSTA/2010/6, para. 46).
2. At the same session, the SBSTA encouraged research programmes and organizations to continue to provide, for consideration under the research dialogue in the future, information on developments in research activities outlined in document FCCC/SBSTA/2007/4, paragraph 47(a–f), taking into account views expressed by Parties, priorities emerging within the UNFCCC process and activities undertaken in support of the Intergovernmental Panel on Climate Change towards the preparation of its fifth assessment report (FCCC/SBSTA/2010/6, para. 47).
3. The secretariat has received eight such submissions. In accordance with the procedure for miscellaneous documents, these submissions are attached and reproduced* in the language in which they were received and without formal editing.

* These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

FCCC/SBSTA/2011/MISC.4

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Paper no. 1: Asia-Pacific Network for Global Change Research

Acknowledgment:

The APN welcomes and appreciates the continuing opportunity to inform, and engage in a dialogue with SBSTA on issues of global change research, capacity development and science-policy interfacing mechanisms within the Asia-Pacific region that is relevant to the convention. The present brief summarises the current main activities undertaken by APN to address some of the issues outlined in the recently published document **FCCC/SBSTA/2011/MISC.4** regards those topics for discussion at the dialogue meeting to take place during SBSTA 34, taking into account developments in research activities outlined in document **FCCC/SBSTA/2007/4, Paragraph 47 (a-f)**.

1. What is the APN:

Established in 1996, the Asia-Pacific Network for Global Change Research (APN) is a network of twenty-two member governments in Asia and the Pacific whose vision is to enable countries in the region to successfully address global change (GC) challenges through science-based response strategies and measures, effective science and policy linkages, and scientific capacity development.

As APN is an inter-governmental network, a high priority goal is to produce sound scientific results that can be made available as a supportive tool for policy-making processes. Accordingly, the APN conducts regular synthesis and assessment activities of the projects its supports in order to identify important outcomes, research gaps and/or emerging issues that could be used to support policy development.

APN is financially sponsored by the Governments of Japan (Ministry of Environment [MOE]); Hyogo Prefectural Government), New Zealand (Ministry for the Environment), Republic of Korea (Ministry of Environment [MEV]) and the United States (National Science Foundation [NSF]; United States Global Change Research Program [USGCRP]).

The APN goals are achieved through a number of activities selected from the APN's two main programmes, which involve **two annual open Calls for Proposals in which scientists based in APN member or approved countries can submit proposals for funding support**. The two main programmes are the *Annual Regional Call for Research Proposals (ARCP)* and the *Scientific Capacity Development Programme (CAPaBLE)*. Particularly encouraged to submit APN proposals are developing-country researchers working in collaboration with the APN's international GC partners including DIVERSITAS, ESSP, GEO/GEOSS, IGBP, IHDP, START, WCRP and their related core and joint projects.

Research and capacity building activities under the ARCP, CAPaBLE and other related initiatives of the APN focus on four scientific themes identified in the APN's Science Agenda. These are (i) **Climate Change and Climate Variability**; (ii) Ecosystems, Biodiversity and Land Use; (iii) Changes in Atmospheric and Terrestrial Domains; and (iv) Resources Utilisation and Pathways for Sustainable Development. Under these scientific themes, the APN supports activities that are interdisciplinary in nature and cut across natural, social, economic and political sciences.

Examples of the kinds of activities APN undertakes are:

- Promoting and strengthening GC research, including identifying gaps via syntheses and assessment work
- Identifying and developing existing methodologies and developing new methodologies and tools for effective transfer of scientific knowledge
- Strengthening the interface of policy- and decision-making processes and society in general for mainstreaming environmental concern
- Encouraging initiatives from developing countries for place-based, integrative research
- Aligning with programmes of the GC community

2. New APN Activities:

2.1 APN Climate Synthesis Executive Summary (Synthesis report will be published June 2011):

Work for the present Synthesis - Climate in Asia and the Pacific: A Synthesis of APN Activities began in November 2009 with a scoping workshop followed by an authors' workshop in August 2010. The work entailed summarising over fifty scientific research and capacity building projects funded by the APN that had a climate-related element - whether natural climate variability and/or climate change. The contributing authors' of the synthesis report are leaders in their field and many of them are authors for the next fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR5). The present report will be a useful tool not only for the IPCC, but also for scientists, decision-makers and educators; as it identifies both research gaps and future research activities for the Asia-Pacific region in the context of climate change and climate variability.

The adverse effects of climate change and natural climate variability pose a significant threat to humanity, with the poorest communities being the most vulnerable. Scientific understanding of our climate is advancing at a significant rate, with new information emerging about the likely impacts of climate change, the options to adapt to these changes, and new approaches to mitigation.

Through national and international fora, it is becoming clear that climate is one of the most, if not *the* most, pressing issue in the political arena today. This has been evident in government and stakeholder meetings such as the 34th G8 Summit (Japan, 2008) and the most recent UNFCCC 16th Conference of the Parties Meeting (Mexico, 2010), where commitments to climate change have been underscored, particularly the need to support developing countries for financing and transferring knowledge and skills to respond effectively to climate change.

The IPCC 4th Assessment reports that climate change will interact at all scales with other aspects of the global environment and aggravate existing concerns about the provision of natural resources, including water, soil and air pollution, health hazards, disaster risk, and deforestation. Their combined impacts may be compounded in the future in the absence of integrated mitigation and adaptation measures (IPCCAR4 [SPM], 2007).

The present synthesis report is part of the APN's larger aim to contribute, from the science perspective, to the development of policy options for appropriate responses to climate vulnerability and impacts, including adaptation and mitigation, which in turn will contribute to sustainable development. The timing of this publication also leads into three major activities, the Planet under Pressure and Rio+20 Conferences, both

taking place in the first half of 2012, and the work of the current IPCC 5th Assessment with the report scheduled for release in 2014.

The synthesis report indicates that while there is much activity at the global level, there is a great need to intensify investigative research of climate change and climate variability and trends at the regional level, as these are still poorly understood. Consistent socio-economic data collection is needed. The increasing frequency and severity of floods, droughts and extreme temperatures requires use of appropriate indices to improve monitoring and prediction of extreme events.

The effects of climate on water resources have been studied in APN projects but many issues remain unclear. There is a need for models to predict better the effects of seasonal to inter-annual climate on water. Coastal cities continue to be highly vulnerable to sea-level rise and research is needed in identifying appropriate adaptation measures, strategies, and policies. Similarly small islands are especially vulnerable and research is required into relocation options. APN has supported international workshops to reduce vulnerability and devise coping strategies of agriculture to climate variability and change. These have built the knowledge-base for developing predictive capacity to manage climate variability and climate change-related vulnerability, strengthen overall climate responses and build resilience to socio-economic, and environmental shocks, which is one of the region's urgent development needs.

APN projects have also contributed substantially to the building of regional capacity to include climate change in national sustainable development strategies and action plans. APN workshops on trends in climate extremes have provided a framework for international trend analysis in developing countries around the world. However, what is abundantly clear is that open access to climate data, including relevant socio-economic data, will be essential for countries in the Asia Pacific to carry out risk assessments of their vulnerability to trends in climate within a regional framework. It is, therefore, in the interest of all countries of the APN to promote the open exchange of climate-related data.

Modelling the effects of climate on agriculture and fishery production needs to be refined. Critical to climate adaptation research, practice and policy are downscaled climate data. Developing Regional Climate Models (RCMs) in Asia has helped provide more detailed information on monsoon circulation; and high-resolution regional/local information from RCMs can be used in impact, vulnerability and adaptation studies. There is a need for regional climate models and statistical downscaling methods to help localise GCM results. Especially problematic in the Asia-Pacific are small islands states and areas with rough and steep terrain like the Himalayas.

The investments by APN in projects aimed at improving the Asia-Pacific region's understanding of the climate of the region, at assessing the risks to society and nature from climate variability and change, and at raising awareness of these issues to decision-makers and the public are well justified in terms of need and benefits. Formal assessments and literature citations have demonstrated that these activities have been effective and of high quality.

Given the high quality of APN projects and the potential of many to yield longer-term benefits through the provision of marginal resources, there should be an investigation of innovative means to sustain such projects beyond the term of initial APN support.

Strategic planning of APN would benefit by ensuring that it maintains close contact with the relevant international developments on indicators of the impact of research and capacity building. The APN should continue to recognise the benefits of applying appropriate models to assist the integration of information in complex systems. The APN should recognise that effective application of climate knowledge to practical problems of societies across the Asia Pacific region requires effective dialogue across the traditional boundaries of science, technology and policy.

The APN has a role to play in promoting research in the region that clarifies the strategies that lead to true sustainable development. The Asia Pacific region has a rich variety of cultures, and the APN has been effective in promoting connections and alliances across all these cultures. This effectiveness comes from recognition of cultural differences and not imposing a one-hat-fits-all approach. These sensitivities to culture will be especially important as the APN continues to promote exchanges of knowledge on climate-related issues across disciplines and sectors.

Clearly, the most important aspect of interactions across a region is the human factor. The APN has been effective in promoting innumerable networks of participants in its projects related to climate. One potential element in the future development of sustained networks is through the engagement of young people who can carry their scientific and social networks into the future.

Finally, while substantial progress has been made by APN-supported projects on climate science, capacity building and policy outreach, much remains to be done in the Asia-Pacific region. Among the key trends impacting the region are: rising population, increasing urbanization, rapid economic development, rising energy demand, massive land use and cover change, increases in temperature, heatwaves, floods and droughts, and globalisation. APN may wish to invest in some of these areas in its future strategies and research agendas.

2.2 APN Biodiversity Gap Analysis: Linking and Integrating Ecosystems Services and Biodiversity with Green Growth & Sustainable Development

The Asia - Pacific region is spectacularly rich in biodiversity, but also home to more than half the world's human population. Policy - and decision - making to realise the objective of establishing sustainable, green growth practices in the Asia-Pacific region needs to be underpinned by sound scientific knowledge. However, much of the knowledge needed to effectively link biodiversity and ecosystem services to sustainable development and green growth is lacking throughout the region, particularly in developing countries.

With the above rationale and in the present "United Nations Decade on Biodiversity 2011-2020¹," the APN seeks to contribute to this crucial and urgent period by promoting comprehensive scientific research, capacity development and science-policy connections in a new (initial) 5-year Biodiversity Framework: ***Linking and Integrating Ecosystems Services and Biodiversity with Green Growth & Sustainable Development.***

¹ Official launch will be on the International Day for Biological Diversity, 22nd May 2011:
<http://www.cbd.int/doc/notifications/2011/ntf-2011-027-un-en.pdf>

Gap Analysis Workshop

With funding from the Ministry of the Environment, Japan (MOEJ), and as a contribution to the International Year of Biodiversity 2010, the APN conducted a Biodiversity and Ecosystem Services Gap Analysis Workshop (February 13-15, 2011). The aim of the workshop was to identify gaps in scientific research and capacity development and to establish APN's role in developing an agenda for this important area of research. The agenda would be in line with the UN Decade of Biodiversity, and contribute not only to the UNCBD, but also to the UNCSD (specifically the 2002 WSSD's Johannesburg Plan of Implementation[JPOI]²) and its lead up to Rio+20³; the Millennium Development Goals; and, where appropriate, contribute to the Second Millennium Ecosystems Assessment (MEA2) and the IPBES.

Prior to the Gap Analysis Workshop expressions of interest were sought from experts in the global change community, particularly from those working in the Asia-Pacific region. As a result, the workshop included participation from key experts from ICSU, DIVERSITAS, United Nations University and ASEAN ACB, GEOBON and other key organisations. Gaps and priorities outlined were based on analysis of feedback received from the global change community and invited experts to the APN Gap Analysis Scoping Workshop. Initially, the following issues were considered: vulnerability and predictions; impacts; adaptation and mitigation. The workshop also reviewed and took into account key publications and background papers on biodiversity and ecosystem services and all relevant issues at the sub-regional level.

The four Research Themes identified are indicated below all of which have a link with climate change:

- **Theme 1:** *Drivers and pressures for biodiversity change that influence ecosystem services (land-use change; climate change, etc.)*
- **Theme 2:** *Assessment of impacts of biodiversity loss and vulnerability to the shrinking of ecosystem services*
- **Theme 3:** *Model-based prediction of changes in biodiversity and ecosystem services*
- **Theme 4:** *Adaptation, Response and Mitigation of the Depletion of Biodiversity and Ecosystems Services*

The next steps are to have a steering group meeting to develop the framework further and integrate it into the activities of the APN. It is expected that a calls for proposals will be launched in the above themes for both regional research and scientific capacity development activities.

² WSSD JPOI: http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

³ Rio+20 Summit, 4-6 June 2012: <http://www.uncsd2012.org/rio20/>

DIVERSITAS

Introduction

DIVERSITAS, under the auspices of ICSU and UNESCO, delivers policy relevant scientific knowledge on biodiversity, to promote the conservation and sustainable use of biodiversity. The study of the interactions between climate change and biodiversity represents a high priority throughout the DIVERSITAS projects ranging from studying rapid evolution of species in the face of climate change to improving the representation of biodiversity in earth system models that are used to project future climate.

DIVERSITAS along with a wide range of other partners has embarked on several initiatives to improve the observations, experiments and models in order to detect, understand and model *climate change impacts on biodiversity as well as the feedbacks of biodiversity change on climate and global biogeochemical cycles*.

Science highlights

Observing climate change impacts on biodiversity and ecosystem services

Substantial progress was made during 2010 in developing the implementation plan for a new global biodiversity observing system (GEO BON), released at CBD-SBSTTA 14 in May 2010. GEO BON represents the implementation of the biodiversity component of GEOSS, the Global Earth Observing System of Systems. DIVERSITAS is one of the co-leads of GEO BON. One of the goals of GEO BON is to detect footprints of climate change impacts on biodiversity and ecosystem services, including carbon storage. Scientific projects are on-going in DIVERSITAS to address some of the knowledge gaps, such as ecosystem services monitoring, to set up this observation system.

Modelling the interactions between biodiversity and climate change:

DIVERSITAS in collaboration with a variety of partners including the IGBP, is facilitating the development of improved regional and global vegetation models through the use of new global plant trait databases ("TRY" and "TraitNet" initiatives) and via a network of researchers working on better representations of migration, mortality and disturbance regimes ("Biome Boundary Shift" = BBS initiative). Recent work has led to substantial improvements of the representation of biodiversity in regional and global models.

Assessing future changes

DIVERSITAS, along with the UNEP-WCMC, released at CBD-SBSTTA 14 (Nairobi, May 2010) a synthesis of biodiversity scenarios for the 21st century for the Global Biodiversity Outlook 3 (GBO3) of the Convention on Biological Diversity. This synthesis is a novel assessment of global biodiversity scenarios which focuses on multi-model comparisons and confrontations of model scenarios with observations. This report identifies climate change along with land use change as the main future drivers of biodiversity loss (e.g. species extinctions) and changes in the distribution of species, functional groups and biomes, but this assessment also illustrates the large uncertainties that are associated with these projections.

Toward an IPCC-like mechanism for biodiversity and ecosystem services

SBSTA 33 delegates should be aware of efforts to establish an "IPCC-like mechanism for biodiversity and ecosystem services", called IPBES (Intergovernmental Platform for Biodiversity and Ecosystem Services). The 3rd and final intergovernmental and multistakeholder negotiation on IPBES (7-11 June 2010, Busan, Republic of Korea), approved the establishment of this mechanism. This mechanism is currently being submitted for approval to the UN General Assembly for a possible launch later in 2010, the International

Year of Biodiversity. DIVERSITAS has played a key role in moving this initiative forward and in engaging and representing the scientific community in this process. This new assessment process, if established, will be of great relevance to the work of UNFCCC and its SBSTA.

Gaps

A variety of projects (e.g. GBO3, BBS) have identified a number of areas where research on the interactions between biodiversity and climate change are urgently needed including: greater use of multi-model analyses of climate change impacts on biodiversity, substantial increases in benchmarking of models with observations, improvements in understanding the links between biodiversity and ecosystem carbon storage at regional scales, etc.

Issues of high relevance to the UNFCCC process

Biodiversity "tipping-points"

The GBO3 Biodiversity Scenarios synthesis highlights a wide range of biodiversity "tipping-points" that may occur in the 21st century. Many of these are partially or entirely driven by climate change or rising CO₂ concentrations and involve strong feedbacks between biodiversity and climate at large regional scales. Some of these tipping points are reasonably well known in the climate change community (e.g., widespread dieback of the Amazonian forest, massive degradation of coral reefs), but others are less known (e.g., interactive effects of climate change and socio-economic drivers on desertification and deforestation in West Africa, interactive effects of overfishing and climate change on marine fisheries). In addition, the impacts of climate-driven "tipping-points" on biodiversity are often less well studied than the impacts on biogeochemical cycles, even though the impacts on ecosystem services via biodiversity are often large.

Research for adaptation

Adaptive management strategies for biodiversity in the face of climate change

Among many initiatives, DIVERSITAS co-sponsored a session on "Biodiversity: Enhancement of Resilience or Facilitating Transformation?" at the IARU International Scientific Congress on Climate Change in March 2009, Copenhagen, Denmark. The follow up objectives are to examine different adaptive management strategies for biodiversity in the face of climate change and also to examine how climate change mitigation and adaptation goals might be in conflict with or complementary to protection of biodiversity. DIVERSITAS is also, through networking and international workshops, facilitating research on the capacity of species to adapt to climate change through "rapid evolutionary" processes and to link this adaptive capacity to models of ecosystem function.

Key publications

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Larigauderie A, Mace GM, Mooney HA. 2010. *Colour-coded targets would help clarify biodiversity priorities*. *Nature*. 464(7286): 160

Larigauderie A, Mooney HA. 2010b. *The Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services: moving a step closer to an IPCC-like mechanism for biodiversity*. *COSUST*. 2(1): 9-14

Leadley P, Pereira HM, Alkemade R, Fernandez-Manjarrés JF, Proença V, Scharlemann JPW, Walpole MJ. 2010. *Biodiversity Scenarios: Projections of 21st century change in biodiversity and associated ecosystem services*. *Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 50, 132 pp*

Mace GM, Cramer W, Diaz S, Faith DP, Larigauderie A, Le Prestre P, Palmer M, Perrings C, Scholes RJ, Walpole M, Walther BA, Watson JEM, Mooney HA. 2010. *Biodiversity targets after 2010*. *COSUST*. 2(1): 3-8

Mooney H., Larigauderie A., Cesario M, Elmquist T, Hoegh-Guldberg O, Lavorel S, Mace GM, Palmer M, Scholes R, and Yahara T. 2009. Biodiversity, climate change and ecosystem services. *Current Opinion in Environment Sustainability* 1: 46-54. Mooney, H.A. and Mace, G.M. 2009. Biodiversity policy challenges, *Science*, 325:1474.

Perrings C, Mooney HA and Williamson M (eds). 2010. *Bioinvasions and Globalization: Ecology, Economics, Management and Policy*, Oxford University Press, Oxford

C. V. Vörösmarty et al. 2010. Global threats to human water security and river biodiversity. *Nature*. In press.

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Earth System Science Partnership (ESSP)

Community building for new insights in climate science and global environmental change research

Introduction

The ESSP is a science partnership of the four international global environmental change research programmes – an international programme of biodiversity science (DIVERSITAS), International Geosphere-Biosphere Programme (IGBP), International Human Dimensions Programme on Global Environmental Change (IHDP), and the World Climate Research Programme (WCRP) - for the integrated study of the Earth system, the ways that it is changing, and the implications for global and regional sustainability.

Science highlights

Agriculture as a driver for deforestation

REDD+ has now got considerable impetus, and a work program on REDD+ will be initiated in Bonn. A key issue is “agriculture as a driver of deforestation”. The majority of deforestation is caused by agriculture, but given the role of agriculture in meeting global food security targets, it is not simply a case of restricting agriculture to ensure the success of REDD+. Climate Change, Agriculture and Food Security (CCAFS) a coordinated effort of Consultative Group on International Agricultural Research (CGIAR) and the ESSP, shows that countries involved in REDD+ are not yet taking agriculture seriously in their REDD+ strategies and early actions, and much more integration of the agriculture and forestry sectors is needed. Research has also shown the gains that can be achieved by intensifying agriculture and thus reducing the pressure on forests. Yet other work shows how forest governance approaches have to be combined with agricultural incentives to meet both mitigation and food security goals.

Observed impacts of climate change and resulting impacts for society

A two degree rise in temperature (and changes in rainfall patterns) is predicted to have major changes on farming and food systems. For agriculture, a four degree world is beyond the bounds of both local and global knowledge. Africa-wide, a massive 1.2 million km² may be forced to flip from typical mixed farms, with both crops and livestock, into pure rangeland. But this only considers long term averages - for agriculture, it is often the extremes that count. And these have repercussions throughout the food system and throughout society (e.g. price volatility, export bans, food riots). Farmers are already observing changes in weather patterns and in pests and diseases, and have linked the changes to climate change. They are responding by changing crop varieties, switching to completely different crops and, in some cases, migrating. In a number of cases the local adaptation strategies have increased greenhouse gas emissions. Key questions relate to how to enhance the capacity for accelerated adaptation, how to improve climate risk management and how to manage trade-offs between adaptation and mitigation. New tools, technologies and institutional options are available for driving early action in “climate-smart” food systems.

Emissions of carbon dioxide

Global Carbon Project (GCP) launched the Carbon Budget 2009 in November 2010. It confirms the earlier findings that the fossil fuel CO₂ emissions continue to grow strongly and despite the global financial crisis. The annual growth rate of atmospheric CO₂ was 1.6 ppm in 2009, below the average for the period 2000-

2008 of 1.9 ppm per year (ppm = parts per million). The mean growth rate for the previous 20 years was about 1.5 ppm per year. This increase brought the atmospheric CO₂ concentration by 39% above the concentration at the start of the industrial revolution. The present concentration is the highest during at least the last 2 million years. Fossil fuel CO₂ emissions decreased by 1.3% in 2009. These emissions were second highest in human history, just below 2008 emissions, and 37% higher than in 1990 (Kyoto reference year). Coal is now the largest fossil-fuel source of CO₂ emissions. About 92% of the growth in coal emissions for the period 2007-2009 resulted from increased coal use in China and India

Global Carbon Project (2010) Carbon budget and trends 2009.

[www.globalcarbonproject.org/carbonbudget] released on 21 November 2010

Financial crisis and emissions

The abrupt decline in fossil fuel emissions by 1.3% in 2009 is indisputably the result of the global financial crisis (GFC). However, the decline was smaller than anticipated because: 1) the contraction of the Global World Product (GWP) was only -0.6%, as opposed to the forecasted -1.1%; and 2) the impact of the GFC was largely in developed economies which led more carbon-intense economies to take a larger share of the production of global wealth (with associated higher emissions). Emissions in 2010 are expected to have increased by at least 3%, already back to the high growth rate observed since 2000. There is evidence that CO₂ emissions from land use change could have been lower in 2000-2010 compared to the previous decade, though the uncertainty is large.

Friedlingstein, P, R. A. Houghton, G. Marland, J. Hackler, T. A. Boden, T. J. Conway, J. G. Canadell, M. R. Raupach, P. Ciais and C. Le Quéré, Update on CO₂ emissions, Nature Geosciences, 2010

Carbon sinks

Natural land and ocean CO₂ sinks removed 57% of all CO₂ emitted from human activities during the 1958-2009, each sink in roughly equal proportion. During this period, the size of the natural sinks has grown almost at the same pace as the growth in emissions, although year-to-year variability is large. There is the possibility, however, that the efficiency of the natural sinks is declining, an issue currently under intense debate in the scientific community. In 2009, the CO₂ sink increased slightly in response to the end of La Nina event that perturbed the global climate system from mid 2007 to early 2009.

Global Carbon Project (2010) Carbon budget and trends 2009.

[www.globalcarbonproject.org/carbonbudget] released on 21 November 2010

Human water security and aquatic biodiversity security

Recent results of a study, prepared by Global Water System Project (GWSP) and DIVERSITAS scientists provide a worldwide joint assessment of human water security and biodiversity security. The assessment is based on 23 selected indicators. The study concluded that while the positive effects of beneficiary investments to improve water security for human use could be proven, though sometimes at the expense of aquatic biodiversity, no comprehensive data were available about direct investments to protect and rehabilitate biodiversity. The lack of consideration and safeguarding of biodiversity has a serious consequence in the context of climate change. As ecosystem service security is closely correlated with ecosystem health, and hence biodiversity, the climate change induced shifts of ecosystem boundaries will increasingly jeopardize the livelihoods of those who rely directly on ecosystem services. The over one billion subsistence farmers worldwide are among those primarily affected. While it was acknowledged that the poor would be most affected by climate change, this can be proven even through the indirect secondary effects of biodiversity loss.

It is worth to note and to emphasize that wetlands and streams, due to their biological transfer function are particularly vulnerable. Aquatic species extinction is about twice as high as that of terrestrial ones. Bad and short sighted water policies accentuate the effects of climate change and vice versa.

C. J. Vörösmarty, P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S. E. Bunn, C. A. Sullivan, C. Reidy Liermann, P. M. Davies (2010): Global threats to human water security and river biodiversity. Nature, Vol 467: 555-561.

Human health in changing climate

The Global Environmental Change and Human Health (GECHH) project foster international networked research, promote training and capacity-building and to enable science/policy bridges highlighting the importance of integrative and holistic approaches in addressing the linkages between climate change and human health, and also within the context of the Millennium Development Goals. Among the GECHH activities, it is important to recall the upcoming GECHH 2011 Symposium “Global Environmental Change and Human Health: Healthy Forests for Life” (Verbania, Italy 19-21 September 2011) organized in partnership with the Institute of Ecosystem Study (ISE) and the Water Research Institute (IRSA) of the Italian National Research Council (CNR). The Symposium and other initiatives will allow for furthering the understanding of the linkages between climate change and human health, taking into account – inter alia – the growing evidence that a number of mitigation and adaptation strategies result in major health co-benefits, and that the value of these health co-benefits can potentially offset the costs of implementing the strategies by varying amounts depending on the strategy and the setting. For instance, a number of greenhouse gas (GHG) mitigation strategies result in health co-benefits, including policies to promote active travel (walking and cycling) in urban centres and the reduction of private car use which can result in substantial reductions in cardiovascular disease, diabetes, depression and some cancers related to sedentary lifestyles.

Furthermore, GECHH also fosters international efforts to increase adaptation options in the health sector, through improved understanding of vulnerable populations and regions, sharing of lessons learned in modifying current and implementing new public health policies and measures to address the health risks of global change, and collaboration with international processes such as the UNFCCC Nairobi Work Programme.

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SysTem for Analysis, Research and Training

Introduction

START is the global change SysTem for Analysis, Research and Training, a non-governmental research organization. We assist developing countries in building the expertise and knowledge needed to explore the drivers of and solutions to global and regional environmental change. Our goal is to reduce vulnerability through informed decision-making.

Climate change, land and ecosystem degradation and biodiversity loss are all drivers of global environmental change. Developing regions are not only particularly vulnerable to adverse impacts of these changes, but have very limited access to scientific and technical knowledge to assist in formulating solutions. This is the gap START seeks to fill.

Building capacity for research in developing countries

- Identifying opportunities for developing countries to participate in regional and international climate change research, including funding opportunities
- Results of regional research programmes activities and collaboration with developing countries: success stories of improved research capacity

The African Climate Change Fellowship Program (ACCFP)

Through Round 1 of the African Climate Change Fellowship Program, which was completed in 2010, START and its partners (University of Dar es Salaam and the African Academy of Sciences) matched 44 Post-Doctoral, Doctoral, Teaching and Policy Fellows, representing 42 institutions across Africa, with 18 Host Institutions in Africa to implement research projects that enhanced their capabilities for advancing and applying knowledge for climate change adaptation. START is collaborating with the Institute of Resource Assessment at the University of Dar Es Salaam to implement Phase II of the ACCFP, which includes two round of Fellowship awards (both to begin in 2011) and integrative seminars that add value to the Fellowship experience. The Fellows, together with their Home and Host Institutions of the ACCFP, form the foundation of a growing Pan-African network on adaptation to climate change.

Global environmental change (GEC) research grants

Global environmental change (GEC) research grants awarded to early- to mid-career scientists from Africa and the Asia Pacific region have significantly enhanced understanding of global change impacts and adaptation across a range of sectors and geographical scales including food security and agriculture, forestry, land-use, water resources and urbanization. The GEC grants have also provided new opportunities for long-term collaborative research partnerships and networks, strengthened outreach to policy and practitioner communities and have contributed new knowledge highly relevant to human well-being.

Through the Africa GEC grants program, START will in 2011 make 18 grants to African scientists to work on interdisciplinary and cross-institutional research collaborations on global environmental change, agriculture and food security. Work in over 40 research institutions across 17 countries in Africa will be supported through this year's grants. The program is funded by the US National Science Foundation with co-support, for the Africa component, from the Climate and Development Knowledge Network and with additional support from the Climate Change, Agriculture and Food Security initiative of the Earth Science System Partnership and the CGIAR.

Communicating climate change science

- Communicating research results - examples of good practices and overcoming challenges
- Ways to enhance effectiveness of policy-science dialogues, including the SBSTA research dialogue

City-level dialogues:

START's *Cities at Risk* (CAR) program for coastal megacities in Asia, which began in 2009, brings together scientists, urban planners and other key decision-makers to examine climate related risks, potential vulnerabilities, current coping strategies and potential adaptation responses across Asian coastal megacities. The Cities at Risk II conference held in Taipei, Taiwan in April 2011 resulted in the initiation of city-level adaptation / disaster risk reduction stakeholder dialogue programs in Jakarta, Indonesia and Ho Chi Minh City, Vietnam to begin later in 2011. Two additional cities will be added in 2011-2012. As part of this effort, city-level training workshop(s) for practitioners and a regional workshop to bring together all stakeholders will be convened to explore key insights and lessons learned from the cities and their implications for climate change adaptation in urban areas across Asia and elsewhere in the developing world.

National dialogues:

In 2010 START, in partnership with the WMO, UNEP, IPCC, University of Dar es Salaam, University of Ghana and the Bangladesh Centre for Advanced Studies, convened national-level science-policy dialogues in nine countries across West Africa, East Africa and South Asia to enable better integration of climate change issues in development planning. The dialogues, which brought together IPCC scientists, national scientists, parliamentarians, government ministry and agency representatives, NGOs and civil society representatives, and the national media, examined climate change risks in the context of agriculture and food security, human health, water, ecosystem services and biodiversity conservation, urbanization, and energy.

Regional dialogues:

A regional dialogue on climate change, agriculture and food security for semi-arid West Africa was convened by START and the Forum for Agricultural Research in Africa in 2010 in Niamey, Niger. The dialogue examined climate change risks to pastoral and agro-pastoral systems in the West African Sahel, opportunities for adaptation, and policies and measures needed to support adaptation planning. START together with the Asia-Pacific Network for Global Change Research will convene a regional science-policy dialogue on integrated disaster risk reduction with a focus on Asian cities and megadeltas in late 2011.

An important outcome of these multi-stakeholder dialogues has been the identification of potential policy responses to support adaptation, the need for better enforcement of existing policies and regulations that govern environmental protection, disaster response, and food security, and the need for targeted programs to build capacity in the areas of climate services, integrated research and assessment, and climate change communication.

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Submission from the Inter-American Institute for Global Change Research (IAI)

The Inter-American Institute for Global Change Research (IAI) provided in documents FCCC/SBSTA/2009/MISC.5 and FCCC/SBSTA/2010/MISC.6, updates related to its research in the La Plata Basin. In this submission, the IAI presents a summary of research advances which suggest that land use changes may affect the regional climate of the La Plata Basin.

The La Plata Basin is one of the world's main food exporters, and it is therefore a key region for global food security. During the last three decades, increased demand for food, biofuel and cellulose have been driving large-scale changes in land use that affected more than 30 million hectares. The IAI is investing important research efforts in the La Plata Basin integrating scientific groups that are studying the impacts and feedbacks of the main land use changes on biophysical variables (e.g., soil carbon stocks, climate, water resources) as well as on socioeconomic characteristics (e.g., employment, rural migration, food production, rural livelihoods).

Climate determines ecosystem structure and functioning through the timing and amount of water and solar energy (Stephenson, 1990). Conversely, ecosystems also influence climate through multiple pathways, primarily by determining the energy, water, and chemical balances between the land-surface and the atmosphere (Chapin *et al.*, 2008). These balances are determined by biophysical properties at the land surface, such as albedo, surface roughness, stomatal resistance, leaf area index and others. Changes in land cover will thus have an impact on those interactions, the overlying boundary layer, and eventually the processes that modulate precipitation (e.g., Pielke and Avissar 1990; Stohlgren *et al.* 1998; Pielke *et al.* 2007). The size, the geographic location and the patchiness of an area where land cover changes take place may determine the extent to which they affect local, regional and global climate (Marland *et al.* 2003).

Changes in land cover imply changes in the land's biophysical properties. In order to understand the complex nature of their coupled interactions, it is necessary to resort to regional mesoscale models that simulate land surface-atmosphere feedbacks and their impacts on regional climate. IAI research results indicate that land use change in the La Plata basin is significantly affecting the albedo (surface reflectance) of large areas. Reduced reflectance as a consequence of, for instance, tree plantations which have 30% lower albedo than natural grasslands causes warming, which could reduce the benefits of carbon sequestration in these afforestations. In contrast, the enhanced albedo after deforestation of the semiarid Chaco - which reduces warming - could counterbalance the greenhouse effects of carbon released upon conversion to agriculture.

The regional climate of the La Plata basin is sensitive to extensive changes in land cover, and those changes are highly non-linear. In regions where forests and savanna are replaced by crops, an overall increase in albedo leads to a reduction of sensible heat flux and near surface temperature. A decreased stomatal resistance favors more evapotranspiration, but the more noticeable effect corresponds to a reduction of surface roughness that leads to stronger low-level winds that, in turn, favor a larger amount of moisture being advected out of the northern part of the basin. Changes from grasslands to crops reduce the albedo and thus increase the near surface temperature. As the reduction in surface roughness is not as large as in the northern sector, there is a deceleration of the northerly moisture fluxes, and a net increase of moisture flux convergence and precipitation. However, since changes in land use are heterogeneous, lateral gradients of the land biophysical properties will lead to differential forcings on the atmosphere, and advective processes not accounted in a point energy balance will develop. Given the large regions under land cover change, it should be expected that effects will affect regions outside the basin, due to, e.g., advective processes in downstream circulations and precipitation.

The regional effects of deforestation imply changes in the surface water and energy budgets, as well as in the low level circulation (e.g., through changes in the surface roughness). In the case of the Amazon, deforestation may lead to a reduction of evapotranspiration and moisture flux convergence (MFC), and consequently of precipitation (Nobre et al. 1991). The deforestation affects not only the intensity of precipitation, but may shift patterns due to, e.g., advective processes (Hahmann and Dickinson 1997). Remote effects can also be expected (Werth and Avissar 2002).

A consistent set of time-varying biophysical properties has been identified by taking advantage of the Ecosystem Functional Types (EFTs) homogeneous functioning and the parameters of land surface models. Some land-surface properties showed greater interannual variability than others across the entire study area. Considerable interannual variability was found for surface roughness, stomatal resistance, and minimum leaf area index. Low interannual variability was observed for emissivity, and radiation stress. Rooting depth, background albedo, Green vegetation fraction, and maximum leaf area index showed intermediate variability.

Numerical experiments with a regional climate model show that a representation of the land surface that takes into account realistic conditions during anomalous periods reduces the model biases in precipitation and improves the representation of extremes like floods and droughts. It is further suggested that inclusion of interannual variability of land surface conditions in regional models adds information that can lead to improvements in climate predictability.

The impacts and associated feedbacks of land use changes on biophysical and socioeconomic variables are complex and non-linear, and include a multitude of dimensions. The coupled human and natural dimensions of land use change processes require effective inter-disciplinary research to identify and propose feasible options to mitigate the resulting impacts.

International Geosphere-Biosphere Programme

Introduction

The International Geosphere-Biosphere Programme (IGBP) is a research programme that studies the phenomenon of Global Change (www.IGBP.net). IGBP research addresses the interactive physical, chemical and biological processes that define Earth System dynamics, changes that are occurring in these processes and the role of human activities in these changes. IGBP contributes to new knowledge on climate change, as well as many other global environmental change issues, by coordinating research activities through the IGBP Core Projects and by organising workshops and synthesis activities that bring together scientists from a wide range of disciplines. The nine Core Projects of IGBP address processes on land, in the atmosphere and oceans, and the interfaces between these. The projects include two integrative crosscutting projects that address future and past global change. Many IGBP activities have considerable collaboration with other partner programmes.

Research highlights

An eye on the Arctic coast

A recent report entitled “State of the Arctic Coast 2010: Scientific Review and Outlook” provides a comprehensive picture of the status and current and anticipated changes in the most sensitive Arctic coastal areas. The assessment takes a social-ecological approach that explores the implications of change for the interaction of humans with nature. The report is aimed to be a first step towards a continuously updated coastal assessment and to identify key issues seeking future scientific concern in an international Earth system research agenda. The report is organized in three parts: the first provides an assessment of the state of Arctic coastal systems under three broad disciplinary themes – physical systems, ecological systems, and human dimensions; the second examines progress in integrative approaches to monitoring, understanding, and managing change in Arctic coastal systems; the third identifies data gaps and research priorities over the coming decade.

Forbes D L (2011) State of the Arctic Coast 2010 – Scientific Review and Outlook.
<http://arcticcoasts.org>

Ocean fertilisation summary for policymakers published

Geoengineering schemes involving ocean fertilisation to tackle climate change have a low chance of success, according to a new summary for policymakers on the issue. Ocean fertilisation involves adding iron or other nutrients to the surface of the ocean to trigger growth of microscopic marine plants – these plants use dissolved carbon dioxide to grow, which led to the idea that deliberate fertilisation of the ocean on a large scale would remove carbon dioxide from the atmosphere. The summary notes that there are still major knowledge gaps. For example, it is unclear whether findings from small-scale experiments apply fully to larger scales. And a major concern is the possibility of large-scale fertilisation having unintended consequences for ecosystems. The latter was the theme of an IGBP synthesis workshop held in La Jolla, California, at the end of January. A diverse group participated in this assessment, and a report will be published shortly.

Wallace D W R et al. (2011). Ocean Fertilization. A Scientific Summary for Policy Makers.
IOC/UNESCO, Paris 2010. IOC Brochure 2010-2.
<http://unesdoc.unesco.org/images/0019/001906/190674e.pdf>

Bounding the role of black carbon

A major assessment report on the role of black carbon in climate is due to be published in 2011. The report will: 1) summarize the state of the science of black carbon as a climate forcing agent and, specifically, the implications for mitigation decisions. The information will contribute to decisions that allow co-benefits for both climate and air quality/human health. 2) explain widely-varying forcing estimates, especially in the context of IPCC values, thus providing updates to AR4, and input to AR5. 3) present bounded uncertainties, especially for co-emitted species and cloud changes. 4) hand over usable numbers for mitigation decisions, which will be assured by engaging policymakers from the start.

Nitrogen and climate

Humans have perturbed the nitrogen cycle greatly, leading to substantial environmental effects as well as economic ones. Nitrogen also has direct and indirect contributions to climate change. The direct contributions are increased emissions of N₂O (nitrous oxide) to the atmosphere. The indirect contributions include, for example, increased concentrations of O₃ (ozone). Both N₂O and O₃ are greenhouse gases and contribute to atmospheric warming. Another indirect contribution is the increased loading of nitrogen-containing aerosols, which have the potential to scatter solar radiation and will act as a cooling agent. And nitrogen compounds enhance the productivity of ecosystems, thereby sequestering carbon. The net effect of the human perturbations of the nitrogen cycle is cooling of the climate, according to a report that emerged in October 2010. This will be discussed further at a joint workshop of the IPCC and the Task Force on Reactive Nitrogen proposed for later this year.

Terrestrial carbon budget refined

Researchers have announced that global vegetation draws down 123 billion tonnes of carbon from the atmosphere each year. The most accurate measurement to date of the carbon exchange between atmosphere and land was made possible by a global network of over 250 measuring stations. The result will help improve climate models because the terrestrial carbon balance is a major area of uncertainty.

The highest gross carbon uptake in terrestrial ecosystems is found in tropical forests – over a third (34 percent) of the carbon dioxide (CO₂) uptake from the atmosphere. Savannahs cover twice the area but account for about one quarter (26 percent) of the global CO₂ uptake. The research team, from 18 institutes, also discovered that rainfall plays a more significant role than previously thought in determining the amount of carbon captured by plants during photosynthesis. Precipitation rates were found to have considerable influence in more than 40 percent of vegetated regions, and in half of all croplands. This has important implications for global food production.

Beer C et al. (2010) Science 329: 834-838.

Forest and Grassland Response to European Heat Waves

Europe experienced major heat waves in 2003 and 2006, and such waves are expected to become more frequent in the future. Depletion of soil moisture played a part, but how did the type and distribution of vegetation influence the temperature extremes? A team of researchers reports that forests and grasslands responded in fundamentally different ways during the course of these prolonged heat waves.

The team's analyses show that the surface over grasslands is cooler than that over forests during the early stages of a heat wave. This is because of higher evaporation over grass. But eventually this causes soil-moisture depletion in the grasslands, and there is a shift in behaviour as the heat wave advances: the surface over grasslands begins heating up and might cause a shift in the regional climate to even higher temperatures. Prolonged dry and warm conditions during the summer of 2003 in Europe meant that grassland became the main source of heating during the later stages of the heat wave. This likely explains the extreme temperatures measured in this region in August 2003. The researchers contend that forests could serve to

ameliorate the effects of prolonged and severe heat waves, and also contribute to preserving water by virtue of generally lower evapotranspiration.

Teuling AJ et al. (2010) Nature Geoscience 3: 722-727.

Researchers call for systematic analysis of Southern Ocean food webs

The Southern Ocean region is experiencing rapid changes in ocean temperature and seasonal ice cover, and showing significant changes at all trophic levels. Complex interactions within food webs modify responses of individual species and influence the response of entire ecosystems to change. Yet ecological research in the Southern Ocean is often centred on key species or localised systems, a tendency that is reflected in much of the modelling effort to date. To build on this, the researchers say, a systematic analysis of regional food web structure and function is required.

Murphy E J et al. (submitted). Special issue of Progress in Oceanography on Comparative Analysis of Marine Food Webs.

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International Human Dimensions Programme on Global Environmental Change (IHDP)

Introduction

The continued advance of the social sciences toward greater inclusion within the global change arena has meant that IHDP's research remains at the forefront of social science integration. In particular, the IPCC and other intergovernmental processes have made significant use of research stemming from IHDP's projects. A brief update of these research activities is provided here for UNFCCC-SBSTA 34.

Science Highlights

Human security, sustainable adaptation, equity

The GECHS synthesis process has revealed that climate change requires both a technical response and "sustainable adaptation" (see Special Issue 3 (2011) 3-6 in *Climate and Development* journal), which includes a greater understanding of the role of individual and collective beliefs, values, worldviews, priorities and loyalties. A significant milestone for GECHS in the latter part of 2010 was the integration of their concepts and perspectives on human security into the assessment reports of the IPCC. Policymakers made use of GECHS research regarding Norway's support to the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) process. In addition, other activities (e.g. workshops, conferences, research articles, etc.) were used by the GECHS community to further bring human security concerns directly into IPCC's focus.

O'Brien, K., St. Clair, A.L. & Kristoffersen, B (eds.) 2010. Climate Change, Ethics and Human Security. Cambridge: Cambridge University Press.

Eriksen, S. & Brown, K (eds.) 2011. Special Issue: sustainable adaptation to climate change. Climate and Development, 3: 1-85.

Earth system governance, architecture, agency, adaptiveness, accountability

The Earth System Governance Project has made key progress concerning the areas of architectures of earth system governance; agency in earth system governance, and accountability and legitimacy of earth system governance. A particular highlight in this regard is the project's strong contribution to ICSU Grand Challenge 4 concerning an effective governance structure for global change, which could have further implications concerning the Copenhagen Green Climate Fund. In addition, co-hosting and endorsement of large conferences like the 2010 Berlin Conference; the ISEE 2010 Conference; and the Democratizing Climate Governance Conference, resulted in an improved integration of the concept of earth system governance with other scientific communities. Similarly, the research agenda is strengthened by the advancement of curricula studies, particularly stemming from the Global Alliance of Earth System Governance Research Centres. Numerous working papers and publications further reflect these and other contributions from the project.

Biermann, F., Pattberg, P. & Zelli, F. (eds.) 2010. Global Climate Governance Beyond 2012. Architecture, Agency and Adaptation. Cambridge: Cambridge University Press.

Bulkeley, H. & Newell, P. 2010. Governing Climate Change. London / New York: Routledge.

Urban sustainability, adaptation strategies

The strong linkage between the adaptation strategies of urban areas concerning climate change has been a key focus of UGEC activities in 2010. This was reflected by the project's 1st International Conference on Urbanization and Global Environmental Change, which highlighted the need for greater transdisciplinarity and/or convergence within the field of urban sustainability, i.e. tying differing scales and knowledge together in such a way as to create plausible climate change adaptation strategies. Other highlights include co-sponsorship of the Training Institute on Urban Responses to Climate Change and the 1st World Congress on Cities and Adaptation to Climate Change. All in all, UGEC's research activities continue to provide critical data concerning the cities in climate change adaptation.

Lwasa, S. 2010. Adapting urban areas in Africa to climate change: the case of Kampala. Current Opinion in Environmental Sustainability, 2(3): 166-171.

Romieu, E., Welle, T. & Schneiderbauer, S. (et al) 2010. Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications. Sustainability Science, 5(2): 159-170.

Industrial transformation, sustainability transition, system innovation

Research of the IHDP-Industrial Transformation Project has identified innovation hotspots in emerging economy settings which reveals that developing countries do not have to follow conventional development trajectories. The application of transition concepts and models generated useful new insights about the generation, adoption and diffusion of new ways of doing things. Sustainability experiments and socio-technical regimes functioned as bridging concepts for academic researchers, policymakers and practitioners, further revealing innovative activities in diverse settings. This further emphasized the role of rules and social practices in socio-technical change.

Berkhout, F., Verbong, G. & Wieczorek, A. (eds.) 2010. Socio-technical experiments in Asia – a driver for sustainability transition? Special Issue of Environmental Science and Policy, 13(4): 261-338.

Adaptation and vulnerability, deltas and estuaries, islands at risk

The research of the Land-Ocean Interactions in the Coastal Zone (LOICZ) project supports sustainability and adaptation to global change in the coastal zone. Key highlights from 2010 include the mapping of LOICZ research onto the ICSU Visioning Grand Challenges, as well as the development of a conceptual framework for social-ecological system analysis identifying seven components describing the social dimensions of coastal management. Additionally, new research hotspots include islands at risk; coastal urbanization and megacities; and the vulnerability and adaptation responses of coastal systems.

Liu, K.-K., Atkinson, L., Quiñones, R. & Talaue-McManus, L. (eds.) 2010. Carbon and Nutrient Fluxes in Continental Margins. Springer: Berlin.

Longstaff, B.J., Carruthers, T.J.B., Dennison, W.C., Lookingbill, T.R., Hawkey, J.M., Thomas, J.E., Wicks, E.C. & Woerner, J.L. (eds.) 2010. Integrating and Applying Science: A Practical Handbook for Effective Coastal Ecosystem Assessment. IAN Press: Cambridge.

Large-scale risks, disasters, entry- and exit transitions, risk modeling

The recently established Integrated Risk Governance (IRG) project aims to identify the mechanisms, trends, impacts and predictability of risks in the context of global environmental change, as well as to develop risk assessment models and methods for integrated risk simulation. The project's governance perspective directs attention to a number of concerns, including policies designed to reduce the vulnerability of individuals and communities to the impacts of extreme events, decision-making processes relating to the establishment and

deployment of response capabilities, and institutional arrangements (e.g. insurance schemes) capable of protecting individuals from the worst impacts of extreme events.

The 2010 Summer Institute for Advanced Study of Disaster and Risk (SI2010)

Land use change, sustainability science

With the strong linkage between land use change and global environmental change (including climate change) and with the Global Land Project (GLP) on the path to synthesis, key research criteria for 2011/12 includes, among others: climate change, agriculture and food security; pathways to sustainable land management; ecosystem services provided by land systems, prioritization and trade-offs; land change in China and land use intensity. Additionally, a major finding of the GLP is that the magnitude of land deals in Africa is significant and that land deals are extensively negotiated throughout Africa. Other research highlights can be found throughout GLP's contributions to all three WG's of the AR5.

Singh, J. et al. 2010. Conceptualizing Long-Term Socio-ecological Research (LTSER): Integrating the Social Dimension. In: Müller, F. et al. (eds.): Long-Term Ecological Research, Between Theory and Application. Dordrecht, Heidelberg, London, New York: Springer.

Friis, C. & Reenberg, A. 2010. Land grab in Africa: Emerging land system drivers in a teleconnected world. GLP Report No. 1. GLP-IPO, Copenhagen.

Ecosystems, coupled human environmental system

The Integrated History and future of People on Earth (IHOPE) is a new project of the IHDP. As such, key research highlights are limited. However, IHOPE is a thematic project that cuts across disciplines in examining the history of the idea of environmental prediction and the reception of both optimistic and pessimistic predictions by societies, ultimately aiming to learn from our environmental past to inform future possibilities and ways forward, particularly where climate change is concerned. The specific objective for IHOPE is to identify slow and rapidly moving features of complex social-ecological systems, on local to continental spatial scales, which induce resilience, stress, or collapse. The basic framework for accomplishing this involves integrating theory, comparative studies and integrated socio-ecological modeling across a range of spatial and temporal scales.

Barthel, S. et al. 2010, Social-ecological Memory in Urban Gardens. Retaining the capacity for management of ecosystem services. Global Environmental Change, 20(2): 255-256.

Beddoe, R. et al. 2009. Overcoming systemic roadblocks to sustainability: the evolutionary redesign of worldviews, institutions and technologies. Proceedings of the National Academy of Sciences, 106: 2483-2489.

Capacity Development

The IHDP and its projects are continuously developing human dimensions research networks and building capacity, particularly with a focus on scholars from developing countries. As a global Programme, it pays much attention to the composition of its research groups to ensure a balance in gender, regional and disciplinary backgrounds. It was proven more often than not that the composition of such endeavours has an impact on how science is being conducted and which questions are being asked. For example, to bridge the "North-South Divide" remains a challenge in order to complement the "Western" approach towards science with perspectives from the "Global South", which often pay more attention to issues of equity and human well-being, or reach out to the development agenda more forcefully.

Inclusive Wealth Report

The Inclusive Wealth Report (IWR) is a joint initiative of UNEP, UNU-IHDP and the World Bank. The project aims at developing the first report on wealth and changes in wealth of nations, with a particular focus on developing countries. The main objectives of IWR are:

1. To carry out a comprehensive analysis of the different components of wealth by country and their link to economic development, particularly highlighting the importance of natural capital.
2. To formulate policies based on the notion of asset portfolio management. The ways in which nations manage their diverse assets and create productive economic bases for the future, have critical implications for long-term sustainable development.

Work on the development of the report was initiated in March 2010 by IHDP through a grant from UNEP. The World Bank has recently launched the International Partnership on Environmental Accounting and will begin work on developing accounting case studies in a number of selected countries. The first IWR is planned to be launched in April of 2012, at the Rio+20 conference.

Assessment of Response to Change

The global environmental change (GEC) research agenda has largely been framed from within the natural sciences. Biophysical dimensions of the problem—from carbon emissions to rising sea levels to biodiversity loss—are well-accepted, and the human activities that generate environmental change have been quantified. What is lacking in GEC research, however, is a clear and comprehensive framework for the social dimensions of the problem. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report has identified human behavior evolution, scenarios of how societies will develop in the future and other social sciences topics as among their list of questions requiring further research, while two of the five “Grand Challenges” emanating from the International Council for Science (ICSU) visioning process on GEC research target societal response and innovation.

IHDP plans to address these needs by coordinating a comprehensive assessment of existing social sciences findings on the relationships between beliefs and values, socioeconomic structures and incentives, behaviors, and mechanisms of societal change, followed by a synthesis showing how these apply in the context of global environmental change. A recent global survey of social scientists and others in IHDP’s extended network and the broader social sciences community documented strong support for undertaking such an assessment. We anticipate that this assessment will help reframe the social questions and mobilize a stronger social sciences component within the GEC research community—just as the Millennium Ecosystem Assessment resulted in new paradigms and lasting research collaborations on ecological dimensions of global environmental change.

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World Climate Research Programme: Scientific Foundation for Decision Making

Introduction

WCRP continued to support high priority scientific research activities during the past year in support of its mission of facilitating analysis and prediction of Earth's climate system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. These activities enabled progress on: 1) the scientific understanding of climate variability and change on seasonal, decadal and centennial time scales; 2) the analysis, interpretation and synthesis of the scientific knowledge in order to provide the required climate information for decision makers concerned with climate adaptation, mitigation and risk management; and 3) training and development of early career climate scientists, and a dialogue between climate experts and decision makers at the regional and global levels. In the following sections, we provide some examples of these three categories of activities.

Advancing Climate Science

About 20 modeling groups from around the world are currently running the CMIP5 experiments that represent the most ambitious multi-model inter-comparison and analysis project ever attempted. The WCRP Working Group on Coupled Models (WGCM), in consultation with the IGBP Analysis Integration and Modeling of the Earth System (AIMES) and a number of other elements of WCRP and the climate research community, is coordinating three major categories of experiments and analysis based on model simulations. They are; 1) Decadal Hindcasts and predictions simulations; 2) "long-term" simulations; and 3) "Atmosphere-only" (prescribed SST) simulations for especially computationally-demanding models. More details on the Climate Model Intercomparison Project (CMIP5) can be found at: <http://cmip-pcmdi.llnl.gov/cmip5/>. Some model data are already available for analysis through PCMDI web page, with more results steadily becoming available soon. The multi-model datasets will mature through the course of 2011 as more model data become available. Ultimately, these results will be available through the peer reviewed publications for use in the 5th IPCC Assessment Report (AR5).

CMIP5 also includes a series of experiments on short-term climate prediction (2005-2030) and provides international coordination of research on understanding the mechanisms associated with regions/modes of climate variability and change, and our ability to predict them. It is well established that, based on knowledge of the initial conditions, important aspects of regional climate are predictable up to a year ahead. Predictability at this time scale is primarily, though not solely, associated with the El Niño Southern Oscillation (ENSO), and is currently addressed by seasonal forecasting. On multi-year timescales other factors are also important, including low frequency variations in ocean circulation and changes in external (or boundary) forcing from anthropogenic (e.g. greenhouse gases and aerosols) and natural sources (e.g. solar variability and volcanic eruptions). CMIP5 has organized a set of experiments that include climate predictions up to 2035. The experiments are organized in a core set and an additional tier 1 set. The core experiments will allow assessment of the forecast quality (i.e. in a hind-cast mode) on time-scales when the initial climate state is most likely to exert some influence. The tier 1 near-term experiments also include predictions with 1) additional initial states after the year 2000 when ocean data is of better quality, 2) volcanic eruptions removed from the hindcasts, 3) a hypothetical volcanic eruption imposed in one of the predictions of future climate, 4) different initialization methodologies, and 5) the option of performing high-resolution time-slice experiments with specified SST for certain decades in the future.

Another major ongoing effort within WCRP is the Climate-system Historical Forecast Project (CHFP, <http://www.clivar.org/organization/wgsip/chfp/chfp.php>). This project is a multi-model, multi-institutional experimental framework for the assessment of state-of-the-science seasonal forecast systems, and to evaluate the potential for untapped predictability due to interactions between the components of the climate system that are currently not fully accounted for in seasonal forecasts. A workshop was held in October 2010 on Seasonal to Multi-decadal Predictability of Polar Climate that focuses on mechanisms for climate predictability in Polar Regions from a phenomenological and process-oriented perspective (<http://www.atmosp.physics.utoronto.ca/SPARC/PolarWorkshop/main.html>). WCRP also co-sponsored with the World Weather Watch Research Programme (WWRP), a workshop on Sub-seasonal to Seasonal Prediction that took place in December 2010 in Exeter UK. The outcomes of the workshop included the identification of high-priority research topics and the establishment of an international research project to facilitate progress on characterising uncertainties and enhancing quality of seasonal climate prediction.

The WCRP SPARC project, through its Chemistry Climate Model (CCM), Validation (CCMVal) activity, made a major contribution to the 2010 Ozone Assessment through the coordination and analysis of CCM simulations performed in support of the Assessment. A detailed process-oriented evaluation of CCMs using performance metrics, as well as an objective and robust statistical analysis method, were developed as part of the peer-reviewed SPARC CCMVal Report (http://www.atmosp.physics.utoronto.ca/SPARC/ccmval_final/index.php). The CCMVal model results not only confirmed our understanding of past ozone depletion, but quantified the two-way interaction between ozone depletion and climate change. For the first time, meaningful statistical measures of uncertainty could be placed on the model projections used in the Ozone Assessment.

WCRP is planning an Open Science Conference (OSC) entitled “Climate Information in Service of Society”, to be held 24-28 October 2011 in Denver, Colorado, (www.wcrp-climate.org/conference2011). The purpose of this conference, which coincides with the 30th Anniversary of WCRP, is to assess our current state of knowledge in climate variability and change, identify the most urgent scientific issues and research challenges, and ascertain how WCRP can best facilitate research and develop partnership critical for progress in addressing these challenges. The OSC will provide an excellent opportunity for exchange and collaboration across the international research communities/programmes (e.g. WCRP, WWRP, IGBP, IHDP), and users of climate information resulting from these research programmes.

Providing Climate Information for Decision Makers

WCRP scientists played a major role in the success of the World Climate Conference-3 held in Geneva in August 2009 (http://www.wmo.int/pages/gfcs/index_en.html). The High Level segment agreed to establish a Global Framework for Climate Services (GFCS) to strengthen production, availability, delivery and application of science-based climate prediction and services. Strengthening of WCRP as well as ESSP partnership is seen as key to a successful GFCS.

The provision of climate information at regional to local scales is an important requirement to support informed decision making in response to potential climate change. Such information is needed to assess the impacts of climate change on human and natural systems, enabling the development of suitable adaptation and risk management strategies at the regional to local level.

The WCRP Task Force on Regional Climate Downscaling has launched the CORDEX project (http://wcrp.ipsl.jussieu.fr/SF_RCMTerms.html) in order to provide quality-controlled data sets, model simulations and regional climate-based information for the recent historical past and for the rest of 21st century in form of climate projections. CORDEX domains cover the majority of populated land regions on the globe with a major focus on Africa. The project is well underway and is becoming a reference for the community of practice in regional climate downscaling and analysis. The group organized the first International CORDEX Conference in Trieste in March 2011 that reviewed the status and main issues of the

CORDEX initiative over the various CORDEX domains. Special sessions were devoted to the Africa domain and to the assessment of the first multi-model CORDEX simulations over this region, followed by a special training session for the African scientists towards developing research and analysis capacity in this region.

Research on “Climate Extremes” is one of the WCRP cross-cutting activities and it is focused on the design of an intercomparison framework through which both observations and climate model representations of extremes and projections of climate can be assessed, and by which changes in climate extremes can be better evaluated and communicated to the decision makers. The overall aim of this activity is to accelerate progress on the prediction/projection of climate extremes with a focus on developing capabilities and products which facilitate practical applications for stakeholders in regions/sectors around the world. A workshop on Metrics and Methodologies for Estimation of Extreme Climate Events, jointly sponsored by WCRP and UNESCO, has been organized in September 2010 at UNESCO Headquarters, Paris, France (<http://www.extremeworkshop.org/>). The workshop considered stakeholder requirements for improved information on climate extremes, reviewed progress in meeting these requirements, identified gaps, and facilitated an active dialogue amongst researchers from different disciplines, climate data producers and stakeholders to develop a strategy for future research. Drought has been identified as an important focus of the WCRP extremes activity and a major international workshop was organized in March 2011 in Barcelona, Spain (<http://drought.wcrp-climate.org/workshop/>). The key recommendations that resulted from this workshop include the development of a drought catalogue to provide a summary of our current understanding of the causes of drought world-wide, the definition of case studies and coordinated analysis of the mechanisms, research priorities to improve drought predictability and prediction skill, and the development of an experimental drought early warning system (DEWS) that takes advantage of our current capabilities in drought prediction and monitoring.

Training Next Generation of Climate Scientists

WCRP has been partnering with WMO, GCOS and ICPAC to execute a World Bank-sponsored project on climate risk reduction for the Greater Horn of Africa countries (http://www.wcrp-climate.org/CB_projects_GFDRR.shtml). A series of three coordinated workshops brought together climate practitioners and users to assess available climate data and information for water resources and agriculture, and to identify best practices and gaps that need to be filled. The overall objectives of the workshop programme were to help ensure that attention is given by countries in the GHA region to observation and data needs, to demonstrate the use and value of regional models, to provide advice on model limitations, and to improve capabilities across the GHA for using data records and model projections for adaptation planning.

WCRP has launched a grants programme to enable and support the active participation of about 200 individuals among students, early career scientists and scientists from developing countries to attend the WCRP Open Science Conference. More than 400 applications are received and they are being reviewed by an expert Panel to select the final recipients of these grants. WCRP has reached a formal agreement with major international scientific and technical programmes (e.g. American and European Geophysical Unions, American Meteorological Society) to award more than 100 complimentary membership and access to their annual meetings to the best papers and posters to be presented by these scientists at the WCRP Open Science Conference.

WCRP also constituted a policy to invite and support participation of early career scientists and graduate students in everyone of its co-sponsored scientific and technical meetings, workshops and conferences. In 2010, WCRP supported 150 such candidates representing 27 countries, mostly from the developing regions/nations.

WCRP in partnership with START is developing a regional research capacity development for Asia and Africa in conjunction with the CORDEX to ensure long-term availability of experts who are able to translate scientific knowledge of climate variability and change for use by decision makers in food and

agriculture, water resources management, urban and peri-urban agriculture and development, etc.

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