Third Meeting of the Belmont Forum/Council of Principals

The Pavilion Conference Centre, BMW Pavilion, V & A Waterfront Cape Town, South Africa

26-27 October 2010

Third meeting of the Belmont Forum, to be held at the Pavilion Conference Centre, BMW Pavilion, V & A Waterfront Cape Town, South Africa, 26-27 October 2010

AGENDA

26 October	**Millennium Room**		**Paper**
09:00	**Introduction and Overview of Meeting Objectives**	**Tim Alan**	**BF10/07**
09:30	**Belmont Challenge White Paper**	**Steven**	**BF10/08**
11:00	**Break**		
11:15	**ISCU International Capability Study to Address the Belmont Challenge**	**Deliang**	**BF10/09**
12:00	**ICSU Visioning Process and Institutional Challenges**	**Deliang**	**BF10/10**
12:30	**Lunch**		
13:15	**ICSU Concept Paper on a Earth System Science for Global Sustainability Initiative to jointly take forward the Belmont Challenge and ICSU Visioning** **Agree principles of an initiative** **Agree Action Plan**	**Deliang**	**BF10/11**
15:15	**Break**		
15:30	**ISSC Proposal for Social Science Agenda Setting Workshop**	**Heide**	**BF10/12**
16:30	**CCAFS: Opportunities for the Belmont Forum/IGFA to help move forward the agenda on global change and food security and strengthen collaboration between the global change research and development research communities**		**BF10/13**
17:30	**Summary of Outcomes Day 1 and Planning for Day 2**	**Tim Alan**	**Oral**
17:45	**CLOSE OF DAY ONE**		
19:00	**Pre-dinner reception : The Quarterdeck Restaurant, Portswood Hotel**		
19:30	**Dinner: Welcome address from Albert van Jaarsveld**		
	After Dinner Talk: Dr Guy Midgley, South African National Botanical Institute		

27 October	Millennium Room		Paper
09:00	Introduction to Day 2	Tim	Oral
09:10	Collaborative Research Actions: Progress, Opportunities, Challenges:		
	Introduction	Tim	BF10/14
09:15	Climate Services: WMO Perspectives for International Collaboration on Research	Ghassem	BF10/14 (background information)
10:15	Break		
10:30	Water Security	Tim	BF10/14 (background information)
110:50	Coastal Security	Tim/Ian	BF10/14 (background information)
11:10	Securing the Biodiversity Baseline	Johannes	BF10/14 (presentation)
11:30	Forests and Agriculture	Reynaldo	
11:50	Ocean Acidification	Gina	
12:10	Collaborative Research Actions: Summary and Next Steps	Tim	BF10/14
12:45	Lunch		
13:30	Collaborative Research Actions deferred from January: Human Health; Bio and Renewable Energy, Land Use Trade-Offs and Geo-Engineering	Tim	BF10/14 (background information)
14:00	Introduction to the IGFA Meeting	Tim	BF10/15
15:00	Reflection on the Belmont Forum: Progress, Priorities and Resources	Tim Alan	BF10/16
15:30	CLOSE OF BELMONT FORUM/ COUNCIL OF PRINCIPALS MEETING		

BELMONT FORUM **BF10/07**
OCTOBER 2010

INTRODUCTION AND OVERVIEW OF MEETING OBJECTIVES

Action

DISCUSS and AGREE the meeting objectives, desired outcomes and agenda namely:

- To agree and finalise the principles of the Belmont Challenge, set out in the White Paper
- To agree the principles of a joint way forward with ICSU and ISSC and develop an action plan for this
- To review progress on, and decide the next steps for, Collaborative Research Actions
- To prepare for the IGFA Plenary Meeting
- To reflect on the overall direction and progress of the Belmont Forum, identify key factors for success, and any interventions needed.

BELMONT FORUM **BF10/08**
OCTOBER 2010

BELMONT CHALLENGE WHITE PAPER

Purpose of Paper

An action from the January meeting was for Steven Wilson to take the lead in developing this paper.

The revised paper specifically seeks to:
- More fully articulate the vision for 'Apollo Mission' scale challenge
- Define the priority outputs (knowledge and capabilities) that society will most urgently need in the 21st century
- Start to set out a strategy to get us there, including underpinning research and institutional challenges, and mechanisms for working together across international funding agencies and global research communities

Earlier drafts were reviewed and input to by a sub-group of Belmont Forum members and the Co-Chairs.

Action

The objective is to DISCUSS and FINALISE the White Paper and:

- AGREE the principles for the Belmont Challenge vision, outputs and strategy, set out.

Specifically to:

- IDENTIFY where there is agreement on the principles and what the final paper should contain
- AGREE next steps and responsibilities for delivery of final internal paper and any external-facing version needed

The Belmont Challenge: A Global, Environmental Research Mission for Sustainability

v. 0.8 – 13 October 2010

1. EXECUTIVE SUMMARY

In 2009, the world's main funders of environmental change research formed a new, high-level forum called the Belmont forum. Its aim is to align international resources to accelerate delivery of the environmental science-derived knowledge and capabilities that society needs to address environmental change.

This paper sets out the Belmont Forum's priorities for this knowledge and capabilities, and the underpinning research and organisational challenges needed to deliver them. It will form the basis for funders to engage in dialogue over future months with stakeholders from research, government, business and civil society, with the objective of mobilising new partnerships and their collective resources to deliver a global environmental research mission for sustainability.

We seek to add value to strategies that are currently evolving from the environmental change research community. As public sector funders, we offer perspectives from the nexus of research and government, where we are responsible for prioritising investment of public money towards research approaches that can deliver the greatest welfare and economic benefits to society. It is clear to us that: (i) the priority research challenges should be those that can deliver the knowledge society needs, and (ii) stakeholders from government, business and civil society must play a full role directing, governing, using and supporting this research.

We consider that:

In recent decades Earth System science has provided society with a valuable, basic understanding of the environment and human society as interconnected systems, how humans are changing the global environment, and how these changes may affect human well-being.

To enable society to address environmental change in the 21st century, this knowledge of the Earth System must now be built on, to provide information on impacts, vulnerabilities and risks of environmental change and adaptation and mitigation strategies. This knowledge must be provided at decadal and regional scales, at which decisions are made. The research and knowledge will create unprecedented opportunities for equitable economic and social development. Funders have defined the 'Belmont Challenge' to describe this need:

> ***To deliver knowledge needed for action to avoid and adapt to deleterious environmental change including extreme hazardous events.***
>
> *This requires:*
> - *regional and decadal analysis and prediction,*
> - *advanced observing systems,*

- *integration with social sciences,*
- *effective coordination mechanisms,*

With priority foci being:

- *Coastal Vulnerability*
- *Freshwater Security*
- *Ecosystem Services*
- *Carbon Budgets*
- *Most vulnerable societies*

Priority knowledge and capabilities that the Belmont Challenge must deliver for society over the next decade and beyond include:

- Predictions of risks, impacts and vulnerabilities,
- Information on the state of the environment,
- Enhanced environmental information service provision to users.

These capabilities are highly interdependent and need to be delivered in an integrated way. We propose an Earth System Analysis and Prediction System (ESAPS) as an integrating framework around which to organise the research and knowledge. An ESAPS would: overcome critical limitations for development of predictive models by promoting assimilation of improved environmental data; support evidence-based decision-making by linking interconnected elements of the policy cycle; and build on the concept of Climate Services by adding information about multiple environmental change stressors, to provide 'Environmental Services.'

The intellectual and organisational challenges involved in delivering an ESAPS and meeting the Belmont Challenge require a profound change to the way we support and undertake global environmental change research. In particular, there are needs for: overarching strategic governance to establish key priorities among competing demands and promote cooperation; a greater voice of users in defining and governing the research priorities; a step-change increase in collaboration across disciplines, which will require framing environmental change challenges in ways that engage groups other than environmental sciences, and across regions, especially to build capacity in developing countries; and improved mechanisms for major transnational funding, that overcome current constraints to cross-border support while adhering to national requirements and statutes.

Recently, a number of international initiatives by intergovernmental and research communities, in addition to the Belmont Forum, have started to consider and stimulate organisational change to address challenges included above. We propose that these initiatives are drawn together, with stakeholders from business and civil society, into a high-level joint strategic task force. This task force would, over the next 1-2 years, develop a comprehensive strategic roadmap for supporting and delivering an integrated research mission for sustainability. It would refine and prioritise the research challenges, secure the necessary political and financial support, and build the necessary links with decision-making systems to facilitate the update of research outputs by users.

2. INTRODUCTION

This White Paper sets out the perspective of many of the world's major environmental research funding agencies on the 'grand challenges' for global change research that need to be delivered over the next 10-20 years, to support sustainability. These perspectives will form the basis for funders to collectively engage in dialogue over future months, with research providers, coordinated through ICSU and ISSC, and with the primary users of research from government, business and civil society. The objective is to mobilise partnerships and their collective resources to support and deliver a coordinated global environmental research mission for sustainability.

The paper considers:

- The critical environmental and social-science derived knowledge and capabilities that society needs to respond appropriately to the threats and opportunities precipitated by environmental change in the 21st century,
- The pivotal research challenges that need be met to provide this knowledge and capability. The focus is explicitly on interventions that require global-scale international cooperation, are solutions-focused, and integrate observations, prediction and knowledge platforms,
- The essential need for a new strategic and integrated partnership approach, in order to mobilise the resources and build the capacity needed,
- The key requirements of a Roadmap for delivering this transformative international research agenda, focusing on partnerships between funders, providers and users of research, coupled with appropriate prioritisation.

3. BACKGROUND

Developing an Understanding of the Earth System and Global Environmental Change

In recent decades Earth System science has provided society with a basic understanding of the environment and human society as interconnected systems. It has started to generate understanding of how human actions are changing the global environment and predictions of how these changes may affect future human well-being. We know that humankind is pushing important environmental variables on which we depend (climate, freshwater, biodiversity, elemental cycles) outside the stable boundaries that they have exhibited over the last 10,000 years. This period, the 'holocene' is the one during which human society has evolved and prospered[1]. There is no doubt that our current path is unsustainable. Evidence is emerging that the rate and magnitude of anthropogenic environmental change is moving towards states beyond our ability to control or adapt to it [2]. The Global Environmental Change programmes (IGBP, WCRP; IHDP, DIVERSITAS and their partnership programme ESSP[1]) coordinated under the auspices of ICSU, and international observational programmes (such as GCOS, GEO/GEOSS) have played an important role in

[1] Spell out acronyms

directing, synthesizing and communicating research to promote this improved understanding of global environmental change.

Providing Science-Based Solutions

The information that society now needs, in order to respond to the challenges of global environmental change, must build on this basic and global-scale understanding to provide science-based solutions for societal action. Society needs critical information about interconnected environmental and societal risks and how to manage them, including how to protect life and property, make decisions about trade-offs between different enviro-societal management options, and transition to sustainable economies. This will require science-based knowledge about the impacts of global environmental change at much higher resolutions than provided to date – specifically at the regional and decadal scales at which decision-makers operate. The information will need to be aligned with influential societal decision-making systems.

By providing the foresight and insight to enable innovative technical and societal solutions to environmental change, research will create unprecedented opportunities for equitable economic and social development. These will include:

- Enabling effective transitions to low-carbon, resource-efficient economies, through assessing whole-system impacts and trade-offs for innovation options in sectors such as energy, agriculture, water and waste,
- Providing an evidence base for development, auditing and regulation of new markets for trading ecosystem services, such as carbon sequestration, nitrogen fixation, water purification, etc.,
- Monitoring and forecasting to protect property and infrastructure, reducing average insured losses and providing confidence for investment,
- Improving health and well-being through reduced vulnerability to natural hazards and pollution, and
- Lifting people out of poverty through supporting innovative sustainable development pathways towards Millennium Development Goals

Providing this knowledge, predictions and decision-support tools, with the required urgency, is an enormous intellectual and technical challenge. Understanding the interconnectedness of the 'Earth System' across its physical-chemical-biological- -societal dimensions and across spatial and temporal scales, and leveraging this understanding to predict changes and inform behaviours and decisions, will require interdisciplinary conceptual frameworks of enormous complexity. Understanding what environmental information is most crucial to know, and what measurements, technologies, and models are needed for this, is a significant challenge in its own right. Delivering the this data collection and provision, modelling and stakeholder engagement will require a step-change in technical capabilities (particularly in high-performance computing, data management, sensor technologies, and interactive communication tools). These are 'Grand Challenges' and require new ways of prioritising, funding and doing research that can mobilise and coordinate the resources of all stakeholders in a decade-long mission for sustainability.

International research communities have recently described their priorities for 'grand challenge' research for sustainability. For example:

- "Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade"[2] developed by ICSU as part of its ongoing visioning process,
- "Regional Environmental Change: Human Action and Adaptation – What does it take to meet the Belmont Challenge"[3] – a report of an ICSU Panel commissioned by the Belmont Forum of Environmental Change Funding Agencies,
- Developing a common strategy for integrative global environmental change research and outreach: the Earth System Science Partnership[4] – a strategy paper of the ESSP,
- A Safe operating space for humanity[1] – coordinated by the Stockholm Resilience Centre,
- WMO Third World Climate Conference – Declaration to Establish a Global Framework for Climate Services (September 2009).
- Nobre et al. – An Earth System Prediction Initiative for the 21st Century[5], and
- [WMO WCC3 Statement on Global Framework for Climate Services – GA to add proper title]

There is considerable alignment among these analyses and visions. In particular around the need for:

- Improved forecasts of regional and decadal scale changes that fully take into account coupled natural-human systems – requiring a suite of integrated Earth System Models,
- Observations of the Earth system that can validate models, provide early warning of change and support decision making - requiring advanced observing systems that integrate environmental and social data, quantitative and qualitative data, and historical and contemporary data and are at a high-enough resolution to detect systematic change and capture extreme events,
- Knowledge of 'tipping points' (critical thresholds at which non-linear environmental change will occur that will disrupt wellbeing of society), our proximity and vulnerability to them, and strategies for avoiding, adapting and enhancing our resilience to them – requiring integration of environmental and complexity science, and of 'impact' and 'response' research,
- Knowledge of technical and social innovations that can overcome barriers to sustainability, likely to include options for international trade in the Earth System – requiring highly integrative and synthetic science, and comparative assessments of whole-system and whole-life-cycle environmental impacts and trade-offs for different options, and
- Knowledge platforms – two-way information and communication tools that support the needs of sectors such as agriculture, energy, insurance, health, transport etc for information on forecasts, impacts, vulnerability and adaptation – will require a step-change in science-society bridging activities and capabilities, including mechanisms to enable science to be directed in response to user-identified needs.
- Co-design of research agendas among stakeholders - connecting scientific, economic and social development agendas in directing and benefiting from research.

The existing Global Environmental Change Programmes, each undertake research relating to these needs, and frequently do so in partnership with users, especially from intergovernmental bodies. However, it is recognised by research providers and funders alike that the impact of the programmes may be limited by their current organisation, which has evolved in an opportunistic and fragmented way. Intervention to promote strategic overarching direction and prioritisation, and integration across structural borders, in which all key stakeholder sectors are engaged, is needed, if we are to succeed in securing support for and delivering the research mission for sustainability.

4. THE FUNDERS' PERSPECTIVE: THE 'BELMONT CHALLENGE'

Funders of environmental research are part of the equation for realising a research mission for sustainability and are keen to see the enhanced level of coordination needed. In July 2009, the world's major funders of environmental change research, and ICSU, met at Belmont House, Maryland USA, to consider how best to align financial and human capital towards delivering the environmental science knowledge base that society will need in the 21st century. (This group has since been called the 'Belmont Forum' and it operates as the Council of Principals for the broader International Group of Funding Agencies for Global Environmental Change Research (IGFA)).

As funders, we do not seek to introduce an additional or alternative vision into the mix of strategies emerging from the global environmental change research community. We seek to add value to them by contributing a funders' perspective on how emergent 'grand challenge' research might be prioritised and organised, in order to maximise the impact of, and potential for, sustainable, international support of the magnitude required. We offer this perspective as agencies that, operating at the nexus of research and government, are responsible for prioritising investment of public money towards research approaches that can deliver the greatest welfare and economic benefits to society. It is clear to us that: (i) the priority research challenges should be those that can deliver the knowledge society needs, and (ii) stakeholders from government (including public sector funding agencies), business and civil society must have a central role in the joint, strategic governance of the research, playing a full role directing, governing, using and supporting it. In other words, the international global change research community must 'seal' the contract with society, first proposed by Jane Lubchenco[6] in 1998.

As a result of the July 2009 meeting, funding agencies, defined 'The Belmont Challenge' around which, in our view, international collaborative research should be focused. During 2010 we further articulated and prioritised the sub-challenges within the Belmont Challenge. The Belmont Challenge takes account of the strategic visions set out by international research communities described above, as well as our organisations' own strategic priorities, as informed by our research communities, our governments and our stakeholders in business and civil society. Our priorities are in broad agreement with the analyses of the world's major scientific programmes and councils.

The Belmont Challenge is:

To deliver knowledge needed for action to avoid and adapt to deleterious environmental change including extreme hazardous events.

This requires:

- *regional and decadal analysis and prediction*
- *advanced observing systems,*
- *integration with social sciences,*
- *effective coordination mechanisms,*

With priority foci being:

- *Coastal Vulnerability*
- *Freshwater Security*
- *Ecosystem Services*
- *Carbon Budgets*
- *Most vulnerable societies*

Critical Interventions

We suggest below some priority knowledge and capabilities that the Belmont Challenge must provide society, and some of the pivotal research challenges and capacity-building needed to get us there.

The priorities for knowledge and capabilities are organised into 3 areas:

(a) Predictions of risks, impacts and vulnerabilities,
(b) Information on the state of the environment,
(c) Enhanced environmental information service provision to users.

The capabilities are highly interdependent. Scientifically, our technical ability to develop improved predictive modelling tools will depend on assimilation of improved data in the state of the environment. Furthermore, society's decision-making needs require them to be interlinked, since monitoring, analysis and evidence-based information are interconnected components of the policy-cycle. It is therefore essential that these capabilities are developed in an integrated way. In priority (d) we propose the development of an Earth System Analysis and Prediction System (ESAPS) as an *initial* example of a potential mechanism to integrate and coherently organise global change research outcomes to support decision-makers in dealing with critical issues in global change such as adaptation, mitigation or integration of climate services.

The priorities listed in (a) – (d) below are not exhaustive. In particular they lack social science dimensions. We also lack information on the extent to which the priorities can be met through improved coordination of existing capability, or where investment in new capability is required. Further development and prioritisation should take place as part of the Roadmap described in section (5) below.

a) <u>Predictions of risks, impacts and vulnerabilities</u>: To provide foresight about changes in the Earth System at Regional and Decadal Scales, which takes

full account of societal interactions and focus on changes that may cause abrupt and potentially irreversible and disastrous changes

Priorities will include developing predictive capabilities for:

i. The likelihood and severity of extreme hydro-meteorological events and their impacts on human socio-economic systems in a given geographical region, from seasons to decades, under different GHG emission and land-use scenarios,

ii. Likelihood of biodiversity loss that will compromise provision of essential ecosystem services for a given terrestrial or marine region, under given climate and management scenarios, and

iii. Predictions of the environmental and health impact of changes to other biogeochemical cycles (e.g. nitrogen, phosphorous) or to increased loadings of toxic pollutants

Underpinning Research Challenges:

We agree with the consensus among the international science communities, about the need for convergence around limited number of Earth System models, which can then be developed into a hierarchy of models with regional capability. The models must have the ability to analyse and predict change to the Earth system that includes representation of coupled, physical, chemical, biological, social and economic processes. Development of, and outputs from, these models should be linked to decision-making systems.

The modelling studies should focus on the probability of occurrence of future extreme events, the impacts of these on human societies, and consequences (including costs) of different adaptation and mitigation strategies. This will require understanding of non-linear dynamics and thresholds beyond which systems tip into alternate states. Predictions of impacts and risks that compare and integrate 'bottom-up' approaches (i.e. critical thresholds) and 'top-down' approaches (e.g. downscaling) will be important for providing maximum insight and benefit to users.

b) Information on the state of the environment: to verify the accuracy of predictions, assess proximity to disruptive change and monitor the effectiveness of management strategies.

Priorities will include observing systems that provide:

i. Data and knowledge to improve, verify and refine model predictions at regional and decadal scales,

ii. Data and knowledge to assess proximity to disruptive tipping points in order to identify vulnerable regions/societies, provide early warning of disruptive change (e.g. Extreme hydro-meteorological events, disruption of ecosystem services, etc.), and inform avoidance/adaptation strategies, and

iii. Monitoring of stocks and fluxes of key environmental change variables (e.g. carbon, nitrogen, water, deforestation) to support markets and regulation.

Underpinning Research Challenges

There is a need for linked sensors, data preservation and information systems that are prioritised on environmental and social variables that characterise dynamics and vulnerabilities of regions and systems.

Data/information systems must be accessible, with a range of data products and visualisation tools for non-specialists and linked with decision-making systems.

In order to maximise efficiency of existing capability, there is a need to improve coordination between existing observational and data systems, and between academic and operational systems. There are currently some major international programmes aimed at improving effectiveness and coordination of global and regional monitoring systems (e.g. GEOSS; ICSU World Data Systems, WMO) that will be important partners.

c) Enhanced environmental information service provision to users through knowledge platforms: Delivering applied knowledge to support innovative adaptation and mitigation solutions, based on the observations and predictive knowledge outlined in (a) and (b)

These must enable:

i. Interaction with end users to identify what predictive and observational capabilities will bring most effective knowledge for adaptation and mitigation solutions,

ii. Products developed on a regular schedule, tailored to user needs,

iii. Identification of strategies needed to reduce vulnerability to change (mitigation or adaptation), and

iv. Comparative analyses (costs and benefits) of different mitigation and adaptation strategies, based on whole-system, whole-lifecycle impacts, vulnerability and risks. Include assessments of the trade-offs and strategies to mange the tradeoffs.

ICSU[2] has identified some priority needs for information on strategies and tradeoffs including: How can global energy security be provided entirely by sources that are renewable and have neutral impacts on other aspects of global sustainability; How can competing demands for scarce land and water be met over the next half-century – while dramatically reducing land use GHG emissions, protecting biodiversity and maintaining or enhancing other ecosystem services; How can ecosystem services meet the needs for improving the lives of the world's poorest peoples and those of

developing regions (such as safe drinking water and waste disposal, food security, and increased energy use) within a framework of global sustainability? What are the potentials and risks of geo-engineering strategies to address climate change?

Underpinning Research Challenges

New information systems and tools to support communication and participatory research approaches between research providers and users are needed. These platforms will need to provide information and services beyond those traditionally provided by national meteorological and environmental services – e.g. to sectors including agriculture, insurance, investment, health, transport, commerce and manufacturing. The systems will also need to transcend national perspectives and serve global users.

Comparative analysis of different approaches towards risk reduction will require development of risk models, and multi-disciplinary quantitative analysis of their outputs. It will be important to identify any potential unintended consequences of changes. The risk models will need to be able to integrate quantitative and qualitative information.

(d) Development of Integration Mechanisms

There would be enormous benefits from integrating the research and knowledge products outlined in (a) – (c) to provide stakeholders and decision makers with a holistic decision-support system for critical issues facing global change mitigation and adaptation, including, but not limited to Earth systems analysis and prediction Integration of observations, and analysis would overcome critical limitations to model development for environmental change, on global, regional and eventually local scales . Integration of observations, modelling and knowledge platforms would ensure connectivity between key components of the policy-cycle, on which evidence-based decision-making depends. It would also build on the concept of Climate Services, adding information about multiple environmental change stressors, to provide 'Environmental Services'.

An example of such a mechanism is an Earth System Analysis and Prediction System (ESAPS). The ESAPS would seamlessly align and integrate distributed environmental change research capability around the world. It would focus on research, observation systems and knowledge that require global cooperation. Application of this information for addressing specific national, regional and local issues would be undertaken by national, regional or local organisations.

Key elements of the ESAPS would include:

- As comprehensive a description of as many components of the Earth System as possible, subject to the constraint of the computational resources available
- A fully-coupled data assimilation system, allowing observations of all components of the Earth System to be brought into the analysis-model system

- Credible re-analysis of the last 50 years, as a vital test of the system
- Prediction capability with clearly defined societal driver scenarios used for the unknowable (typically human behaviour) elements.

Capacity Building

Delivering an Earth System Analysis and Prediction System to address the Belmont Challenge over the next decade and beyond requires a comprehensive strategy to mobilise, align and strengthen the human, institutional and financial resources of funders, providers and users of environmental research. Priority elements of this strategy should include;

- Governance – An authoritative, international, multi-sectoral partnership, with effective representation from the major stakeholder groups will be critical for establishing clear priorities among competing demands, promoting cooperation among key players, and championing uptake of outputs. This relationship must go beyond governments to include business and civil society,

- Collaborative Research – integrating the full range of sciences and humanities and cross-regional to global scales. This will require framing environmental change issues in ways that encourage and enable participation of groups other than environmental scientists, especially social scientists. Networking existing centres of excellence across regions and disciplines will be important. Such a network would build a focus on interdisciplinary Earth System science, while incorporating regional initiatives. It would provide access to state-of-the-art facilities and training to scientists around the world,

- Building Capacity in Developing Countries – in order to assess regional aspects of global environmental change, impacts and vulnerabilities, and provide information to public and private sector decision-makers there is an enormous need for capacity building in developing countries. Regional networks of partnerships between scientists and institutions from developed and developing countries to conduct research are important and could facilitated through the network of centres of excellence, described above

- Next Generation Sustainability scholars - a major and transformative effort will be required to train graduate, doctoral and post-doctoral researchers with the interdisciplinary, cross-sectoral skills needed to address context-specific problems of sustainability

- Enhanced mechanisms for major transnational funding – a suite of collaborative tools is needed that overcome current constraints to transnational funding while adhering to national requirements and statutes. These should span the spectrum of cooperation, from alignment and sharing of national programmes and capabilities to co-design and co-funding of joint programmes and capabilities.

The organisational changes needed to develop this capability represent a profound change to the way we do environmental science today. However, a number of initiatives, linked to the strategic visioning activities described above, are starting to consider and stimulate appropriate organisational change. These include: Strategic alignment of funding agencies through establishment of the Belmont Forum; The Global Environmental Change Programme's analysis of new institutional frameworks required for global sustainability research, led by ICSU; and the WMO High Level Task Force that is developing an Implementation Plan for a Global Framework for Climate Services.

5. ROADMAP

The Belmont Forum proposes that a high-level, **joint strategic task force**, with representation from across the major stakeholder groups (research providers, research funders, government, business and civil society) is established as an over-arching governance mechanism to drive forwards the integrated, global research mission for sustainability set out under the Belmont Challenge and ESAPS. Such a task-force is consistent with a proposal discussed by global environmental change programmes and funders as part of the ICSU Visioning process in June 2010. We consider it essential that only one such group is established, and that it is developed jointly through funders and the Global Environmental Change community coordinated through ICSU and ISSC, and in partnership with other stakeholders.

Over the next 1-2 years, this task force would develop a comprehensive, strategic **Roadmap** for supporting and delivering the 'grand challenge' research needed over the next 10-20 years. The strategic task force would be responsible for: establishing the research priorities; securing political and financial support; promoting the integration of existing programme structures into more streamlined systems; commissioning ICSU and ISSC, the Global Environmental Change Programmes, International Observational Systems, and other appropriate providers to deliver the research; and building the necessary linkages with decision-making systems to facilitate uptake of the research outputs by users.

The Roadmap should:

(a) **Refine and prioritise** the needs for environmental-science derived knowledge and capability set out above and in the visions and strategies of the international scientific organisations and other stakeholders from government, business and civil society. A priority will be more strongly engaging social science and user voices in determining these priorities.

It should agree the **outcomes** required (knowledge, capability and services needed by society and corresponding underpinning research challenges) and a **strategy** (key players (funders, providers, users), timetable and budget) for delivering them. The outcomes and strategy should be clearly **prioritised.** The prioritisation should have at its core the critical research and integration needs and mechanisms to provide environmental information services to governments, business and society at large (such as through an ESAPS). It should also reflect the urgency with which the

information is needed, and the tractability of the research providing that information. This prioritisation should include identification of 'quick wins' where there is significant existing capability to deliver an outcome.

(b) Ensure that wherever possible, implementation focuses on **increasing the effectiveness of existing capability, through improved prioritisation and coordination.**.

Specify which outcomes of the roadmap can be delivered by more focused and coordinated use of existing research national and international research programmes, infrastructure and training. Set out a strategy for organising the existing capability and delivering the resulting outcomes, to include:

- coordination and integration of existing observations, datasets, programmes, training and knowledge exchange platforms, and
- reallocation of resources from capability that is not a priority, to enhance capability that is

(c) Identify which outcomes require **investment in new capabilities** (i.e. cannot be delivered by more efficient use of existing capability). Set out a strategy for delivering the new investments and the resulting outcomes.

Over the next few months, the Belmont Forum, in partnership with ICSU and ISSC, will discuss with stakeholders from research, government, business and civil society, our proposal for a Joint Strategic Task Force to develop a Roadmap for the global environmental science mission set out in the Belmont Challenge and ESAPS. The objective of these discussions will be to identify how the funders' research agenda may be best aligned and taken forward with similar emerging high-level strategies of our stakeholders.

References:

(1) Rockstrom et al. (2009) . A Safe operating space for humanity. Nature 461: 472 – 475
(2) ICSU (In press?) "Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade"
(3) ICSU Panel (2010) "Regional Environmental Change: Human Action and Adaptation – What does it take to meet the Belmont Challenge"
(4) Leemans et al. (2009) Developing a common strategy for integrative global environmental change research and outreach: the Earth System Science Partnership. Current Opinion in Environmental Sustainability 1: 4-13.
(5) Nobre et al. (2010). Addressing the complexity of the Earth System. Bulletin of the American Meteorological Society X: XX – XX (in press).
(6) Lubchenco (1998). Entering the Century of the Environment: A new social contract for Science. Science X: XX - XX

BELMONT FORUM **BF10/09**
OCTOBER 2010

ICSU STUDY OF THE INTERNATIONAL CAPABILITY TO ADDRESS THE BELMONT CHALLENGE

Purpose of Paper

An action from the first meeting (July 2009) was for the Belmont Forum, through NSF, to commission an ICSU panel to assess existing capability to address the Belmont Challenge and new capability needed to fill gaps, with a focus on solvability of problems, infrastructure and personnel needed.

The panel's report was published in September 2010 and identifies some priorities for research and makes recommendations for action by funding agencies.

Action

- The objective is to DISCUSS the report and:
    - DECIDE whether to accept the reports conclusions and recommendations, and
    - If so, AGREE how specific recommendations should be taken forwards (this may include taking forward through the proposed *'Earth System Science for Global Sustainability Initiative'* to be discussed under item BF10/11)

Regional Environmental Change: Human Action and Adaptation

What does it take to meet the Belmont Challenge?

ICSU
International Council for Science

ICSU

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both national scientific bodies (121 National Members representing 141 countries) and International Scientific Unions (30 Members). The ICSU 'family' also includes more than 20 Interdisciplinary Bodies—international scientific networks established to address specific areas of investigation. Through this international network, ICSU coordinates interdisciplinary research to address major issues of relevance to both science and society. In addition, the Council actively advocates for freedom in the conduct of science, promotes equitable access to scientific data and information, and facilitates science education and capacity building. [www.icsu.org]

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Regional Environmental Change: Human Action and Adaptation

What does it take to meet the Belmont Challenge?

Preliminary report of an ad hoc ICSU panel

August 2010

Preface

In late 2009 the Belmont Forum, a group of major funders of international global change research, invited the International Council for Science (ICSU) to conduct an analysis of the international research capability required to respond to the challenge of delivering knowledge to support human action and adaptation to regional environmental change. This challenge was named the Belmont Challenge and requires regional and decadal prediction, advanced observing systems and the integration of the social sciences.

To address this task, ICSU set up a panel consisting of 15 international experts with Guy Brasseur as the chair (Annex 1). While the panel members served in their personal capacity, the report was able to benefit from, and build upon, the collective wisdom of a large community with which they interact. The analysis draws on the existing synthesis and assessment products of the broader scientific community, the experiences and strategic plans of the global change programmes[1] and other related international and national activities, and many peer-reviewed papers. This report summarizes the panel's findings.

The report has undergone extensive peer review. Inputs were sought from relevant ICSU bodies and other organizations. Nevertheless, the scale of the task and the limited time available did not permit a comprehensive analysis of all issues; consequently, the report should be regarded as a preliminary analysis. Indeed, one of the outcomes of the analysis is the realization that the details of the Belmont Challenge itself need to be better specified, and further studies on a number of important areas are needed.

Initially, the starting point and thus the focus of the Belmont Challenge was: 'to deliver knowledge to support Human Action and Adaptation to Regional Environmental Change'. It was recognized that decadal prediction would be an essential first step in this process, but after some consultation, particularly with external reviewers and the Belmont Forum, it was decided to expand the analysis to include mitigation. To some extent this is reflected in the structure of the report and the fact that coverage of areas is somewhat uneven.

While this report was being drafted by ICSU, parallel work was being conducted by the Belmont Forum to detail the Belmont Challenge, in the form of a white paper. Unfortunately, the timing was such that the panel could not take full account of this work. Despite these limitations, we nevertheless hope that the report will be a useful starting point for addressing the Belmont Challenge, since it represents an important component of a complete Earth system research agenda.

In 2008 ICSU initiated an Earth System visioning exercise that has defined five grand challenges for global sustainability research, with concrete scientific questions under each of the challenges. Some of the visioning outcomes cover elements set out in the Belmont Challenge. Although this analysis and the visioning process are two independently designed processes, the overlap in the priorities identified only serves to underline their importance.

Partly due to the overlap, there has been some confusion, within the research community, about the two parallel processes. While the visioning process was mandated by the ICSU General Assembly in 2008 to outline options for an overall framework for global environmental change research, the present report is an analysis requested by the funders and should not be regarded as an implementation plan for the visioning process, although the discussions and suggestions of the analysis may provide useful inputs to the ongoing visioning process.

[1] DIVERSITAS, an International Programme of Biodiversity Science; International Geosphere-Biosphere Programme (IGBP); International Human Dimensions Programme on Global Environmental Change (IHDP); World Climate Research Programme (WCRP); and Earth System Science Partnership (ESSP).

This report is the culmination of contributions from many organizations and individuals. In addition to the panel members and the contributors listed in Annex 1, many others have played an important role. On behalf of ICSU, I would like to express very sincere thanks to the dozens of reviewers whose advice and recommendations have served to significantly improve the report. A special thank you goes to Guy Brasseur, and to Mel Shapiro who assisted the chair of the panel in a most efficient and effective way. NSF provided financial support to the project. Colleagues from the Belmont Forum also provided useful information about the articulation of the Belmont Challenge and feedback to earlier versions of the report.

Deliang Chen
Executive Director
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Executive Summary and Recommendations

In June 2009, the US National Science Foundation (NSF) and the UK Natural Environment Research Council (NERC) led a meeting in Belmont, Washington DC, attended by representatives of several of the world's major global change research funding agencies and the International Council for Science (ICSU). These agencies, supporting basic and applied research in Earth system science, identified a challenge for the international scientific community to *develop and deliver knowledge in support of national and international government action to mitigate and adapt to global and regional environmental change with an emphasis on regional hazards.* This challenge is hereafter referred to as the *Belmont Challenge*. In response, a panel was assembled by ICSU. It was tasked to assess the willingness, readiness and capacity of the international research community to respond to the Challenge and to address issues related to the integration of weather, climate, ecosystem, energy, health, agriculture, engineering and social science research, emphasizing near-term (year-decade), as well as medium-term (20 years) options, challenges, and approaches to the needed level of international activity. This requires a dialogue between stakeholders (political, economic and social actors, either as individuals, groups or organizations), and natural and social scientists.

The environmental problems facing today's society cannot be overcome by a single nation or a single scientific discipline. Responding to these challenges demands highly coordinated and collaborative research and service agendas. The panel proposes a research agenda to provide the scientifically based information needed by local, national and international decision makers, as they take actions for the benefit of society and environmental sustainability. This agenda will mobilize the full spectrum of scientific disciplines. Reducing vulnerability and increasing resilience to environmental stress is a unifying goal of the diverse communities involved in these issues.

The panel highlights the need for the development and implementation of:

- Integrated tools for analysis, prediction and projection in support of the capability of environmental management to identify and respond to hazards, risks and vulnerability, and to develop mitigation and adaptation strategies. A major challenge is to develop integrated Earth system analysis and prediction systems, including the characterization of regional vulnerability and risks.
- More effective use of physical and societal observations to improve global-to-regional environmental analysis and prediction.
- Information/communication tools and facilities that provide authoritative and easily accessible information to policy makers and decision makers.
- Capacity-building strategies in both developing and developed countries, as well as scientific partnerships between institutions from different geographic regions of the world.

The panel recognizes the urgent need to:

- **Coordinate efforts and enhance the support** required to address the needs of a sustainable environment and the needs of society. The challenge is to integrate environmental and developmental issues that have often been addressed independently in past decades.
- **Facilitate the dialogue between scientists, decision makers and the general public** to support decisions and actions at the forefront of society's needs.
- **Encourage natural and social scientists to work together** to ensure that environmental observations, analyses, predictions and services most effectively meet the needs of society.
- **Maintain and expand access to, and use of, the current global observing and monitoring systems** through coordinated databases and develop assimilation procedures to achieve the maximum benefit.

- **Respond to society's increasing demand for detailed information** at the regional and local scales. This requires sector-relevant information that includes observations, analyses, high-resolution projections/ predictions at timescales from days to decades.

The panel established the following priorities to address the Belmont Challenge:

- **Develop Earth system knowledge:** Building on past successes, mobilize existing research teams and networks to develop and deliver the knowledge required to address pressing global to local environmental and societal issues, with the support of funding agencies and national and international programmes.
- **Facilitate the communication of knowledge to decision makers:** Identify the objectives and means for effective translation and communication of scientific knowledge for targeted sectors and regions in order to realize the intended benefits from the application of such knowledge.
- **Nurture the next generation of experts:** Invest in training scientists and associated staff through fellowships and research grants, emphazing scientific challenges at the interface of natural and human systems.

The panel recommends the following actions by the funding agencies:

1. **Establish an international research and educational network for Earth system science.**
2. **Promote the development of the human capital** required to address the Belmont Challenge.
3. **Establish multi-national interdisciplinary and transdisciplinary teams** that promote a dialogue with decision makers to identify the key environmental and societal issues that regions are facing.
4. **Encourage diverse approaches** for the analysis of multi-stressors, responses and feedback processes affecting the physical, chemical, biological and social systems in selected regions particularly prone to human perturbations and environmental change.
5. **Develop and coordinate advanced experimental, observational, and computational facilities** that address the Belmont Challenge and provide support for the operational and maintenance costs of these facilities.
6. **Develop integrated Earth system models** with global and regional capability that provide predictions and projections of the evolution of the Earth system, including weather, climate and other environmental changes, the occurrence of natural and human-induced extreme events, as well as the impacts of these changes on ecosystems and human society.
7. **Conduct a study focusing on issues associated with the integration of natural and social sciences.**
8. **Address issues related to the vulnerability and adaptability of human societies** to environmental change and risks affecting vulnerable regions, as well as the economic and environmental impacts of potential mitigation and adaptation strategies.
9. **Initiate partnerships between nations** to draw on their collective scientific and societal expertise; support the special research and infrastructure needs of developing countries.

1. Introduction

There is emerging interest within national academic research funding agencies to coordinate their support for international and interdisciplinary Earth system research. In June 2009, the US NSF and the UK NERC led a meeting of principals of several of the world's major global change research funding agencies and ICSU, in Belmont, Washington DC. Participants at the Belmont meeting agreed on the need for an improved forum for dialogue between research funding agencies and the scientific community represented by ICSU, and for a coordinated process for early-phase engagement on global environmental change research strategies and priorities. As a result, a new high-level forum, called the Belmont Forum, was established, with the aim of identifying strategic priorities for international collaboration.

This meeting established the *Belmont Challenge*, with a focus on *Regional Environmental Change: Human Action and Adaptation*. It aims at delivering knowledge to support human action and adaptation to regional environmental change. Responding to this challenge requires regional and decadal prediction, advanced observing systems and inclusion of social sciences. The objective is *to develop and deliver knowledge in support of national and international government action to mitigate and adapt to global and regional environmental change and its associated regional hazards.*

Regional and decadal-scale monitoring, projections, and adaptation and mitigation strategies are urgently required by decision makers for priority issues such as: coastal zones; water cycle and water resources; ecosystem services and food security; carbon cycling, including ocean acidification; deforestation; land use and soils; and the most vulnerable societies. Research in these areas is central to the provision and utilization of environmental information services for decision-support to governments, business and society at large.

ICSU was charged by the Belmont Forum to conduct an analysis of international research willingness and capability to take action, with a focus on solvability of problems, infrastructure and personnel needed to meet the Belmont Challenge. Responding to the Belmont Challenge will require major advances in the prediction of integrated and comprehensive daily-to-seasonal-to-decadal changes, to improve the utilization and development of observing systems, and to accelerate the integration of natural, engineering, health and socio-economic sciences. There is also a need to build upon existing globally coordinated multidisciplinary, interdisciplinary and transdisciplinary efforts to achieve this objective (see the box on the next page for definitions).

In response to the Challenge, ICSU convened a panel of international leading experts charged with:

- Assessing the willingness, readiness and capability of the international research community to respond to the Belmont Challenge, and provide recommendations for action.
- Addressing issues related to the integration of weather, climate, ecosytem, energy, health, agriculture, engineering and social science research at the regional level.
- Focusing both on the near-term (year-decade) and on the medium-term (20 years) challenges and approaches at the required level of international activity.
- Identifying impediments and how to overcome them.

- Discussing adaptation and mitigation science needs.
- Fostering the necessary collaborative interdisciplinary research activities among international partners.

The primary objectives of the Belmont Challenge are to determine:

- how to address major scientific issues related to environmental changes at the interface between natural and human systems; and
- how to use the resulting knowledge for assessments of impacts, adaptation, vulnerability and the management of associated risks.

Research during the last decades of the 20th century, and into the 21st century, has focused on environmental diagnostics and predictions. The additional focus in the first decades of the 21st century has been to integrate strategies for socio-economic development and environmental sustainability.

Delivering environmental information requires that the issues at the forefront of society's needs be identified. There is an urgency to expand the environmental change research arena by addressing research challenges that mobilize the full spectrum of disciplines, theories and methodologies. We must ensure that individuals and communities participate in the development of research agendas to address social, political and economic problems. Science should provide the basis to assist governments in informing and warning their citizens of impending changes to the environment on daily-to-seasonal-to-decadal timescales, so that actions can be taken to reduce risks, alleviate impacts and benefit from opportunities.

The Belmont Challenge places an emphasis on enhancing the contributions of the *social sciences* to research in global environmental change. This requires that leaders of the social science community engage in all areas related to the agenda of the Belmont Challenge. It is important that social scientists, from the outset, be part of the broader agenda that includes engaging with physical observation, analysis and modeling systems. It is equally important that methods used in the social sciences be understood and appreciated by other scientific communities involved.

The panel recommends that ICSU, in cooperation with the International Social Science Council (ISSC), convene a panel to specifically address the issue of integrating natural and social sciences.

Definitions

Regional Change: Change that occurs over a usually continuous segment of a surface or space often recognized through some common natural or cultural characteristics. A region can cover: a large, almost continental area (e.g. the Asian Monsoon region); a somewhat smaller, though still multi-national area (e.g. the Mediterranean region); or a small area within a country (e.g. the southwestern United States). Understanding the interplay between neighbouring regions and the Earth as a whole is a vital part of understanding the behaviour of the Earth system.

Environmental change: Change that affects different aspects of the social-ecological system including changes in weather, climate, hydrology, ice cover, ecosystems, land-cover and land-use, biodiversity, biogeochemical cycles, chemical composition of air and water, environmental services, etc.

Multidisciplinary: A range of disciplines working on the same problem or question, but with the implications that there are limited or no interactions among these disciplines.

Interdisciplinary: Many disciplines strongly interacting, sharing concepts and approaches, and developing new integrated approaches that span disciplines. Approaches are interdisciplinary when they focus primarily on the integrated system, not only on its components.

Transdisciplinary: Transdisciplinary science refers to research that cuts across social and natural sciences, and includes at least five constitutive features: problem-oriented, beyond disciplinarity, practice-oriented, participatory and process-oriented.

2. Readiness of the Community

The panel discussed the readiness of the community to undertake necessary steps in response to the Belmont Challenge. Most stakeholders (e.g. policy makers and decision makers in diverse socio-economic sectors) concur that *integrated* information is required to develop and implement mitigation and adaptation strategies that more effectively respond to the regional manifestations of global environmental change. However, at present, government frameworks are not always optimally suited to fully respond to the challenges resulting from environmental change. Requirements for advanced weather, climate and other environmental services for diverse socio-economic and environmental sectors focus on time scales ranging from daily-to-decadal, with a strong emphasis on issues that arise at the regional scale.

Scientists are cognizant of their responsibility to address interdisciplinary, global-to-regional issues. However, some believe that their research is primarily guided by fundamental disciplinary challenges and secondarily by societal requirements for scientific information.

Both disciplinary- and societal-driven research are required. There will be important new insights of direct relevance to environmental issues from fundamental basic research, as well as from research defined by society. Intellectual excitement is essential for creativity and innovation. Addressing large complex and intellectually challenging problems requires an institutional framework.

The Belmont Challenge calls for new intellectual and structural approaches. In the past, scientific research was often initiated because it was academically challenging, and secondarily to address a pressing societal issue. The Belmont Challenge calls for an approach in which major cooperative research initiatives are developed from a dialogue between scientists and stakeholders; it is not clear whether the entire research community is fully ready for such an approach. On a positive note, many academic institutions are currently restructuring their curricula to engage in the interdisciplinary and transdisciplinary research needed to solve complex problems that society is facing. There is a growing community within academia, including within the student population, that is engaging in interdisciplinary research of societal relevance.

The *physical-climate, climate-impact and resilience-adaptation-vulnerability* research communities—which, historically, have been separate —must expand their coordination and collaboration. Funding agencies must be encouraged to establish strategic visions that draw these three communities closer together. The physical-climate and the climate-impact communities use, primarily, an approach based on scenario-driven sector impact models, while the resilience-adaptation-vulnerability research community adopts an approach in which climate change is treated as one of the many interacting stresses. These contributions to the Belmont Challenge will be of central importance, since its approach is aligned with what managers at local and regional scales need. Methodologies for impact–vulnerability–adaptation studies should be further developed. Reducing vulnerability and increasing resilience to environmental stress should be a goal for society, including the scientific communities involved. It should be recognized, however, that regional aspects should be developed with a global perspective in mind. Indeed, regional studies must take into account both regional manifestations and impacts of global changes in order to accurately represent the behaviour of the regions of interest.

In past decades, scientific assessments (e.g. those conducted by the Intergovernmental Panel on Climate Change, IPCC) have been important avenues for initiating dialogue between the scientific community and political and economic actors. In the future, these assessments in addition to presenting a critical and expert synthesis of the work conducted by the scientific community, will have to better address broader issues of importance to society.

Addressing the Belmont Challenge requires that a broad range of weather, climate, biogeochemical, geochemical and socio-economic information be collected, coordinated, archived and disseminated. The panel highlights the need for comprehensive and easily accessible databases and for integrated analysis and prediction systems. It notes that:

- Large amounts of Earth system data are available. However, expanded databases are required, e.g. for: surface and ground-water hydrology; oceans; health; public vulnerability/response; and impacts on human and socio-economic activities, and on ecosystems.
- All environmental data should be made openly available to all research users.
- The use of advanced weather and climate data assimilation and prediction systems to combine the best aspects of both data and models (e.g. accuracy and consistency, respectively) is an important aspect of advancing the use and value of multidisciplinary information.
- There is a need to improve long-term, high spatial and temporal resolution observations and predictions that seek to capture extreme environmental and societal events.
- Prediction models need to be tailored to address the integrated science issues posed in the Belmont Challenge. Developing high-resolution global-to-regional Earth system analysis and prediction models, that account for natural as well as human-driven processes, will most effectively be accomplished by strong cooperation between academic, government and risk-management (e.g. insurance) institutions.

3. Impediments

3.1. Funding Structure

In general, academic funding tends to remain mostly structured along traditional disciplines and the level of development of co-designed programmes is less than optimal, e.g. in terms of integration between natural and social sciences. Several attempts have been made by different agencies to develop cross-cutting initiatives. It is increasingly common to see solicitations for proposals by funding agencies that transcend a given discipline.

Co-designed programmes (social and natural sciences) and funding schemes should be developed and coordinated at the local, national and international levels. To complement existing programmes in either natural or social science, the participation of the ongoing international programmes, which have acquired experience in linking different national research communities, would be useful. To be successful, co-designed international projects require long-term scientific commitment and support. Current funding is not optimally structured to address long-term research needs, such as those required to address the Belmont Challenge.

Today's environmental issues are often related to the vulnerabilities and opportunities of specific regions. In some nations, there is a need for enhanced support of scientific research by regional/local governments. Regional authorities should be involved in integrated studies—on subjects such as water, extreme natural events, food and health—in their region.

3.2. Educational Systems

Important initiatives have been taken by the research community to facilitate research and education at the intersection of disciplines. However, many universities continue to emphasize traditional topics and approaches. Specifically, PhD students should be encouraged and supported to address multidisciplinary or interdisciplinary problems. They should also be encouraged to supplement their initial PhD education with post-doctoral training in other disciplines, within natural or social sciences or outside (e.g. humanities).

Students often believe that it is difficult to develop a successful career without a strong specific disciplinary focus. However, there are clear exceptions, for example, geography, anthropology and economics. Similarly, natural scientists are often reluctant to engage in the socio-economic integration and application of their science. The present reward/recognition system at most universities is not sufficiently conducive to what is required to meet the Belmont Challenge.

Some academic institutions have recently established inter-disciplinary, multi-departmental research institutes that focus on climate and social-ecological issues, and developed Earth system science undergraduate and PhD programmes that provide opportunities to address the Belmont Challenge. The introduction of curricula linking natural sciences, engineering and socio-economics (e.g. economics of environmental change, risk management) should be encouraged.

The education system should encourage post-doctoral researchers to expand their interdisciplinary engagement. Academic and governmental institutions should develop interdisciplinary visiting programmes with international and multi-cultural participation.

Addressing the Belmont Challenge requires a strong engagement with universities and the research branches of operational agencies. The interplay of environmental issues with engineering should be enhanced.

3.3. Infrastructure and Facilities

The infrastructure to address environmental issues, especially at the regional scale, has often been developed separately by the natural science and socio-economic communities, and government service providers. Today, information provided by these communities and providers needs to be integrated into a single framework. This task is a major challenge, since the vocabulary, methodologies and approaches adopted by the different communities differ significantly. In certain cases, the lack of spatial disaggregation of environmental and economic data are incompatible with the needs of natural scientists. For example, trace gas emissions compiled by official authorities in different countries are often provided as single values for the entire country, while environmental models require highly spatially resolved geographic distributions of these emissions.

Monitoring environmental conditions is important to assess the vulnerability of societies and to develop mitigation and adaptation strategies. In order to support long-term monitoring activities, there is a need for better cooperation between agencies that fund research—across the spectrum from basic research through to operational research. Progress would be made if the funding for essential observing systems were successfully transitioned from project-based research funding to ongoing operational funding. A major challenge in sustaining and updating observational capabilities is to demonstrate their effectiveness and impacts (e.g. on research, analysis, data assimilation, forecasting). Currently, only a small fraction of available observations are used for research and operation due to a variety of issues, including lack of access, restrictions by some nations, inconsistency in processing and documenting the different products, complexity of the algorithms used, difficulty in use and interpretation by non-experts, and lack of training.

Integrated environmental studies utilize information produced by different research and operational institutions. The panel believes that there is inconsistent support provided to enable integration of data and to check data quality. While there is sufficient work in some areas (due to sufficient support), existing work is insufficient in others. For example, there is an important issue that arises regarding the units of analysis when integrating natural science and social science efforts. While social science data are almost always collected in terms of political/administrative units (e.g. census tracts, municipalities, provinces, nations), natural science data are usually collected based on regular spatial intervals (e.g. a grid of 5 km). A major challenge for all of us, therefore, will be to find a way to harmonize the resultant data sets. In many instances, access to existing data remains limited by restrictive information-sharing policies. Environmental data acquired by public funds should be accessible to scientists. In addition, international programmes should play a major role in evaluating the consistency of related data sets and in producing and evaluating unified data sets that incorporate the data products from multiple providers. Initiatives should be taken to develop visualization of data with emphasis on data and systems that are accessible to non-specialists.

Finally, the panel highlights that the development of a family of Earth system prediction models—that include a representation of physical, chemical and biological details at global-to-regional scales with sufficiently high spatial resolution—cannot be achieved without access to dedicated supercomputing facilities. Even though much support has been provided for the installation of supercomputing systems by some countries, challenging problems require even more powerful machines. For example, models that resolve clouds, hurricanes and strong precipitation, urban air quality, surface hydrology, local environmental conditions and ecosystem status, require development of and access to much more powerful machines. Grid and cloud computing are playing an increasingly important role in many disciplines; these approaches will be particularly useful in fostering collaborative research in Earth system research. Their development should be encouraged.

4. Road Map to Address the Belmont Challenge

The panel proposes a road map to facilitate the implementation of the Belmont Challenge by considering the identification of issues and the approaches needed to address these issues.

4.1. Identifying key issues

In order to identify the key issues within the Belmont Challenge, it is crucial to improve the dialogue between the scientific community and the diverse stakeholder communities, especially at the regional level. There is a need for an iterative, interactive process, involving both communities engaging in dialogue to identify and analyze issues and questions (originating from this dialogue), and to determine their significance. At the same time, scientists should engage in dialogue among the disciplines in order to develop responses to the needs of society. Ultimately, the identification of the key issues should involve both stakeholders and scientists.

Discussions conducted at the international level, often involving stakeholders, have identified important research questions to be addressed for better management of planetary resources. In its early definition of the Belmont Challenge, a few near-to-mid-term foci were identified:

1. coastal zones in the 21st century: ecosystems, people, commerce and security;
2. water quality and water resources: availability and distribution;
3. sustainable carbon-based economy, including ocean acidification, deforestation, land use and soils; and
4. the most vulnerable societies, with low-response capacity and with high societal vulnerability to environmental changes.

Other issues will be raised through the dialogue with stakeholders. Here, the participation of social scientists (e.g. economists, political scientists, sociologists and psychologists) will be crucial. Illustrative examples of issues that need to be addressed by these communities of scientists are provided in the box on the following page. A broad engagement of social scientists—from different communities and different regions of the world—is necessary to identify not only the specific social science questions that the Belmont Challenge raises but also the social science perspectives that must be brought to bear on the full range of priorities identified—predictions and observations included.

Illustrative example: Broad societal issues for the Belmont Challenge

A key challenge is to understand the roots of human behaviour as it pertains to human-environment interactions. It is important to understand how and when major behavioural changes occur.

Within this framework, some of the focus should be on:

- top-down approaches featuring public policy making and implementation;
- bottom-up approaches featuring the role of social movements;
- the role of institutions and, more specifically, governance systems;
- decision-making under uncertainty, including the roles of rules of thumb and heuristics (educated guess, intuitive judgment or common sense) and the role of local or traditional knowledge, as well as religious or spiritual beliefs; and
- human security, specifically options available to individuals and communities to stop, to mitigate or to adapt to environmental change and related social vulnerabilities, and their capacities to do so.

4.2. Addressing the issues

Responding to the Belmont Challenge will require that the scientific community: (i) enhance its understanding of the multiple stressors affecting the environment, their combined impacts and feedbacks, as well as the vulnerability of ecosystems and society; (ii) better quantify the rates of change, the controlling factors and feedbacks at relevant spatial and temporal scales; and (iii) assess the environmental and societal consequences of mitigation and adaptation strategies. These issues will be addressed by:

- Developing and evaluating the next-generation of Earth system models coupled to observations.
- Developing a diagnostic and projective capability for societal and ecological vulnerability.
- Developing decision-support tools to map out how policy decisions affect future environmental and societal changes.

These issues require more effective use and further development of four elements:

1. observation and monitoring systems;
2. analysis and prediction systems;
3. information and communication tools; and
4. capacity building capability.

1. Elements of global and regional environmental and socio-economic observation systems and data management

The *first element* is the development of more effective uses of existing observations. The research community will need to define and advocate for additional *observation* and *monitoring information* systems to respond to the Belmont Challenge. The focus should be on observations that characterize the dynamics of a region, e.g. weather and climate variations and trends, extremes, vulnerabilities of both social systems and ecosystems, and societies as drivers of change and at risk from change. This will include different aspects of environmental and socio-economic evolution, e.g. extreme weather and other disasters, fires and air pollution, as well as economic and social benefits and impacts. The panel recommends that a few regional pilot projects be initiated in selected societally and environmentally vulnerable regions. Attention should be given to natural and human drivers of change and subsequent responses. Opportunities to use existing and future observation platforms (e.g. in space, or on aircraft, ships or land) as well as using dedicated platforms, should be fully exploited.

Examples of information needed from observation and monitoring systems

- Regional and local information on forcing and response, e.g. land cover and water resources.
- Environmental parameters with high spatial/temporal resolution, to be able to describe the frequency and spatial distribution of extreme events.
- Socio-economic data, including systematic mapping and assessments of costs associated with disasters at global, regional and local scales. These data should be obtained with consistent methodologies for assessment of natural hazards proceeding from the probability of their occurrence and recurrence and using empirical, statistical, and deterministic approaches to enable estimates of hazard potential, affected areas and impact duration.

2. Integrated Earth system analysis and prediction systems

Earth system science integrates observations, research, monitoring and prediction of the most probable evolution of the Earth system in response to natural forces and human activity. It synthesizes, integrates and assimilates *in situ* airborne and space-based Earth observations, together with human-dimension information, into comprehensive and consistent four-dimensional descriptions of the evolving Earth system. Such analyses form the basis for projections/predictions by dynamic Earth system models, e.g. ensemble prediction models, regional coupled models, statistical and neural network models. Dynamic downscaling will meet some of the user-needs at local and regional scales for socio-economic, agro-meteorology, human health, policy, resource, threat, risk and adaptation-mitigation applications.

The *second element* is the development of integrated regional *modeling tools* for analysis and projection/prediction, in support of environmental management (risks, vulnerability and adaptation) and provision of information. Here, priorities are the development and evaluation of a hierarchy of models, and their use to diagnose and analyze the past evolution of environmental and socio-economic systems, to predict the future state and to characterize vulnerability and risks. This requires the development of a hierarchy of Earth-system models with regional capability that includes a representation of coupled physical, chemical and biological processes. High resolution multi-model (ensemble) simulations for different scenarios should be performed. A wide range of environmental issues need to be considered, including climate change, flooding, droughts, tropical cyclones, sand and dust storms, winter storms, land-use changes, overexploitation of marine resources, loss of biodiversity, ocean acidification, lake eutrophication, air and water pollution, toxins, invasive species, and perturbation of biogeochemical cycles. The focus of these modelling studies should be on trends, abrupt changes and the probability of occurrence of future extreme events.

Some important considerations are improving the skill for prediction on daily-to-inter-annual timescales, and assessing decadal-to-centennial predictability limits and the predictive skills of models. This requires that predictive skills be investigated for past variability and change. The relationship between information required for model initialization and subsequent predictive skill should be addressed. Since decadal predictions of high-impact local events are still over the horizon and any information from such predictions is likely to be probabilistic, scenario-based projections will remain a useful approach as input to decision-making. Here, scenario development and analysis should be developed as a tool for structuring interdisciplinary discussions at the regional level, taking into account the global context in which regional changes take place. Clearly, the new generation of models should take the human dimension into consideration. The panel emphasizes that a decision-information system regarding hazards, risks and responses will benefit from advanced data assimilation systems coupled to high-resolution models.

The panel believes that the long-term goal is the *development of integrated Earth system analysis and prediction systems*. By fully engaging with the relevant disciplines and communities, it will be possible to develop integrated observing, analysis and prediction systems that address coupled atmospheric, land, ice, biosphere and oceanic components and their future evolution under severe human-related stress.

To accelerate progress in this area, the following recommendations are made:

- Accelerate collaboration between the meteorological, oceanographic, hydrological, ecological, and climate communities, and share methodologies and software, e.g. model-to-observation software, diagnostics packages.
- Converge internationally on a limited number of appropriate models that will be developed by a large, interdisciplinary community of scientists.
- Develop and assess decadal prediction systems as extensions to existing seasonal forecasts systems.
- Concentrate investments in high-performance computing that will allow a rapid increase of resolution for forecasting systems through improvements in the representation of physical, chemical and biological processes.
- Encourage investments in observing systems and implement the transition of research findings into operational services, particularly in the case of ocean observations.
- Secure new funding for historical Earth system re-analysis and re-forecast activities.

Another important challenge is the development of a *prediction/projection capability for the characterization of vulnerability and risk* (personal, health, economic) and response strategies (resilience, insurance). Here, key research questions are: How vulnerabilities (e.g. population, infrastructure, economic activity and livelihood, health) can best be determined and portrayed in a way that provides the critical information required by policy makers and decision makers? How can appropriate adaptation measures best be identified, evaluated and prioritized? Who and what are the people and places most at risk and why? And, how might the risks change with time?

It will be important to consider models at various scales, able to run multiple scenarios and ensembles in order to get a probabilistic distribution of results. As model simulations become available, uncertainties will have to be quantified to the maximum extent possible. The differences in the uncertainties coming from the different models will have to be addressed through model-model and model-data inter-comparisons.These model results will support future international assessment activities.

Illustrative example: Towards a seamless weather, climate and Earth system prediction system

1. Advances in the representation of physical processes (e.g. tropical convection, atmosphere/ocean/land/ice interactions, aerosols, cloud microphysics and radiation, boundary layer turbulence) and their interactions with the global circulation will lead to more skilful predictions of regional to global weather and climate. This success will translate into socio-economic applications for improving early-warning systems for weather- or climate-induced hazards. Applications could be for agriculture, the water cycle and its management, or health—particularly in regions affected by monsoons.
2. Advances in coupled data assimilation are a prerequisite for long-range weather and climate predictions. Historically, data assimilation research and its applications have focused mostly on the requirements of operational short- to medium-range weather forecasts. The next generation of assimilation and re-analysis projects will have to integrate information provided by climate, weather and Earth system research programmes.
3. An important requirement is to build satellite missions and implement planned ones that provide long-term capability for process studies, data assimilation and prediction.
4. High-performance computing and archive centres will be required to enable efficient numerical modeling, advanced experimental design, improved data processing and distribution of data (including relevant socio-economic information and analysis).

3. User-Interface: Environmental service in support of informed decision making

The *third element* is to develop *information/communication tools*, or more generally *integrated Earth system knowledge platforms* to provide scientific results to stakeholders and specifically to policy makers and decision makers/managers. Here, it is important to advance the two-way communication system between science and society. Information must be objective and easily accessible. New media and communication technologies are very important tools and they should be fully exploited. Direct dialogue with stakeholders is an important component of a communication system. Working with information providers and disseminators, including teachers and journalists, should be encouraged. Communication should emphasize the probability of occurrence of key parameters that are badly needed by policy makers and decision makers/managers.

It is necessary to integrate stakeholder consultation with research across a wide range of Earth science disciplines, engage the private sector, and to do so in partnership with various national efforts. One important element is to identify the stakeholder needs for Earth system observation and prediction products. Recently, national leaders, investors, business leaders and policy makers have begun to seek strategies to help prepare for the adverse and beneficial impacts of environmental change on business, industries, local communities and entire nations. Unfortunately, decision makers are not yet fully provided with the information needed to develop cost-effective strategies to reduce vulnerabilities, such as:

- the probability of various types of climate change happening in a particular geographic region from seasons to decades;
- the vulnerability of various natural and human systems in this geographical region to environmental changes; and
- the costs and benefits of strategies to reduce vulnerability.

The establishment of a Global Framework for Climate Services[2] provides an opportunity for developing bridges between research, operations and society. The Framework must integrate knowledge on multi-stressors affecting social and ecological systems and the complex feedbacks that exist between different components of the Earth system. Hence, the Framework will provide information as an extension of current national meteorological and hydrological services. They must embrace the physical climate system, biogeochemistry and socio-economic sciences. This approach presents research, personnel and capacity challenges across the disciplines. The service function should remain coupled to research. The focus should be on impacts, vulnerability and adaptation.

Providing information on the global and regional environment that specifically supports human action and adaptation to environmental change requires that research funding agencies and their constituencies coordinate closely with operational funding agencies.

[2] The decision to establish a Global Framework for Climate Services was made during the High Level Segment of the World Climate Conference 3 in Geneva, 31 August–4 September 2009. More information on the Framework can be found at: http://www.wmo.int/wcc3/declaration_en.php

Illustrative example: Towards the quantification of human and economic risks associated with environmental changes

- Develop products (observation and model) on a regular basis, tailored to users' needs, including those for specific regions and sectors.
- Run models responsively for multiple scenarios in ensembles to provide uncertainty estimates.
- Develop data delivery systems to provide results to users.
- Include socio-economic information so human and economic costs of risks and impacts can be characterized and/or estimated.
    - Modeling of risk requires the integration of natural and socio-economic sciences—how to do best is a key research question. Risk assessment and modeling, and the provision of evidence-based scientific advice require natural and social scientists to collaborate. Modeling of risk requires the development of holistic models incorporating natural processes, infrastructure, societal factors and human behaviour.
- Support extensive multi-disciplinary quantitative analysis of model outputs, especially to identify potential unintended consequences of changes.
    - Development of risk models, which can incorporate both quantitative and qualitative information will allow for the comparative analysis of different approaches towards risk reduction. Scientists undertaking this research should work closely with local communities and authorities so that science is integrated into societal concerns and policy development.
- Provide comparative analysis and integrative approaches that analyze the context and related risks, vulnerabilities and projected impacts from both the top-down (i.e. downscaling) and bottom-up (i.e. critical thresholds approach)—resulting in additional research insights and benefits for users.
- Communicate uncertainty in forecasts and risk assessments to decision makers and the public—this is a challenging task, for which drawing on local indigenous knowledge systems will help.
- Address decision making in governance and society—political, economic, social factors. Identify key obstacles/barriers to urban adaptation to environmental change, including knowledge gaps, human and financial resources and institutional capacity.

4. Capacity Building

The *fourth element* is to develop a *capacity building strategy*. Such a strategy will apply to both developing and developed countries, with particular attention to the needs of the societies under greatest stress. Capacity building requires a sustained approach. This can be facilitated by education programmes, especially in developing countries, as well as supporting infrastructure—especially for data delivery, archiving, and visualization. Extensive opportunities should be provided for scientists from developing countries to visit leading institutions around the world—to share experiences and help build a global scientific community. Opportunities should be created for early career scientists, especially those from developing countries, to work alongside established scientists (e.g. on field campaigns and assessments). Two-way partnerships between scientists and institutions from developed and developing countries should be established.

5. Instruments and Suggested Initiatives

The panel concludes this report with suggestions to facilitate the implementation of activities that respond to the Belmont Challenge, recognizing that many of these ideas are presently under consideration by the scientific community. In particular, the recent ICSU-led visioning process—to develop a holistic strategy for global sustainability research—is exploring options for a new institutional framework to meet the five grand challenges that have been identified as part of the visioning process. The following suggestions, which should build on the experiences and capacities from the existing global environmental change programmes and activities, may also provide useful inputs to the ongoing visioning process.

5.1. International Research and Educational Network for Earth System Science (IRNESS)

Create an International Research Network for Earth System Science (IRNESS) with access to state-of-the-art facilities, including interdisciplinary databases and high-capacity supercomputing. This network of centres will host staff and visiting scientists, develop a strong interdisciplinary focus towards integrated Earth system science and support regional initiatives. Its agenda will be broad and highlight integrated, interdisciplinary aspects of environmental sciences (physical climate system, social-ecological system). It will focus on regional and global environmental issues, including: climate change; land use/cover changes; chemical pollution; loss of biodiversity; human health under environmental stress; adaptation and mitigation policies; and international negotiations. It will be accessible to scientists from around the world. The network will facilitate an international programme that brings together the knowledge needed to support dialogue that contributes to adaptation measures and environment management. The network will build upon existing academic and government agency centres and will include virtual components linking participating institutions. The centres will be connected through modern telecommunication facilities. The network will offer training classes for scientists and other stakeholders and will offer a post-doctoral programme and a senior visitor programme.

Develop an international doctoral programme for interdisciplinary Earth system science. Support and expand existing initiatives that attract students from different disciplines and from around the world. Within a network of universities and other research institutions, the programme would provide an international Earth system curriculum that would bridge natural and social sciences. In addition, it would organize summer schools, where students from all around the world could be exposed to and exchange perspectives on issues and their impacts in different regions.

5.2. Pilot Studies

Conduct interdisciplinary pilot studies in selected regions with the purpose of developing mitigation and adaptation strategies to natural and human-induced environmental changes. Such studies should be coordinated by scientists from the region and should be regarded as regional Earth system integrated studies.

6. Conclusions

The environmental problems facing today's society cannot be overcome by a single nation or a single scientific discipline. Responding to these adversities demands highly coordinated and collaborative research and operational service agendas. The proposed agenda in this report will lead to the provision of the scientifically based information needed by local, national and international decision makers as they take actions for the benefit of society and environmental sustainability.

The panel concludes with the following requirements:

- At a time of globalization, environmental and development issues need to be addressed at the international level. Countries, as well as agencies within individual countries, need to increasingly work together to coordinate and support research required to address global societal needs. The challenge is to integrate in a single framework environmental and economic issues that have been largely addressed separately in past decades.
- An integral component of the Belmont Challenge is to develop and maintain a two-way dialogue between scientists, policy makers and the general public by which scientists provide answers that are pertinent to the questions posed by society.
- It is important to maintain and expand the access and the use of the current global observing and monitoring systems, to coordinate databases and to develop assimilation procedures with the purpose of gaining maximum benefit from these observations. It is equally important to contribute to the development of new observing systems, both physical and societal.
- Society increasingly requests detailed regional and site-specific information. Earth system models should provide high-resolution predictions at the timescales of days-to-seasons-to-decades; this requires the next generation of prediction models to achieve a higher degree of useful predictive skill and to represent high-resolution processes, such as weather and surface hydrology changes and their interactions with socio-economic activities at seasonal to decadal time scales.
- The most advanced and powerful dedicated supercomputing facilities are required to resolve key high-resolution physical, chemical and biological processes as well as human activities and treat the full complexity of these issues.
- It is important to expose a new generation of natural and social scientists to environmental observations, analyses and predictions and to communicate the excitement and challenge of integrating complex Earth system processes into daily-to-decadal weather and climate predictions.

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BELMONT FORUM **BF10/10**
OCTOBER 2010

ICSU VISIONING: GRAND CHALLENGES AND INSTITUTIONAL FRAMEWORKS FOR GLOBAL SUSTAINABILITY

Purpose of Paper

To discuss the Visioning work ICSU has been undertaking to identify scientific and institutional challenges for Sustainability Research (this ICSU initiative represents a research community perspective, and has been developed in parallel to the Belmont Challenge that represents a funders' perspective).

Action

DISCUSS the ICSU proposal and:

- NOTE the evolving outcomes of the ICSU Visioning Process
- IDENTIFY the complementarity between the two visions, in order to build a foundation for working together to take them forwards. This should include complementarity regarding:
  - The priority research challenges, and
  - The integrating, institutional changes needed
- This assessment will help inform the subsequent agenda item on a joint way forwards with ICSU, to be discussed in agenda item BF10/11

Papers for this item

Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade

Summary of June 2010 Sponsors Meeting on Visioning Institutional Frameworks for Global Sustainability

Science Paper: '*Earth System Science for Global Sustainability: Grand Challenges*' **(IN CONFIDENCE FOR BF MEMBERS ONLY)**

Grand Challenges in Global Sustainability Research: A Systems Approach to Research Priorities for the Decade

6 August 2010

The International Council for Science (ICSU) proposes to mobilize the international global change scientific community around an unprecedented decade of research with the aim of delivering knowledge needed to achieve sustainable development. *In doing so it seeks to work in close collaboration with the International Council for Social Sciences (ISSC) and other partners. The pace and magnitude of human-induced global change is currently beyond human control and is manifest in increasingly dangerous threats to human societies and human well-being. There is an urgent need for the international scientific community to develop the knowledge that can inform and shape effective responses to these threats in ways that foster global justice and facilitate progress toward sustainable development goals. The global change research community, which has played a central role in understanding the functioning of the Earth system and the human impacts on that system, holds the promise to meet this need. Realizing that promise requires a focus on new research priorities, and on new ways of doing and using research to address needs at global, regional, national, and local scales. This report is the product of an international consultative process led by ICSU and its partners that was designed to: (a) identify broadly-accepted grand challenges in global sustainability research; (b) identify high priority research that must be carried out to address those challenges; and (c) mobilize scholars in the sciences (social, natural, health, and engineering) and humanities to pursue that research.*

Introduction

The study of the Earth system – the social and biophysical components, processes and interactions that determine the state and dynamics of the Earth including its biota and human occupants – has reached a point of transition. For the past two decades, our priority has been to understand the functioning of the Earth system and, in particular, the impact of human actions on that system. Science has advanced to the point that we now have a basic understanding of how human actions are changing the global environment and a growing understanding of how those changes will affect society and human well-being. This research has provided invaluable insights regarding the biophysical processes that determine the functioning and resilience of planet Earth, the sensitivities of different components of the system, evidence of the accelerated pace of global environmental change caused by the human enterprise, the possible consequences of those changes, and the human dimensions of how to address these challenges.

This science also tells us that the rate of global environmental change is, so far, vastly outpacing our response and, thus, that our current path is unsustainable. We know enough to state with a high degree of scientific confidence that without action to mitigate drivers of dangerous global change

and enhance societal resilience, humanity has reached a point in history at which changes in climate, hydrological cycles, food systems, sea level, biodiversity, ecosystem services and other factors will undermine development prospects and cause significant human suffering associated with hunger, disease, migration, and poverty. If unchecked or unmitigated, these changes will retard or reverse progress towards broadly shared economic, social, environmental, and developmental goals.

Our existing knowledge provides a useful basis for vital activities needed to manage specific parts or features of our world in transition, but it falls well short of what can be considered integrated solutions. How can we change human behaviour and shape political will so as to make it possible to meet targets for reductions in greenhouse gas emissions that will avoid dangerous climate change? How can societies most effectively and equitably respond to the global change that is already underway? How can they eradicate extreme poverty and hunger and achieve environmental sustainability?

The international scientific community holds the promise of delivering the knowledge necessary for answering these crucial questions. But realizing that promise will require a refocusing of research priorities and a reorientation towards new research frontiers. We will have to meet a twofold challenge, namely to develop response strategies to global change, on the one hand, and to deepen our knowledge of the functioning of the Earth system and its critical thresholds and the on the other hand. This will require new ways of doing research that better link science and society to address the needs of decision-makers and citizens at global, regional, national, and local scales.

Over the next decade the global scientific community must take on the challenge of delivering knowledge required to support efforts to achieve sustainable development in the context of global environmental change. Solution-focused, strategic, interdisciplinary, long-term research is needed to improve our knowledge of the social-environmental risks facing humanity and to provide science-based support for actions to achieve sustainable development. We rapidly need to deepen our understanding of how the Earth system operates in response to human pressures, improve our ability to predict future risk patterns, and explore social transformations in the world that can overcome barriers to sustainability. We refer to this field as "global sustainability research." [1] Global sustainability research builds upon and integrates expertise within the sciences (social, natural, health, and engineering) and humanities and applies it to pressing coupled social-environmental research questions of human interactions with the Earth system.

Just as we are at a point of transition in the focus and scale of global social-environmental research, we are also at points of transition in the disciplines that must be involved and the processes by which that research is undertaken. There is a need for transitions from:

- *Research dominated by the natural sciences to research involving the full range of sciences and humanities.* Social sciences have long been a component of Earth system research, but tackling the grand challenges described here requires a stronger involvement and greater

[1] We consider the field of "global sustainability research" to be largely equivalent to "Earth System research," but with a more explicit recognition of the human dimension. The Earth System is defined as the unified set of physical, chemical, biological, and social components, processes and interactions that together determine the state and dynamics of the Earth, including its biota and its human occupants. Although Earth System science includes humans as an integral component of the Earth System, this term is seen by many to focus primarily on the natural system. The term "global sustainability research," helps to give greater emphasis to the central importance of the social sciences in this research agenda.

integration of the social sciences, health sciences, engineering and humanities, along with the natural sciences. It is increasingly clear that pathways to address rapid global change can only be found through inquiries that integrate the full range of sciences and humanities in ways that may lead to significant transformations in these disciplines as they are currently understood. It also requires the inclusion of local, traditional and indigenous knowledge.

- *Research dominated by disciplinary studies to a more balanced mix of disciplinary research and research that draws disciplinary expertise into an integrated approach that facilitates inter- and transdisciplinarity.* The solutions to the grand challenges must be rooted in disciplinary research, but disciplinary research alone will be insufficient. Many of the priority research questions can only be solved through effective interdisciplinary research. Moreover, it is clear that both research progress and the effective use of scientific results by society and decision-makers can often be enhanced through transdisciplinary research; that is, through greater involvement of external stakeholders in the research process. Research will often be most useful, and the results most readily accepted by users, if priorities are shaped with the active involvement of potential users of research results and if the research is carried out in the context of a bi-directional flow of information between scientists and users. An effective response to global environmental change will be aided by the co-creation of new knowledge with a broad range of stakeholders through participatory practices.

These proposed transitions in the disciplines involved and the research processes utilized are needed because they will bring greater expertise to bear in framing and addressing the research priorities, because they help to ensure that the research priorities are relevant to key stakeholders, and because the answers to the research questions can more readily inform decision making.

In light of the urgent needs, ICSU[2] is seeking to mobilize researchers around an unprecedented, 10-year scientific effort to address the grand challenges in global sustainability. The process to reach consensus on the grand challenges and research priorities began with an Internet consultation in July and August 2009.[3] The Internet consultation yielded more than 300 proposed Earth system research priorities contributed by individuals from 85 countries. These proposed research priorities formed the background for a workshop held in September 2009 involving senior researchers, early career scientists, science-policy experts and representatives of research funding agencies. A draft document presenting the selection criteria, grand challenges, and research priorities generated by

[2] Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both national scientific bodies (121 National Members representing 141 countries) and International Scientific Unions (30 Members). The ICSU 'family' also includes more than 20 Interdisciplinary Bodies (IBs)—international scientific networks established to address specific areas of investigation. These IBs are either co-sponsored or uniquely sponsored by ICSU and include the four global environmental change programmes: World Climate Research Programme, International Geosphere-Biosphere Programme, International Human Dimensions of Global Environmental Change Programme, and DIVERSITAS. Through this international network, ICSU coordinates interdisciplinary research to address major issues of relevance to both science and society. In addition, the Council actively advocates for freedom in the conduct of science, promotes equitable access to scientific data and information, and facilitates science education and capacity building.

[3] The full process is described in detail at: http://www. icsu-visioning. org/the-visioning-process/. The Internet consultation (www. icsu-visioning. org) attracted over 7000 unique visitors from 133 countries and over 1000 registered users from 85 countries, who posted research questions, made comments and voted on the questions. By the end of the consultation, 323 distinct Earth system research questions had been posted on this moderated site.

that workshop was circulated for review between December 2009 and March 2010. Review comments from 46 institutions and over 200 individuals have been addressed in this report.

This report aims to provide a widely shared vision of the scientific priorities for global sustainability research in the coming decade. It is intended to: a) mobilize the greater engagement of the international scientific community and, particularly, of the broader social science community, in global sustainability research; b) stimulate innovative new research and guide the prioritization of research topics by scientists, research funders and policy makers; and, c) inform potential users of the findings that might stem from this research, including scientific assessments like the Intergovernmental Panel on Climate Change, and technical advisors to decision-makers in the private sector and governments. Representatives of these stakeholder groups are the audience for this document and have been involved in its development. Additional information on this consultative process is provided in the Appendix 1.

Criteria

We have used the following criteria in selecting the grand challenges and associated research priorities.

1. **Scientific importance.** Does the question address a cutting-edge research challenge that, if answered, could significantly advance our understanding within the next decade of how to achieve global sustainability?
2. **Global coordination.** Is a coordinated international or global approach involving multiple researchers in different regions and often in different disciplines needed to answer the question? If not, then such a question would fall to others (i.e., be outside the remit of this framework, despite its importance to a given field).
3. **Relevance to decision-makers.** Will the answer to the question help to inform actions to meet urgent global social and ecological needs, especially promoting sustainability, reducing poverty, and assisting the most vulnerable in coping with global environmental change?
4. **Leverage.** Does the answer to the question involve a scientific or technical breakthrough, or would it create a transferable theory, model, scenario, projection, simulation or narrative that would help to address multiple problems or other challenges related to global sustainability research?

In addition to these four criteria used for both the selection of the grand challenges and the research priorities, the five grand challenges were also screened against a fifth criterion: did the proposed grand challenge have broad support from the research and funding community (even those not directly involved in answering the question). We believe that each of the grand challenges is widely perceived to be a fundamental question that must be addressed in the pursuit of global sustainability. In the case of the research priorities, we also added a criterion focused on the feasibility of the research: Is it plausible that the question can be answered within the next decade? We are confident that we have the scientific basis and tools available to answer the research priorities listed in this document, but success will require adequate resources and effective coordination of the international research community to ensure that the questions are addressed with focus and intensity.

The Grand Challenges in Global Sustainability Research

Consistent with the use of the concept of grand challenges in other areas of science, we consider the grand challenges in global sustainability research to be a call for scientific innovation or understanding that would remove critical barriers to deciding how to achieve sustainable development. We list five grand challenges in global sustainability. Within each, we list several top-level research priorities that must be addressed during the next decade to make significant progress in resolving the problem posed by the grand challenge. The list of research priorities is neither exhaustive nor necessarily sufficient. Nonetheless, it is our judgment that these questions must be addressed to achieve the most rapid progress. In virtually all cases, a deep base of research and knowledge already exists in the areas identified by these research priorities and, building on that base, it is thus plausible that the research area can be substantially advanced in less than a decade. However, it is by no means inevitable that all the questions can be answered. These are, by definition, big and difficult problems, and will require a focused, multidisciplinary, and integrated research commitment to have a reasonable prospect of success.

The resulting challenges cover a diversity of topics but are united as elements of a systems approach to global sustainability research that examines how the coupled social-environmental system is changing (including the dynamic responses of people and the environment) and what actions and interventions may alter the environmental and social outcomes. (See Figure 1.) The grand challenges adopt a systems approach from the perspective of what is being studied: the full social-environmental global system rather than independent components of that system. They also adopt a systems approach from the perspective of how research can inform actions to achieve global sustainability: none of the challenges can be fully addressed without progress in addressing the other challenges.

Consequently, the five grand challenges are an indivisible package, and the topics are not prioritized either across or within the challenges. Progress on every one of the challenges and research questions is urgently needed. The global sustainability research community has unique capacities to contribute to the solution of these challenges, but all of them will require working with partners outside of this research community as it currently exists.

Challenge 1. Forecasting: Improve the usefulness of forecasts of future environmental conditions and their consequences for people.

Priority Research Questions

1.1. **What significant environmental changes are likely to result from human actions? How would those changes affect human well-being, and how are people likely to respond?**

1.2. **What threats do global environmental changes pose for vulnerable communities and groups and what responses could be most effective in reducing harm to those communities?**

We consider a “useful” forecast to be one that is responsive to the needs of societies and decision-makers for information at relevant spatial and temporal scales and is timely, accurate, and reliable. Our limited ability to anticipate the outcomes resulting from the interaction of complex and diverse

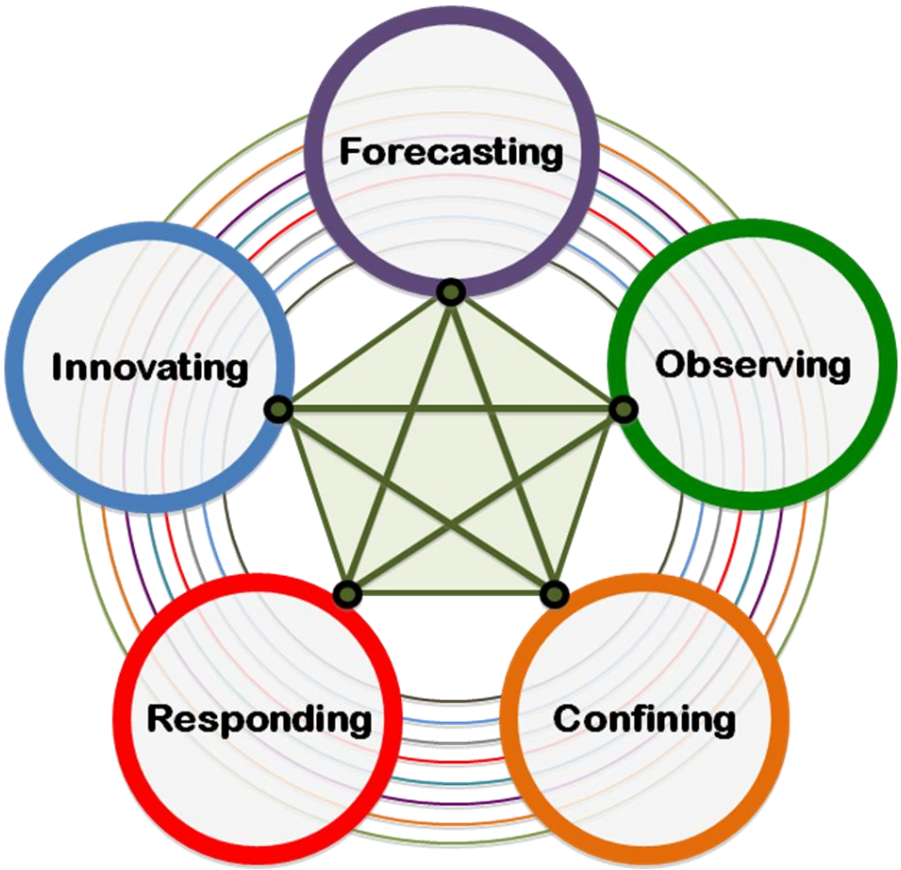

Figure 1. Grand Challenges in Global Sustainability Research. The concentric circles represent the disciplinary research needed in the social, natural, health and engineering sciences and the humanities that must be carried out alongside interdisciplinary and transdisciplinary research in order to address the challenges. The lines linking the grand challenges show that progress in address any challenge will require progress in addressing each of the others.

human societies with equally-complex natural processes is a significant barrier to timely and effective decision-making and action. Although we may never be able to accurately forecast the future of coupled social-environmental systems beyond a time horizon of several decades, there is tremendous potential to improve our ability to use scenarios and simulations to anticipate the impacts of a given set of human actions or conditions (e.g., population size, levels of consumption, greenhouse gas emissions, deforestation, increased agricultural productivity, etc.) on global and regional climate and on biological, geochemical, and hydrological systems on seasonal to decadal time scales. Building on this work, significant advances are now also needed in our ability to assess the potential impact of those environmental changes on human well-being (e.g., impacts on economies, health, food security, energy security, etc.) and the potential human response to such changes. Such forecasts and assessments should be tailored to respond to the questions and needs of the people potentially affected, and the uncertainty should be quantified and clearly communicated.

Answering the research questions posed here will require a major new scientific endeavour to build the capacity to predict changes to the Earth system as a core contribution to global sustainability

research. It includes a pressing need to develop a new suite of Earth system models with the ability of predicting changes to the Earth system from anthropogenic influence at global, regional and, where possible, local scales. This will necessitate major scientific advancements in integrated analyses of the dynamics of interlinked biophysical systems on Earth and coupling these with the human dimensions of global environmental change, both in terms of drivers and impacts. This in turn will have to build on continued progress in disciplinary Earth system research, and major improvements in and intensification of Earth observation systems.

Science cannot, as yet, provide adequate predictions of the Earth system response to pressures from the coupled socio-environmental complex. This is a major dilemma for humanity as a whole. We know that humanity is pushing systems on Earth towards risks that may cause abrupt, and potentially irreversible and disastrous changes. Despite major advancements in Earth system science over the past decade, the uncertainties and risks of anthropogenic change remain too high for comfort.[4] Human development continues along a dimly lit path of uncertainties and risks; in the absence of clarifying headlights policymakers and society at large inappropriately assumes that the stability of the planet will prevail. Scientific evidence to date strongly suggests that it is too risky to continue along this development pathway. We urgently need improved capabilities for analysing and understanding the global environmental change risks facing humanity. We assess that major improvements to an integrated model to predict the Earth system response to anthropogenic pressures is within reach, but will require a major international undertaking over the coming decade, as part of the grand challenge endeavour.

Significant improvement is needed in our ability to provide forecasts that address the full range of plausible outcomes within a probabilistic framework, that incorporate the dynamic response of both the natural and social system, and that provide results at appropriate spatial and temporal scales to assess impacts on economies, ecosystem services and human well-being. Progress in this area of research will require advances in understanding and modelling the fundamentals of physical phenomena, advances in modelling capability (including development of the ultra-high performance computing infrastructure), the incorporation of information from paleo-climate change as well as historical information on social and behavioural responses, and a more interdisciplinary framework of analysis. By meeting this challenge, models and analyses of global and regional environmental change will be able to provide direct support to governance and management at national and regional scales, and over the typical time-frames of political and management decisions.

The human consequences of global environmental change will vary across regions and within societies because of geographic differences in impacts and because of differences in the vulnerability of groups of people. An important focus of efforts to improve forecasting capability must be to better understand which groups of people are most vulnerable to global change, what threats global change poses for those communities, and the potential consequences of different adaptation and mitigation actions. These communities will experience the greatest impacts associated with global change; consequently, there is an urgent need for the scientific community to provide decision-makers and society with information that can guide action to lessen those impacts.

[4] The uncertainty on climate sensitivity alone for a doubling of CO_2 levels in the atmosphere range from 1.5 – 4^{o} C of average global temperature, an uncertainty range that has remained stubbornly high over the past 20 years, despite major advancements in integrating the atmosphere, stratosphere, with the hydrosphere and biosphere in global climate modeling.

Examples of key questions that need to be answered include: How will regional climate change over decadal time scales? What will be the environmental and health impact of changes to other biogeochemical cycles (e.g., nitrogen, phosphorus) or to increased loadings of toxic pollutants? How will the social, economic, and health impacts of global environmental change vary across regions and within societies? What adaptation strategies are needed to reduce vulnerability to global environmental change? When do individual human actions aggregate to cause consequences for larger regions or the Earth system? How are changes in ecosystems and biodiversity going to affect ecosystem services and human well-being? What trade-offs occur among services and human well-being, and are there strategies to minimize the adverse consequences of such trade-offs? What kinds and levels of biodiversity are needed to buffer the impacts of environmental change on ecosystem services?

Challenge 2. Observing: Develop, enhance and integrate the observation systems needed to manage global and regional environmental change.

Priority Research Questions

2.1. What do we need to observe in coupled social-environmental systems, and at what scales, in order to respond to, adapt to, and influence global change?

2.2. What are the characteristics of an adequate system for observing and communicating this information?

Major investments are being made to build more effective global and regional monitoring systems and to ensure their international coordination (e.g., through arrangements like the Global Earth Observation System of Systems). But these systems, which provide a firm foundation, still fall well short of what is needed. The current supply of information needed to manage the social-environmental system, especially at a global scale, as well as the system for delivering that information to decision-makers, is inadequate for the task. Further advances in theories, models, scenarios, projections, simulations, or compelling narratives used to understand the coupled social-environmental system and to forecast changes are constrained by limited availability of data needed to set parameters and validate predictions. Moreover, the paucity of empirical data on changes in social-environmental systems undermines the ability of decision-makers and the public to establish appropriate responses to emerging threats and to address the needs of vulnerable groups of people.

To meet any of the grand challenges, a robust data and information system is needed that can combine data and knowledge gathered over centuries with new observations and modelling results to provide a range of integrated, interdisciplinary datasets, indicators, visualizations, scenarios, and other information products. Ensuring wide access to both past and future data, especially with regard to societal dimensions, is a key challenge that cannot be taken for granted.

The observation, data preservation, and information systems required need to encompass both natural and social features, be of high enough resolution to detect systematic change, assess vulnerability and resilience, include multiple sources of information (quantitative, qualitative and narrative data and historical records), provide information about both direct drivers of change and indirect drivers, involve multiple stakeholders in the research process, support effective decisions at global to local scales, be formally part of adaptive decision making processes, provide full and open

access to data, and be cost effective. They would include critical data needs such as comprehensive time-series information on changes in: (1) land cover and land use, biotic systems, air quality, climate, and the oceans; (2) spatial patterns and changes in freshwater quantity and quality, for both ground- and surface-water; (3) stocks, flows and economic values of ecosystem services; (4) trends in perceived and real components of human well-being (particularly those not traditionally measured, such as access to natural products that are not marketed); (5) socio-economic indicators, including population distribution, economic activities and mobility; (6) patterns of human responses to these developments including changes in policies, technologies, behaviours and practices, and (7) empirical measures of the efficiency of responses. The design of such a system would need to address the question of how local and regional changes can be scaled accurately and effectively to enhance the assessment of global changes, and vice-versa. The entire design should include a process and institutional arrangements for observation systems to be aligned with assessment and policy processes.

This grand challenge is both a research challenge and a challenge for science policy. Fundamental scientific questions need to be addressed in the design of cost-effective systems that can meet the needs of managers and decision-makers. The implementation of such systems, on the other hand, is not a research challenge but will nevertheless require an ongoing and concerted effort by the scientific community if it is to be achieved, even beyond the timescale of the work envisaged here.

Challenge 3. Confining: Determine how to anticipate, avoid and manage disruptive global environmental change.

Priority Research Questions

3.1. **Which aspects of the coupled social-environmental system pose significant risks of positive feedback with harmful consequences?**

3.2. **How can we identify, analyze and track our proximity to thresholds and discontinuities in coupled social-environmental systems? When can thresholds not be determined?**

3.3. **What strategies for avoidance, adaptation and transformation are effective for coping with abrupt changes, including massive cascading environmental shocks?**

3.4. **How can improved scientific knowledge of the risks of global change and options for response most effectively catalyze and support appropriate actions by citizens and decision-makers?**

It is increasingly likely that human interference will trigger highly nonlinear changes in the global environment. Such changes may be abrupt or slow, but in all cases they tend to alter the very character of the life-support system in question and to be largely irreversible on human time-scales. Examples are major shifts in regional climate, rapid collapse of ice sheets, methane release associated with thawing permafrost and warming oceans, and discontinuous transitions in the structure and functioning of biological systems. In turn, disruptive changes in social systems can result from such events, as well as from more gradual environmental changes such when reduced precipitation or degrading soil fertility eventually leads to the creation of environmental refugees. Moreover, an increasingly interconnected world generates linked trends and shocks in seemingly

disparate sectors such as energy, finance, food, health, water and security. Public policies and social and economic institutions are rarely designed with such human-induced disproportional changes and regime shifts in mind.

An urgent research challenge is to understand the underlying non-linear dynamics. This will require, in particular, the future integration of environmental and complexity science, two fields that until now have developed largely separately. In order to confine global change to tolerable domains we will have to identify and track our proximity to planetary boundaries (like critical levels of ocean acidification) and in order to confine the impacts of unavoidable excursions into dangerous systems territory we will have to find optimal ways for enhancing resilience to disruptive change. A major focus of research must also be to better determine strategies for avoidance, adaptation or transformation of social-environmental systems to accommodate changes that are dangerous because of their speed, scale, non-linear nature, cumulative impact, self-amplifying nature or irreversibility.[5] Such research can also inform steps that societies should take to increase their resilience to natural and human induced disasters.

Research into appropriate response and adaptation strategies must extend beyond considerations of 'optimal' approaches to advance understanding of the political and social dynamics of responses. For example, despite the best efforts of analysts to identify optimal policies that might prevent a crisis, it is not uncommon for policies to be changed only when that crisis comes to pass; what does this imply for the design and promotion of response options? And a most exciting task will be to find out whether there are positive social tipping points, i.e., pioneering action that can tip economic machineries or social dynamics into sustainable regimes.

Challenge 4. Responding: Determine what institutional, economic and behavioural changes can enable effective steps toward global sustainability.

Priority Research Questions

4.1. What institutions and organizational structures are effective in balancing the trade-offs inherent in social-environmental systems at and across local, regional and global scales and how can they be achieved?

4.2. What changes in economic systems would contribute most to improving global sustainability and how could they be achieved?

4.3. What changes in behaviour or lifestyle, if adopted by multiple societies, would contribute most to improving global sustainability and how could they be achieved?

4.4. How can institutional arrangements prioritize and mobilize resources to alleviate poverty, address social injustice and meet development needs under rapidly changing and diverse local environmental conditions and growing pressures on the global environment?

[5] These are not the only types of dangerous global changes. For example, relatively linear but small changes in the global environment can have dangerous impacts on people if they occur over long time periods. Grand Challenges #1 and #4 are well suited to addressing impacts such as these. Grand Challenge #3 addresses the risk of more discontinuous or abrupt change.

4.5. **How can the need to curb global environmental change be integrated with the demands of other inter-connected global policy challenges, particularly those related to poverty, conflict, justice and human security?**

4.6. **How can effective, legitimate, accountable and just collective environmental solutions be mobilized at multiple scales? What is needed to catalyze the adoption of appropriate institutional, economic, or behavioural changes?**

Global change exposes gaps in social institutions, including governance and economic systems, for managing emerging global (and local) problems. The time and spatial scales of global change differ fundamentally from the types of problems that humanity has addressed in the past. Currently, decision-makers have incentives that favour short-term and private benefits, rather than long-term and collective benefits. Addressing the problems of global change, including unsustainable resource use, pollution of the global commons, growing resource demand resulting from increased population growth and per capita consumption, increased distrust by citizens of each other and their officials, and growing poverty, will require a step change in research addressing fundamental questions of governance, economic systems and behaviour.

An effective response to global change will also require much greater understanding of the inter-relations between global environmental change, global poverty and development needs, and global justice and security. For example, how will global environmental change influence progress toward the goals of preventing and eradicating poverty and hunger and improving human health? How does global environmental change shift the agenda for sustainable development in the world?

Determining how to achieve changes in social organizations, institutional arrangements and human behaviour is just as important as establishing what changes are desirable. In many cases, successful changes in institutions will stem from steps taken to achieve collective social action in response to the challenge. How can timely actions be undertaken at unprecedented and multiple geographical and geopolitical scales, where the nature and scale of the issues involved means that the actors have widely differing – and disconnected – values, ethics, emotions, spiritual beliefs, levels of trust, interests, and power? How can we better understand the role of individual decisions within diverse settings as the building block of societal decisions? How can we better understand the factors shaping individual behaviour, values and perceptions of threats and risks and how those values and perceptions influence both individual action in relation to global change and the potential for collective action? Recognizing individuals, not just policymakers, as a fundamental unit forces attention to a new level of detail on how information about the environment and feedback on thresholds being reached and breached can impact social changes and actions. Such information can influence individuals, who then incorporate this information along with other factors such as institutions or policies, to make decisions that then aggregate to impact society and the environment.

Challenge 5. Innovating: Encourage innovation (coupled with sound mechanisms for evaluation) in developing technological, policy, and social responses to achieve global sustainability.

Priority Research Questions

5.1. What incentives are needed to strengthen systems for technology, policy and institutional innovation to respond to global environmental change and what good models exist?

5.2. How can pressing needs for innovation and evaluation be met in the following key sectors?

- **a. How can global energy security be provided entirely by sources that are renewable and that have neutral impacts on other aspects of global sustainability, and in what time frame?**
- **b. How can competing demands for scarce land and water be met over the next half century while dramatically reducing land-use greenhouse gas emissions, protecting biodiversity, and maintaining or enhancing other ecosystem services?**
- **c. How can ecosystem services meet the needs for improving the lives of the world's poorest peoples and those of developing regions (such as safe drinking water and waste disposal, food security and increased energy use) within a framework of global sustainability?**
- **d. What changes in communication patterns are needed to increase feedback and learning processes to increase the capacity of citizens and officials, as well as to provide rapid and effective feedback to scientists regarding the applicability and reliability of broad findings and theoretical insights to what is observed in the field?**
- **e. What are the potentials and risks of geo-engineering strategies to address climate change, and what local to global institutional arrangements would be needed to oversee them, if implemented?**

Unprecedented challenges require novel and rapid, innovative responses. While many of these grand challenges address the need for solutions-oriented research, it is increasingly clear that the scale and potential impact of global environmental change may necessitate the consideration of entirely novel technologies, institutions and policies at multiple levels.

A number of issues demand particular research attention in this regard. First, it is clear that fundamental changes are needed in our systems of energy production and use in order to avoid dangerous climate change. Research is needed to help identify and develop new systems for energy production, metering and use and to assess the impacts of these systems on the environment and society.

Second, at current rates of growth in agricultural yield and improvements in water use efficiency, it will be extremely difficult to simultaneously meet the needs over the next half century for: a) increased food demand from growing (and wealthier) populations; b) increased human demand for freshwater for agricultural and urban uses; c) reduced greenhouse gas emissions associated with land use change and agricultural production; d) potential increased production of biofuels; e) reduced rates of biodiversity and forest loss; and, f) enhanced ecosystem services. What are plausible scenarios for addressing this problem? What are the costs, benefits, and risks of different policy, technological or ecosystem-based management strategies that might be applied?

Third, solving the problem of poverty is integral to solving the problems of global environmental change: one is as important as the other since the two issues are tightly coupled. The poor will experience the greatest harm from global environmental change. It is imperative that solutions to the problem of global change simultaneously contribute to the needs for preventing and eradicating poverty and vice versa.

Fourth, in order to rapidly address the challenges of global environmental change, we must greatly enhance our capacity for learning and this in turn requires much more effective feedback loops at multiple scales. One factor that exacerbates the challenge of dealing with global environmental change is that the time scale of human impacts on the global environment (years to centuries) does not provide the immediate feedback that could inform the public and decision-makers. Mechanisms for providing feedback between the slow variables of global change and the fast variables of human response must be developed. Better communication and feedback is also needed that can enable more rapid uptake of solutions and learning across communities and societies. And the scientific community itself needs to develop better means of learning about the applicability of research findings to real-world situations.

Finally, considerable work is underway to explore innovative approaches such as geo-engineering and green energy technologies. How can such innovation be responsibly intensified? How can risks associated with global environmental management be adequately assessed? Although research is needed to explore the entire set of policy, institutional and behavioural changes that could mitigate climate change and enhance adaptation to climate change, increased attention should now be given to research to understand the costs, benefits, and risks of various geoengineering strategies and the institutional arrangements that would be needed to oversee and assess such strategies if they were implemented.

Expected Deliverables

The primary product of the research that will be guided by these grand challenges is the knowledge base needed to support efforts to achieve sustainable development in the context of global environmental change. This knowledge base, and the process of developing it, should make a major contribution to efforts to reduce global poverty and improve global justice in ways that do not unduly exacerbating environmental stresses. The research will also yield a set of more tangible products:

- Improved regional and sub-regional information concerning potential consequences of global and regional environmental change and the likely impacts of different actions to mitigate or adapt to those changes. (Challenge 1 and 2)
- Improved accuracy of regional and subregional forecasts of climate, food security, health and environmental risks, and water availability. (Challenge 1 and 2)
- Improved information on the consequences, costs, benefits and risks of potential mitigation and adaptation strategies. (Challenge 1 and 2)

- Prioritized needs for Earth system observations of geophysical, chemical, biological and social variables and the design features of a system for delivering that information. (Challenge 2)

- A framework for forecasting the likelihood, location, drivers, severity and risk of high magnitude, abrupt or non-linear changes associated with global change. (Challenge 3)

- Options for practices and institutions that allow effective action (or provide sufficient resilience) in response to signals of impending dangerous changes. (Challenge 3 and 4)

- Designs for institutions, procedures and practices that will serve to align disconnected interests, take power asymmetries into account, and facilitate collective action. (Challenge 4 and 5)

- Options for policies and practices that accelerate social and technological innovation relevant to the needs of managing global environmental change. (Challenge 5)

- Methods for exploring the costs, benefits and risks of alternative strategies to achieve global sustainability. (Challenge 5)

- New methods for doing research (involving innovation in synthetic research approaches, participatory practices, and collaborations) and communicating results, in which stakeholders are empowered, informed and motivated through the research process to take effective action. (All Challenges)

- Enhanced capacity to undertake interdisciplinary and transdisciplinary research, including the development of a new generation of scholars taking a systems approach to challenges of global sustainability. (All Challenges)

Call to Action

This document is the product of an agenda-setting consultation that is intended to guide and stimulate scientific research on global change and global sustainability starting promptly and continuing over the next decade. As such, it is a 'living document' that will be improved and revised as more stakeholders contribute to its content and confirm its basic premises. As the agenda-setting process goes forward, the need for input from the larger community will not be limited to responding to the specific research questions, but will also necessitate innovative approaches, including reflection upon and possible changes to the decision making process within scientific institutions in order to better facilitate the interdisciplinary and transdisciplinary research that is needed.

Major progress in addressing the grand challenges and research priorities laid out here can be achieved over the next decade, but not without changes in the existing international research structures to promote interdisciplinary research, also across scientific fields, to enable greater regionalization of that research, and to allow effective interaction with decision makers and other stakeholders to both guide the research questions and deliver the research results. And, the progress cannot be achieved without enhanced resources – the scope of research needed is far

broader and the nature of research organisation far more inclusive than the work carried out over the past two decades.

A major commitment will thus be required by both the institutions carrying out research and the institutions supporting that research. This document is intended to help to catalyze and guide an unprecedented decade of solution-oriented focused and intensive research. Over the next year, those who have participated in this effort will seek to build a coalition of scientists, scientific institutions, and funding agencies that will commit themselves to working together systematically – across disciplines and geographic regions – on agreed priority research questions that are critical to the sustainability of our planet for the future. The collaboration will likely be transformative for all involved, and one in which the goals are recognized as going far beyond science itself.

Appendix 1. Background on ICSU and the international global environmental change research initiatives

Thirty years after the creation of the first global environmental change programme, there is a realization that the planet is in a 'no-analogue' state. While there has been much progress on understanding the complexity and vulnerability of the Earth system, there is the growing recognition science is urgently needed to address how complex social-ecological interactions play out across scales—impacting conditions for all humankind. Scientific findings have shown that the Earth's environment is changing on all scales, from local to global, in large measure due to human activities. Much of the substantiating evidence has come from scientists who are active in the global environmental change programmes: DIVERSITAS (an international programme of biodiversity science), International Geosphere-Biosphere Programme (IGBP), International Human Dimensions Programme on Global Environmental Change (IHDP), and World Climate Research Programme (WCRP).[6] ICSU is the only common sponsor of these four programmes and has a long tradition in the field of global environmental change research.[7] In 2001, the four global environmental change programmes have come together under the banner of the Earth System Science Partnership (ESSP), which promotes international and interdisciplinary research in special focal areas (carbon, food, water and health). The four programmes and ESSP are recognized leaders in the planning and coordination of international global environmental change research (*Science*, 14 March 2008).

Recent reviews of the ESSP, IGBP, WCRP and IHDP have cited their critical contributions to international research as well as to assessments and policy initiatives, particularly in the areas of climate and biodiversity. These reviews, which were done jointly with the relevant scientific cosponsors, consistently pointed to the need to engage the scientific community to explore options and propose steps to implement a holistic strategy for global sustainability research, which would both encourage scientific innovation and address policy needs. The visioning global substantiality research process, which has produced this Grand Challenges in Global Sustainability Research document, emanated from these reviews.

In cooperation with ISSC and other partners, ICSU is leading a broad consultative process to address the decision from the ICSU General Assembly (October 2008) to outline options for an overall

[6] The scope of this appendix is restricted to institutions and organizations sponsored or co-sponsored by ICSU. These are by no means the only organizations carrying out and coordinating research and monitoring relevant to global sustainability. That broader set of institutions will play critical roles in carrying out the type of research described in this document.

[7] In 1979, ICSU co-sponsored the first World Climate Conference, which led to the establishment in 1980 of the WCRP with the World Meteorological Organization (WMO); in 1993 the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) also became a co-sponsor. Based on the studies of the Scientific Committee on Problems of the Environment in the 1970s and early 1980s, the Council initiated the planning of the IGBP in 1986. The International Human Dimensions Programme on Global Environmental Change (IHDP) was established with the International Social Science Council (ISSC) in 1996, and the United Nations University UNU became a co-sponsor in 2007. DIVERSITAS was initially established in 1991 by the International Union of Biological Sciences (IUBS), SCOPE, and UNESCO. In 1996, ICSU joined as a co-sponsor. DIVERSITAS was initially established in 1991 by the International Union of Biological Sciences (IUBS), SCOPE, and UNESCO; in 1996, ICSU joined as a co-sponsor.

framework for Earth system research. The process will have three steps, and is founded on the principle that form should follow function:

1) a consultation primarily with, but not limited to, the scientific community to envision a research strategy and priorities for the next decade (2009);
2) a consultation on the institutional framework needed to deliver the scientific vision that results from Step 1 (June 2010). Invitees to this meeting include the co-sponsors of the GEC programmes and UNEP, as well as funders and key figures from within and outside of the programmes. Prior to this meeting there will be public Open Forum;
3) development of a plan to guide the transition from existing structures to the needed structure (2011).

ICSU has entered into this visioning process with no pre-conceived conclusions, and the ultimate goal is to strengthen, galvanize, and focus the entire sustainability research community on the most pressing societal issues.

Appendix II. Definitions

Coupled social-environment system: A system in which the social and biophysical subsystems are intertwined so that the system's condition and responses to external forcing are based on the synergy of the two subsystems.

Earth system: The unified set of physical, chemical, biological, and social components, processes and interactions that together determine the state and dynamics of the Earth, including its biota and its human occupants.

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.

Food security: the state achieved when food systems operate such that all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Global change: Changes in biophysical environment caused naturally or caused (or strongly influenced) by human activities and the associated changes in society, institutions and human well-being. These may either manifest at the global scale or be occurring on a local scale but so widespread as to be a global phenomenon.

Global environmental change: Changes in biophysical environment caused naturally or caused (or strongly influenced) by human activities. These may either manifest at the global scale (e.g. increasing atmospheric CO_2) or be occurring on a local scale but so widespread as to be a global phenomenon (e.g. soil degradation).

Human well-being: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, equitable and trusting social relations, security, peace of mind, and spiritual experience.

Interdisciplinary: Research that involves several unrelated academic disciplines in a way that forces them to cross subject boundaries to create new knowledge and theory and solve a common research goal.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Systems approach: A research approach that views individual elements as parts of an overall system and assumes that the component parts of a system can best be understood in the context of relationships with each other rather than in isolation.

Resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Transdisciplinary: Research that both integrates academic researchers from different unrelated disciplines and non-academic participants, such as policymakers and the public, to research a common goal and create new knowledge and theory.

Vulnerability: Exposure to contingencies and stress, and the difficulty in coping with them.

Summary of the Sponsors Meeting on Visioning Institutional Frameworks for Global Sustainability

UNESCO Headquarters
Paris, France
23-24 June 2010

The document *Grand Challenges for Global Sustainability Research* (ICSU-ISSC, 2010: http://www.icsu-visioning.org/) defines five major research challenges for the next decade and emphasises the need for an integrated, trans-disciplinary approach to address these. In brief, these challenges are concerned with 1) Forecasting, 2) Observations, 3) Thresholds, 4) Responses, and 5) Innovation. This sponsor's meeting was designed to examine the institutional frameworks that will be necessary at the global level to address these grand challenges. Around 40 people attended the meeting and contributed with their views on on what would be the most suitable institutional framework to support this research agenda. The annex at the end of this summary provides a complete list of the participants who represent co-sponsors of the four global environmental change (GEC) programmes (IGBP, WCRP, DIVERSITAS, IHDP and their partnetship ESSP) and the three global observing systems (GCOS, GTOS, GOOS), chairs of the scientific committees for these programmes, representatives of other related international programmes, research funding agencies, and international experts on related research and organisational structures. The meeting was chaired by Johan Rockström, with support from an expert ICSU visioning task team. The primary goal of the discussions was to agree on the essential elements of an Institutional Framework for implementing the Grand Challenges in Global Sustainability Research. The discussions were informed by a prior online consultation and an Open Forum on 22 June which had brought to together over 100 experts to adreess both the *Grand Challenges* document and the institutional framework.

The sponsor's meeting was organised as a workshop and included both plenary and break-out group discussions. The following consensus conclusions reflect these discussions.

On the Grand Challenges:

- The (further revised) *Grand Challenges for Global Sustainability Research* document is a an acceptable Framework for organising sustainability (or integrated Earth Systems) research over the next decade.
- The Grand Challenges document is attractive in that not only does it integrate research but it also provides a link with integrated services, eg for climate and adaptation.
- A more detailed implementation plan with more specific project criteria and/or research priorities at the programme level now needs to be developed.

On institutional structures:

- The *status quo* cannot deliver the integrated research that is needed to effectively respond to the Grand Challenges.

- The existing GEC programmes have performed very well, but are now variously struggling to attract funding and young researchers.
- The Earth System Science Partnership (ESSP) does not have the resources or the authority to play a lead role in responding to the Grand Challenges. Any evolution of ESSP, or development of a new overarching structure, needs to have both of these.
- Increased resources are essential to make (existing and/or) new structures work.
- The current complex system of global structures, with multiple interlocuters, makes it difficult to co-design with funders and other key stakeholders.
- There is considerable potential for greater 'core' integration of the existing programmes, eg IGBP and IHDP.
- A complete merger of all the programmes is not feasible at this stage.
- A more systematic SWOT (Strength Weakness Opportunity Threat))/gap analysis of the current programmes, joint projects and other international initiatives, eg GCOS and GEOSS, relative to the Grand Challenges would help in defining redundancies and unmet needs.
- Much integrated research in line with the grand challenges is already happening in institutions and networks outwith the GEC programmes and ESSP and this will continue regardless of whether the structures change. However, this opportunistic approach does not constitute the concerted coordinated global effort that is really necessary. Part of the research efforts in many countries will remain poorly connected in the absence of an agreed global agenda.
- Experts caution that there is a window of opportunity and momentum now that has been built during the development of the Grand Challenges and this must not be lost in prolonged discussion about structures. Prompt action is desirable.
- In the end, what matters is delivering the science to answer the Grand Challenges and to do this more rapidly and effectively than is likely to happen with the current structures.

The way forward

Based on the general consensus on key issues summarised in the bullets above, the first steps towards developing a new institutional framework can be proposed.

- There is a need for a new structure which allows more integration of the existing GEC structures and activities. This might be envisaged as a transformed and strengthened ESSP.
- The Grand Challenge agenda should be owned by the new structure and an overarching governance/steering committee should be set-up rapidly to guide the implementation of the transformation,
- The overarching steering committee should have the following tasks:
  1) Scientific leadership and coordination of a major new integrated research program emanating from the Grand Challenge doc (the Global Sustainability Research Program, GSRP flagship),
  2) Co-design and coordination with international funding agencies,
  3) Co-design with partners

[A potential role for the Steering Body in overall strategic planning for ICSU global environmental change research was also discussed.]

- In order to achieve these tasks, the steering committee will need dedicated secretariat support and resources, which might be co-opted from some of the existing GEC programmes and ESSP

As mentioned above a number of participants focused on the lack of evidence regarding the conduct of a systematic gap analysis or SWOT analysis during the course of the visioning process.

There was also a sense that specific and concrete action plans, using the five challenges as a framework, need to be developed to provide a sufficiently inspirational vision to capture the interest of leading scientists and galvanize them into a ten-year commitment to a coordinated research effort. In this regard, the organisational model and success of the recent International Polar Year was noted. The participants noticed an excellent opportunity to formally launch this 10 year inititative during the 2012 Open Science Conference being planned by the Global Change community.

The importance of identifying a few "flagship initiatives" that can galvanize the scientific community to work together constructively to achieve a fairly well-defined goal with a fixed timeline is also emphasized. The Appollo Project metaphor is probably not a good one. But the idea of a focused and goal-directed effort in which we all join forces is crutial to the future development.

Furthermore, several participants argued that any new initiatives should as much as is feasible: 1) be targeted towards the development of operational, integrated, and end to end environmental services delivery systems, and 2) be managed in partnerships with those institutions, such as WMO (and a number of others), that ensure the appropriate operational international coordination between these service providers, and linkages with the stakeholders and less developed countries.

The steering Committee should take up these points and work closely with the existing structures, experts, sponsors, as well as the funders and other stakeholders to guide the transformation.

Annex: Participant list of the Sponsors Meeting

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BELMONT FORUM **BF10/11**
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ICSU CONCEPT PAPER: A GLOBAL SUSTAINABILITY RESEARCH INITIATVE

Purpose of Paper

Recognising potential emerging alignment between the evolving Belmont Challenge White Paper and the ICSU Visioning on Grand Challenges and Institutional Frameworks, the Belmont Forum Co-Chairs have invited ICSU to put forward a concept paper, proposing a joint way forward. The proposed initiative is called an '*Earth System Science for Global Sustainability*'

This considers the task force and road-mapping proposed in the Belmont Challenge White Paper. Over the next 1-2 years, it would design and secure the necessary broad support for an overarching strategic 'sustainability' research programme.

Action

The Objective is for BF members to: DISCUSS the ICSU proposal and:

- AGREE on the principles of an initiative that the Belmont Forum can support
- DEVELOP and AGREE an Action Plan for the Belmont Forum, ICSU and ISSC to take forward the initiative, setting out what we are going to do, how, roles and responsibilities

Papers for this item

ICSU Concept Paper

Cost estimate (IN CONFIDENCE FOR BF MEMBERS ONLY)

Earth System Science for Global Sustainability (ESSGS): A New 10-Year Research Initiative

Draft Concept Paper for Discussion
15 October 2010

The pace and magnitude of human-induced global change is currently beyond human control and is manifest in increasingly dangerous threats to human societies and human well-being. Decision-makers and citizens have an urgent need for knowledge and solutions that will enable effective responses to these threats and that will provide the basis for achieving sustainable development goals. The sheer scale of threats and needs mean that depending on opportunistic and ad hoc measures alone will not suffice.

Therefore, just as the scientific community established the global environmental change (GEC) research programmes 30 years ago in a revolutionary effort to further our grasp of the earth system, ICSU, ISSC and partners now propose an effort that is no less revolutionary: an innovative 10-year Research Initiative on Earth System Science for Global Sustainability (ESSGS), structured as a cutting-edge network encompassing the best of all relevant scientific disciplines, and which is highly integrative, flexible and responsive.

The goals of the Initiative are to:

- Deliver at global and regional scales the knowledge that societies need to effectively respond to global change while meeting economic and social goals;
- Coordinate and focus international scientific research to address the "Grand Challenges in Global Sustainability;"[1]
- Engage a new generation of researchers in the social, economic, natural, health, and engineering sciences in global sustainability research.

Many building blocks would come from the existing GEC landscape; but they will need to be organized in fundamentally new ways to address new research priorities. The Initiative will inspire and enlist the best researchers, be they anthropologists or geophysicists, northern or

[1] There are five interlinked Grand Challenges in all: 1. Forecasting, 2. Observing, 3. Confining, 4. Responding, and 5. Innovating.

southern, young or veteran. And it will mobilize diverse teams quickly and strategically to tackle emerging challenges and deliver solutions at the local, regional and global scale.

Why a New Initiative?

The establishment of the global environmental change research programmes thirty years ago represented a revolutionary response by the scientific community to the need for international coordination of research in order to understand the functioning of the earth system. The Initiative proposed here is no less revolutionary. The scientific community must now deliver the knowledge that will enable countries to meet needs for sustainable development, poverty alleviation and environmental protection in the face of global change. While deepening our understanding of the earth system and of human impacts, the scientific community must now build the capacity to deliver solutions to pressing sustainability challenges at regional scales. It must attract the brightest young scientists, particularly in developing countries, to tackle compelling challenges associated with global sustainability. It must significantly expand the involvement of social scientists and economists in the grand challenge research agenda. It must increasingly adopt research approaches that actively involve stakeholders and decision-makers in the process of defining and carrying out research. And it must effectively deliver end-to-end environmental services.

This past June, when ICSU convened a two-day meeting with the GEC programme sponsors, funders and other key parties, visions for the future shape of global sustainability research sometimes varied. Yet one sentiment united the room: ***business as usual is not an option.*** Current global research arrangements are unable to adequately meet these needs. They do not address the full range of global sustainability research challenges, particularly with regards to research on policy, institutional and behavioral responses to global change. They do not adequately address the needs for regional and decadal prediction of global change; or include a sufficient focus on social science, economic, and transdisciplinary research. And, they do not adequately engage younger scientists or take full advantage of the potential of networked organizational arrangements.

Initiative Characteristics

The Initiative will have the following core characteristics:

Focus on global sustainability research. The Initiative will mobilize the scientific community to deliver the knowledge that societies need at global and regional scales to effectively respond to global change while meeting economic and social goals. This would lead to improved integration of scientific disciplines and organizational structure.

Cutting-edge network structure. The progress that has been made on global change research over the last three decades was due in no small part to the effective use of coordinated research networks. In these "first generation" networks, relatively small coordinating secretariats, guided by scientific steering committees, served to identify research priorities and facilitate the involvement of scientists and the support of national and regional funders for that work. This Initiative will require "second generation" research networks. Some of the features of this network would be:

- Cutting edge knowledge management system;
- Capability of identifying network-wide research priorities and fostering strategic intensity to ensure that those priorities are addressed, and the solutions delivered in a timely fashion;
- Possesses the nimbleness and flexibility to adapt as the challenges evolve;
- Built around bias for innovation at all points in the network to ensure a constant flow of new ideas and talent;
- Designed to mobilize the network to support needs of regional nodes while also mobilizing regional nodes to address global questions;
- Distributed network management and coordination arrangements.

Built around strong regional nodes. Strong regional research nodes that can more effectively identify and respond to needs and priorities of decision-makers at regional and national scales. At the same time, regional research and analysis is increasingly needed to understand Earth system functions, human impacts, and potential responses. A strong regional research presence also facilitates the involvement of younger scientists and helps to build research capacity.

Active engagement with decision-makers. Mechanisms already exist through which the global change scientific community can interact with decision-makers at the global scale. These include the Intergovernmental Panel on Climate Change and the new Intergovernmental Platform on Biodiversity and Ecosystem Services. Through these mechanisms, policy-makers are able to identify their highest priority needs and the scientific community is able to assess the state of knowledge bearing on those needs. These mechanisms also help to reveal policy relevant gaps in research and knowledge and consequently they have helped the global change research and funding community set priorities.

A critical need now exists for similar arrangements to better facilitate science-policy interactions at regional scales. Information provided at regional scales can better inform the key regional and national decisions that will ultimately determine how effective societies are in responding to global change. The Initiative will thus place significant emphasis on either

utilizing existing mechanisms for science-policy interactions (e.g., in Europe) or creating new mechanisms to engage with decision-makers where such mechanisms do not exist.

Actively engage the full range of disciplines. Social sciences have long been a component of Earth system research, but tackling the grand challenges for global sustainability research requires a stronger involvement and greater integration of the social sciences, economics, health sciences, engineering and humanities, along with the natural sciences. The goal of expanding the involvement of the social sciences in global change research has been difficult to achieve. We believe that the strongly regional and networked structure of this Initiative combined with the focus on research aimed at understanding how to achieve sustainability in the context of global change will provide a transformative opportunity for more active engagement of the social sciences, economics and health sciences in particular. In designing the Initiative, we will identify active steps that could be taken to 'grow' the involvement of these disciplines in the Initiative through time.

Actively engage young scientists. The GEC research programmes have been successful over the past three decades because of the caliber of young scientists that became engaged in the programmes when they were established. These research challenges were seen as cutting edge research opportunities around which young scientists could build their careers. Based on our experience of involving young scientists in developing the Grand Challenges for Global Sustainability Research, we believe that the set of new research priorities that more directly address the sustainable development agenda provides a similar opportunity to engage the brightest young scientific talent. To succeed, the Initiative must focus on exciting research questions, must be open to "bottom up" innovation in research directions, and must proactively ensure that governance and decision-making in the Initiative actively incorporates both younger and more senior scientists.

Creating the ESSGS

Building the overarching structure

At the June 2010 meeting of sponsors, funders, GEC programme chairs and key partners, many participants shared a belief that even a reform of the existing Earth System Science Partnership (ESSP) would not be able to effectively guide the initiative. There needs to be a new, overarching structure with the authority and resources that the ESSP never had, and which would be crucial for nudging the GEC community towards a more integrated research.

It is proposed to create a new Steering Committee whose tasks are to oversee the creation of the initiative, and take the lead on the initiative's vision, strategy, fund-raising, and relationships with partners and stakeholders, as well as to provide scientific guidance to the entire Initiative. This Committee will act as an interim governing body to the new initiative and

should be appointed for 18 months to lead its creation and design, and to explore options for its future governance structure. During the 18 months, this group would decide on governance options, explore funding options, obtain the necessary 'high level' commitments from governments, and propose the final Board structure and composition. After the 18 months design period, the Committee would transition into the full board, to govern and implement the initiative. In order to ensure continuity, some of the Committee members may be asked to stay on in the new governance structure.

This Committee will have high level representation from all the main stakeholders including researchers, funders, industry, and other stakeholder groups. The membership of this Committee may look like the following:

1. *Current core programme sponsors*
    - International Council for Science (ICSU) and International Social Science Council (ISSC), and possibly other UN organizations.
2. *Research donors*
    - Representatives of the Belmont Forum and the International Forum of Research Donors (IFORD)
3. *Scientists* (6)
    - Internationally renowned scientists, including at least one early career scientist. The set of scientists will have to have a fair balance with regards to region, gender and scientific background/discipline.
    - Representation of the existing GEC programmes, e.g. via inclusion of the chair of the ESSP.
4. *Users of global sustainability information and knowledge*
    - Individuals with experience at the interface of global change research and policy. This should include people working at global, regional and national scales.
5. *Representatives of civil society and business*
    - This would include representatives from industry, NGOs, and could include other distinguished individuals (e.g., a retired government leader, etc.)

Note that current core programme sponsors may sit on the Committee in ex-officio capacity. Collectively, the set of individuals selected for the Steering Committee (and ultimately for the governing Board) would provide outstanding substantive guidance and bring a set of relationships that could be mobilized in support of the initiative. More specifically, the set of individuals would meet the following criteria:

- World renowned scientific leaders.

- Among the non-scientists, individuals with a strong affinity with science and with the potential use of science in decision-making.
- Individuals with a strong commitment and engagement to both environmental and social concerns.
- Individuals capable of interacting and engaging across existing GEC Programmes and fora.
- Individuals with direct experience and knowledge of political decision-making around environmental issues at the highest levels.
- Individuals who can help open doors for possible core funding and research funding.
- Individuals with expertise in building and governing complex network-based institutions.
- Individuals with experience in building scientific capacities at individual, organizational and systemic levels.
- Appropriate gender and regional balance.

Integrating existing GEC programmes

Although integrated research is already happening in the GEC programmes and outside of institutions and networks contributing to the GEC programmes, these scattered efforts do not constitute a concerted, coordinated global effort. In the absence of a global agenda, research efforts in many countries continue to be left out. The Initiative will thus integrate the current GEC programmes, when necessary and feasible. While there is not yet a consensus for deep integration within the GEC community, there is strong and growing recognition that more effective integration is necessary.

Designing and Creating the Initiative

Once the Steering Committee is in place, it will oversee the development and early implementation of the Initiative. The design of a global interdisciplinary research network such as that proposed here will require an intensive design phase that must draw on the expertise of the scientists who will be involved in the research, but equally importantly must draw on the deep knowledge and expertise that now exists regarding network design and knowledge management. We anticipate the following steps:

1. Engage organizational design experts. As its first task, the Steering Committee will issue an RFP to retain a firm with extensive experience in organizational and network design to 'staff' the design process.

2. Initiate a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis of existing GEC research. Using the Grand Challenges in Global Sustainability as the framework, analyze success of and gaps in the existing research activities at both global and regional scales and gaps in capacity to carry out the necessary research.

3. Explore the greater integration of GEC programmes. One possibility would be that the Steering Committee will successively replace the current ESSP when it starts. Supported by the outcomes of the SWOT analysis, it will carry out discussion with the GEC programmes regarding their integration into the new structure.

4. Assemble information on obvious regional 'nodes' for the network. Dialogs will be carried out with those institutions/organizations in order to identify a set of candidate nodes that could fill gaps in the network.

5. Explore alternative options for the governance, funding, and priority setting for the network (see Figure 1.). The Steering Committee has a life time of 18 months, after which it will be replaced with a more permanent governance structure.

6. Explore options for knowledge management systems.

7. Develop a detailed research plan for the first three years of the Initiative. Based on the Grand Challenges document, develop a much more concrete and specific action plan. As a first step in this effort, a small number of priority areas/directions must be established.

8. Co-design and coordinate an implementation plan. An open call should be issued to scientific community including those who are currently engaged in GEC research and those who are willing and able to contribute to the needs of the action plan. This includes the identification of organizations/institutions that will be responsible for components of the research, the funding needed, and the outputs anticipated.

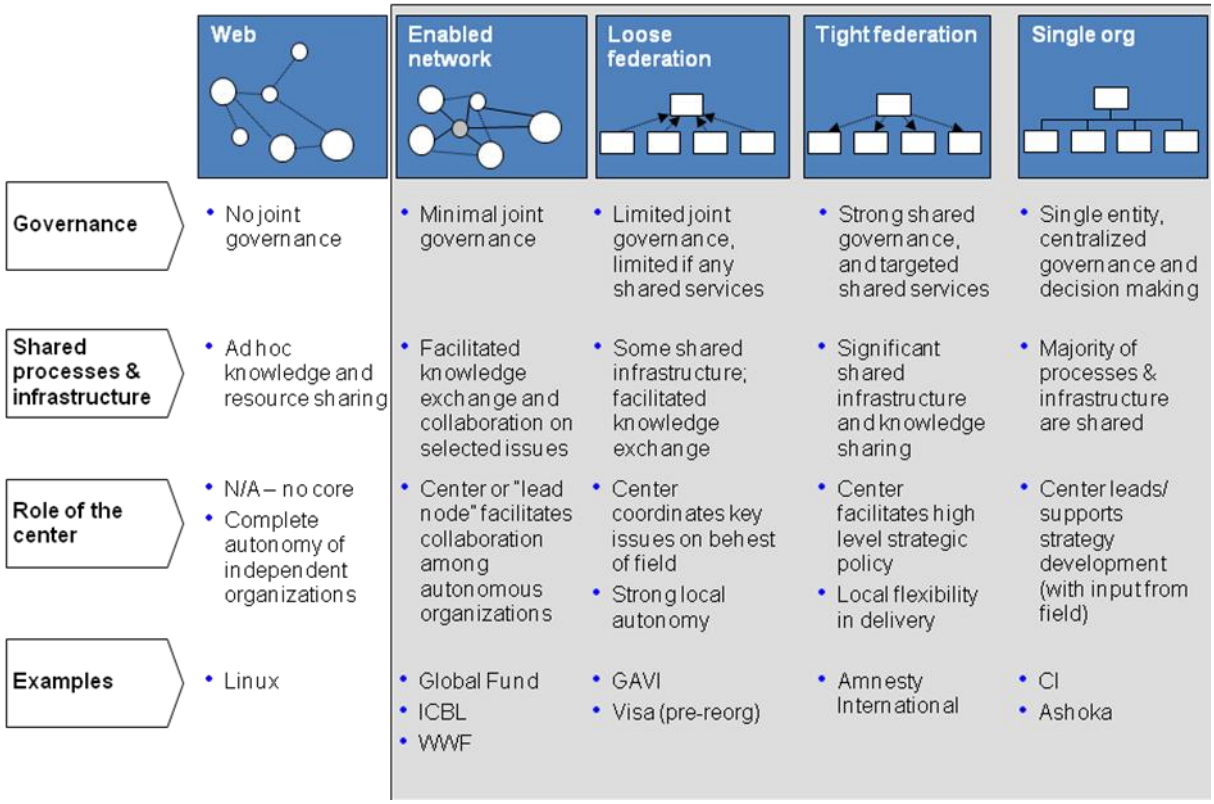
9. Develop a formal relationship among the relevant network nodes that will be promoting and/or carrying out the research and a funding plan for those nodes and for the Initiative management.

10. Reach out to potential partners and user. As an example, the UN High Level Panel on Global Sustainability would be one of such groups.

Launching the Initiative

The 2012 "Planet Under Pressure" conference would provide a useful opportunity to launch the initiative.

Figure 1. Network Design Models (Source: McKinsey & Co.)



BELMONT FORUM **BF10/12**
OCTOBER 2010

ISSC PROPOSAL FOR A SOCIAL SCIENCE AGENDA SETTING WORKSHOP

Purpose of Paper

An action from the January meeting was for ISSC to develop regional dialogues to help stimulate interaction of social sciences with environmental change research. A specific focus was to consider how to frame global environmental research challenges in ways that engage social scientists.

A proposal for a Social Science Agenda Setting Workshop, engaging the regional ISSC groups and other stakeholders, has been developed by ISSC.

NERC supports this proposal in principle and is able to contribute costs of approx. £30k.

Action

The objective for BF members is to DISCUSS the proposal and:

- DECIDE whether to approve the proposed workshop Belmont Forum action for support,
- IDENTIFY any changes needed to strengthen the proposal, and to
- RECOMMEND the level of support, and IDENTIFY sources for any additional support required above the NERC contribution

Social Science Agenda-Setting Workshop

A Proposal from the ISSC to the Belmont Forum

October 2010

Introduction

As ICSU's report on the Belmont Challenge has highlighted, when addressing mitigation of and adaptation to global and regional environmental change, research in the natural and social sciences[1] should be integrated from the outset. Many immediate and concrete problems associated with environmental change call for the integral involvement of social scientists, in framing research questions, selecting methods of enquiry, conducting investigations and interpreting results; these challenges require: 'research that in its very design, execution and application demands the joint efforts of natural and social sciences.'[2]

The social sciences expose critically important connections between global environmental change and relevant issues in education, poverty, conflict and demography. They ensure that policy choices made in one policy sector do not have negative consequences for another; and that decisions aimed at mitigation or adaptation do not reinforce existing social inequalities or generate new ones. They embed solutions to local and regional environmental problems in analyses of globalisation, inequality, development, growth, cultural diversity, human rights and social justice. And, most importantly, the social sciences help us to understand the drivers and impacts of transformation, and inform effective routes to behavioural change, decision-making and associated governance systems.

However, the full potential of social science contributions has yet to be realised, both in the context of an integrated approach, but also within the social science community. The scientific and science policy communities have raised concerns about the capacity of the social sciences to deliver on the challenges set by global environmental change when environmental change research remains at the margins of activity within traditional social science disciplines. Funders report difficulties in securing a strong social science participation in calls that seek to integrate the sciences; in many countries social

[1] The ISSC is the primary international body representing the social, economic and behavioural sciences at a global level. Throughout this document "social science(s)" refers to all three branches of this broad field, encompassing many disciplines and approaches.
[2] Hackmann, Heide, Foreword to *Climate Change, Ethics and Human Security*, Eds Karen O'Brien, Asunción Lera St. Clair and Berit Kristoffersen (Cambridge University Press, 2010), xi

scientists are still more likely to submit proposals to stand-alone disciplinary calls than to those that require trans-disciplinary integration with the natural sciences.[3]

In order to adequately address the Belmont Challenge it will be necessary to mobilise the broader social science community to become engaged with these issues, and to develop incentives for researchers to focus on environmental change priorities. The Belmont Forum has emphasised this and explicitly called for the integration of the social sciences in its work. In order to do this successfully, a critically important action for the Forum to take is to engage directly with social scientists – those working in the field of environmental change as well as those working in related fields in the mainstream social sciences – in order to identify what, from a social science perspective, society's most urgent knowledge needs are and hence what the most compelling research priorities are for international, comparative research that is context-relevant and can contribute to providing regionally-based solutions.

Given the Belmont Challenge focus on global collaboration for purposes of building knowledge and capacities to address regional issues, promoting the positive and rigorous development of regional social science capacities is extremely important. We must ensure that we tackle the problem of global divides in social science knowledge production and utilisation, and find effective, coordinated ways of increasing the production of social science research into environmental change – at individual, organisational and systemic levels – in all parts of the world and particularly in developing countries of the global south.

The essential first step in setting these processes in motion is to bring social scientists together in a social science agenda-setting workshop. This document sets out a proposal for such a workshop. If supported, the workshop would be linked to and build on the ISSC's current activities in this area of work and pave the way for future ones. The ISSC Executive Committee has committed to developing a longer-term ISSC strategy for mobilising the broader international social science community around global environmental change research, and for doing so in partnership with the ISSC co-sponsored IHDP (International Human Dimensions of Climate Change Programme, also co-sponsored by the International Council for Science (ICSU) and the United Nations University (UNU)). This will be a significant focus during the 28th ISSC General Assembly meetings in Nagoya, Japan, 9-14 December 2010, which will include a 2-day Scientific Symposium, 'Changing Nature – Changing Sciences? The challenges of global environmental change for the social sciences and humanities.' The broader framework for the ISSC's efforts in this regard is the Council's commitment to and collaboration with ICSU in the Earth System Science for Global Sustainability Visioning Process.

[3] See Balstad, Roberta, "The interdisciplinary challenges of climate change research" in *World Social Science Report 2010: Knowledge Divides* (UNESCO 2010), 210-213; O'Brien, Karen, "Responding to the global environmental change: social sciences of the world unite!", idem, 11-13; Hernes, Gudmund, "One planet – two cultures?" in *Public Service Review: Science and Technology* 2 (PSCA International Ltd 2009), 54-56.

Workshop Objective, Outcomes and Outputs

The Belmont Challenge

> *To deliver knowledge needed for action to avoid and adapt to deleterious environmental change including extreme hazardous events.*

Workshop Objective

Increase the extent to which social scientists are integrated into work addressing the Belmont Challenge.

Outcomes

- Agreement on the societal and policy needs for social science knowledge related to the Belmont Challenge.
- Increased social science interest in, commitment and contribution to future activities of the Belmont Forum, and to environmental change research in general.
- Increased engagement of social science funding agencies in the Belmont Forum.
- Identification of potential solutions to tackle global divides in social science knowledge production in relation to the Belmont Challenge, resulting in the increased participation of social science scholars from developing countries in work relating to the Belmont Challenge.

Ouputs

- Identification and inventory of the most relevant, urgent and compelling social science research questions in relation to the Belmont Challenge. (Disseminated via ISSC and partner organisations' websites and other communication channels.)
- Clarification and inventory of the barriers to integrating fully with the natural sciences in this work. (Disseminated via ISSC and partner organisations' websites and other communication channels.)
- Identification and inventory of potential strategies and ideas for overcoming barriers to integrating with the natural sciences and to increase production of social science research relevant to the Belmont Challenge. (Disseminated via ISSC and partner organisations' websites and other communication channels.)
- Short report on main conclusions of the workshop regarding capacities, obstacles, ideas and strategies to be developed, etc. (Disseminated via ISSC and partner organisations' websites and other communication channels.)
- World Social Science Forum – special session on Belmont Challenge to report the content covered, broaden participation in the debate, and further mobilise the wider social science community.
- Basis of international network of social scientists focusing on the Belmont Challenge.
- Input and advice for the new global sustainability research initiative proposed by ICSU and ISSC as part of the Earth System Science Visioning process.

Targeted Participants

In order to achieve a truly global scope, the ISSC would approach key regional social science bodies as a primary source of participants. These organisations would be invited to recommend social science scholars from within their regions with an established profile in the field of environmental change, as well as prominent scholars from mainstream social science disciplines. Nominations would be requested from each group to include 1 or 2 senior and 1 early career social scientist (defined as scholars up to the age of 40 with PhD or equivalent research experience). A selection process following nomination, arranged by the organising committee (see sections on "Format" and "Organisation" below), would ensure a good disciplinary spread and the strongest, highest quality possible participants.

The regional bodies are:

CODESRIA – Council for the Development of Social Science Research in Africa
OSSREA – Organization of Social Science Research in Eastern and Southern Africa
CLACSO – Latin American Council of Social Sciences
AASSREC – Asian Association of Social Science Research Councils
ACSS – Arab Council for the Social Sciences
ESF – European Science Foundation; Standing Committee for Social Science
SSRC – Social Science Research Council, USA[4]

The following additional groups would also be invited to participate:

- IHDP (International Human Dimensions of Global Environmental Change Programme) would be brought on board as a partner, representing specific expertise in the field of social environmental sciences. IHDP would be invited to nominate up to 3 representatives.
- 2 of the social scientists that commented on ICSU's Report on the Belmont Challenge or participated in the study panel.
- Executive Secretaries/Presidents of the councils listed above, as they are in a position to provide an overview of regional social science knowledge systems and related priorities, trends and capacities.
- A core group of senior representatives of social science funding agencies (members of IFFA - International Forum of Funding Agencies): e.g. NSF (National Science Foundation, USA), ESRC (Economic and Social Research Council, UK), DFG (German Research Foundation), NWO (Netherlands Organisation for Scientific Research), NRF (National Research Foundation, South Africa), etc.
- Up to 4 ISSC Executive Committee members.
- Up to 3 senior scholars from the humanities, sourced via CIPSH (the International Council for Philosophy and Humanistic Studies, with which the ISSC has a very strong working relationship in part realised through the joint organisation of biannual General Assemblies and Scientific Symposia).[5]

[4] All of the regional bodies are ISSC partners, excluding ACSS and ESF, with which the ISSC currently has strong collaborations.
[5] The workshop will primarily be a social science event, but the significance of disciplines such as history or philosophy in relation to environmental change is increasingly recognised, therefore the involvement of several key scholars working on environmental change in these disciplines would bring added value.

- Representatives of the Belmont Forum.

This would result in at least 14 and possibly more selected participants (of which, 7 would be early career social scientists) nominated by the regional bodies, plus up to 20 representatives of other organisations. A limit of 40 participants is suggested, to maintain the productivity of the discussions.

Format

An organising committee will be established by the ISSC to design the programme and format of the workshop, to include both plenary sessions and space for any breakout groups during the workshop.

The plenary sessions will provide information and background material on:

- The Belmont Forum and ICSU Grand Challenges (as identified by the ICSU Visioning Process).
- Input from the IHDP on its internal consultation to identify important research questions in relation to the Belmont Challenge and ICSU Grand Challenges (this consultation will involve IHDP Project Leaders).
- Presentation of the IHDP-ISSC Packard Foundation Survey undertaken in partnership with UNESCO, to be conducted among the broader social science community to scope research activities and profiles; to solicit the views, recommendations and criticisms of social scientists on global environmental change research; as well as to generate interest in this research field.
- Presentation of the outcomes of the ISSC-CIPSH December 2010 Symposium on 'Changing Nature – Changing Sciences? The challenges of global environmental change for the social sciences and humanities.'

In order to maximise the time for and quality of debate during this consultative, agenda-setting event, a set of key questions will be circulated to participants in advance of the workshop. These questions would feed into the programming of the event. The organising committee would be asked to formulate the questions; examples include:

1) What are the interesting and critical research questions for the social sciences in relation to the Belmont Challenge?
2) What are the most urgent environmental change issues in the regions?
3) Which compelling issues in this field are currently being explored by the social sciences? Which should be explored? (First steps towards a mapping exercise.)
4) What are the capacities/strengths of the social sciences in relation to these issues?
5) What are the barriers to becoming involved in environmental change research for social scientists?
6) How to overcome these barriers; what types of incentives are needed for social scientists to direct attention to environmental issues? At a minimum, what steps are needed to reduce disincentives for focusing on such issues?
7) What mechanisms are needed to strengthen collaboration in and between the regions across disciplines and scientific fields?

In line with the IHDP-ISSC Packard Survey, questions regarding social science methods and data needs could also be covered.

Organisation

The ISSC would seek to collaborate in the organisation of the workshop with its key regional members in the global south, CODESRIA and CLACSO. Informal contact has already been established with CLACSO to assess the possibility of this partnership, to which the response has been positive. The workshop would ideally be hosted in one of these partners' regions in the first half of 2011.

CODESRIA and CLACSO would be asked to assume responsibility for co-organising:

- venue & equipment;
- hotel reservations;
- catering and all other local arrangements.

These partners would not be expected to cover any costs, although we would hope that the venue and equipment would be provided free of charge.

Overall coordination of the workshop would be the responsibility of the ISSC Secretariat, which would assemble an organising committee, chaired by the ISSC and composed of the ISSC Secretary-General or a member of staff representing her, and senior representatives of CLACSO, CODESRIA, IHDP and the Belmont Forum Working Group. The organising committee would communicate via email and Skype. Under its leadership, the ISSC Secretariat would be responsible for:

- collecting nominations for, selecting and inviting the participants (via initial email/phone call followed by formal invitation letter);
- coordinating communication between partners;
- consulting the participants in advance of the workshop to identify and specify key issues for the workshop agenda;
- formulating and distributing the programme;
- non-local logistical organisation: travel etc.;
- coordinating communication of logistical arrangements to participants;
- reporting on the workshop;
- disseminating the results of the workshop to the Belmont Forum and to a wider audience via the ISSC website, member communication channels and press releases.

Estimated Budget

In order to secure the participation of the strongest potential contributors (as demonstrated by the ICSU Visioning Process meeting in September 2009), we would hope to cover the travel and accommodation costs of all participants, excluding representatives of funding agencies (members of IFFA) and Belmont Forum members.

The budget below is based on a workshop of two days with the list of participants whose travel and accommodation expenses should be covered restricted to 35. The costs per person will vary depending on where the workshop is to be held.

Cost Item	**Amount (in Euros)**
Travel & Accommodation (35 participants) @ 1600 per person	56 000.00
Regional Council Nominees (16)	
IHDP Representatives (3)	
Social Scientists involved in the ICSU Report (2)	
Executive Secretaries of Regional Councils (7)	
ISSC Executive Committee Members (4)	
Humanities Senior Scholars (3)	
Catering (2 dinners, 2 lunches) for 45 persons (including staff) @ 120 per person	5 400.00
Venue & Equipment @ 450 per day	900.00
Office Overheads	2 492.00
TOTAL (in Euros)	64 792.00
TOTAL (in Pounds)	£59 628.69

Successful implementation of the workshop proposed here would depend on the ISSC being able to secure additional resources or support for a temporary, part-time member of staff to take on a time-bound organisational/reporting role. Support in the form of a seconded member of staff from a Belmont Forum member organisation, to assist in the organisation/management of the event and to work remotely if necessary, would be welcome.

BELMONT FORUM **BF10/13**
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COLLABORATION BETWEEN BELMONT FORUM AND CCAFS ON FOOD SECURITY

Purpose of Paper

An action from the January meeting was for Albert van Jaarsveld to contact the new ESSP Challenge Programme on Climate Change Agriculture and Food Security (CCAFS) to inform them of Belmont Challenge (White Paper) and offer our cooperation on further development of priorities and opportunities.

CCAFS have proposed some concrete suggestions of areas for collaboration with funders to move the science agenda forward and strengthen collaboration between the global change and development research communities. In August BF Members were provided with the opportunity to review and prioritise these suggestions.

Action

For this item NSF, NRF and CCAFS will lead a discussion on the proposals.

Papers for this item

Letter exchange between Albert van Jaarsveld and Thomas Rosswall

Suggested response from NSF, NRF and CCAFS

National Research Foundation

PO Box 2600
Pretoria 0001
South Africa
Tel: (012) 481 4000
Fax: (012) 349 1179
Int. Code: +27 12
info@nrf.ac.za

www.nrf.ac.za

14 April 2010

Prof Thomas Roswall
Chair : CCAFA Steering Committee
57 chemin du Belvédère,
06530 Le Tignet
France

Dear Thomas

RE: Belmont Forum and Food Security Research

This communication is on behalf of the Belmont Forum of Global Change Research Funders whom are interested to engage with the ESSP Challenge Programme on Climate Change Agriculture and Food Security (CCAFS). The objective of this engagement is to inform the CCAFS community about the Belmont Challenge (White Paper) and offer our cooperation on the further development of research priorities and opportunities in the area of Food security.

Food security has emerged as a very likely research priority to be supported through the Belmont Forum and we feel that a cooperative approach between the Belmont Forum and CCAFS would be most productive and effective.

Please advise when and where you would be able to engage with Belmont Forum members. A preliminary joint IGFA/Belmont Forum meeting is being scheduled for 25-29 October 2010, in Cape Town and could be a possibility.

If you are willing to engage further, please advise so we can make the necessary arrangements.

Yours sincerely
[Signature reproduced electronically on request]

Dr Albert van Jaarsveld
NRF President and Chief Executive Officer

Cc: Tim Killeen, David Allen, Gina Adams

CGIAR-ESSP
Challenge Programme on

26 April 2010

Re. Belmont Forum and Food Security Research

Dear Albert,

Thank you for your letter dated 14 April expressing an interest of the Belmont Forum to engage in the ESSP-CGIAR Challenge Program on Climate Change, Agriculture and Food Security. CCAFS is a major initiative to bring together the agricultural-development and global change research communities. As you know, during my years at ICSU I tried to build bridges to ensure that global change research could become more development oriented. IGFA and ICSU organized the Krusenberg Workshop in May 2005, when we brought together the two science communities, but also IGFA members and representatives of bilateral aid organizations engaged in funding development relevant research. Personally I think this first dialogue was successful and I see CCAFS as a concrete follow-up and to demonstrate necessary scientific partnerships to build on the competencies of the ESSP and CGIAR communities. I am enclosing electronic versions of the CCAFS Science Plan and the Medium-Term Plan 2010 2012.

The CCAFS Secretariat is located at the University of Copenhagen; three offers to host the Secretariat came from universities with a strong commitment to ESSP research and three from CGIAR Centres, with a long tradition of agricultural research to address major development challenges. The scenario work of CCAFS builds on that developed by the ESSP project on Global Change and Food Security (GCAFS).

The funding for CCAFS so far comes primarily from the bilateral development aid agencies (DG Development, CIDA, World Bank) plus support from the University of Copenhagen. I welcome the opportunity to engage the Belmont Forum in a discussion on how to further support the engagement of the ESSP science community in CCAFS.

Next week the CCAFS team will meet with a variety of stakeholders in Nairobi to discuss priorities for the initial three regions of CCAFS research (West and East Africa, the Indo-Gangetic Plain). At the same time, there will be discussion on how a major new initiative of the CGIAR on Climate Change and Agriculture, as part of a major restructuring of CGIAR and refocus of its research agenda, can build on and expand CCAFS. We have been asked to prepare a proposal for a CGIAR Mega Programme (tentative title) on Climate Change and Agriculture and this proposal should be submitted by 10 May and will be discussed by the

CGIAR Consortium Board in late May and the CGIAR Fund Council in July. Many donors have expressed great satisfaction with the CGIAR-ESSP collaboration and see this as a major strength. Thus, this new potential development will make it even more important to ensure excellent working relationships between the two science communities and also seek innovative ways how the research programme can receive financial support from the two sides.

The Steering Committee for CCAFS will meet next week and your letter will be distributed, together with my response. If you should so wish, CCAFS would be very interested in participating in the IGFA/Belmont Forum meeting scheduled for Cape Town 25-29 October. The Vice-Chair of the CCAFS Steering Committee is Professor Mary Scholes, but we will explore the possibility that the CCAFS Director, Professor Bruce Campbell, or I could also attend the meeting. Personally I would greatly appreciate the opportunity to again engage with IGFA/Belmont members. However, in preparation for such a possible participation in your meeting from our side, I think we should start an exchange of e-mails seeking to clarify how a cooperative approach between CCAFS and the Belmont Forum could develop. We are also willing to entertain other possibilities for consultation in the near future.

With my best personal wishes,

Yours sincerely,

Thomas Rosswall
Chair, CCAFS Steering Committee

Cc: Mary Scholes, Bruce Campbell, Rik Leemans

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57, chemin du Belvédère
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France

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CGIAR Challenge Programme on
Climate Change, Agriculture and Food Security (CCAFS)

4 June 2010

Dr. Albert van Jaarsveld
President and Chief Executive Officer
National Research Foundation
P. O. Box 2600
Pretoria 0001
South Africa

Re. Belmont Forum and Food Security Research

Dear Albert,

As a follow-up to my letter dated 26 April, members of the CCAFS Steering Committee discussed various options for cooperation on the further development of research priorities and opportunities in the area of global change and food security. In conjunction with our SC meeting the first week of May, CCAFS arranged a conference to engage with stakeholders in the area of climate change, agriculture and food security. We were pleased that David Allen attended this meeting and I took the opportunity to discuss your letter and our possible response with him. This meeting also provided excellent opportunities to discuss how CCAFS could be transformed into one of the new CGIAR MegaProgrammes (MP), which has been selected for fast-tracking. CCAFS was asked to provide a proposal for such a transfer to a MP. It was very clear that the ESSP partnership was much appreciated and in the submission of CCAFS of a proposal for a MP, we stressed the importance of CGIAR-ESSP collaboration also for a new MegaProgramme to be built on the foundation of CCAFS. Thus, there is a window of opportunity for the global change research community to further engage with the development research community through the CGIAR centres in the context of CCAFS and the MP and to expand on current CCAFS collaboration. It is in this context that we would like to see further engagement with the Belmont Forum.

In our discussion we have tried to identify opportunities for strengthened ESSP-CGIAR collaboration and engagement of the Belmont Forum members in the area of food security research. We have thus identified five potential areas of collaboration, where we think engagement of the Belmont Forum/IGFA can assist in moving the science agenda forward and result in strengthened collaboration between the global change and development research communities.

1. **The Joint Programming Initiative (JPI) of 20 EU, and affiliated, countries on "Agriculture, Food Security and Climate Change".** The initiative (Annex 1) currently consists of 20 countries represented by Ministries and/or research funding bodies. The membership of the Scientific Advisory Board (Annex 2) and the Governing Board (Annex 3) are enclosed for your information. The Scientific Advisory Board, of which I am a member, is charged with elaborating a common strategic vision and a list of priority actions by the end of 2010. It is our hope that the JPI will engage the European science community in global change and food security issues and that member countries will develop joint calls for proposals. The JPI has suggested that collaboration should be developed with Sub-Saharan Africa, where CCAFS could have an important role to play. The JPI and CCAFS will also have complementary roles and provide jointly a platform to address climate change and food security in a global context. It is hoped that the JPI will engage with other OECD countries in bilateral discussions, so that additional partnerships can be built. It should be noted that five of the 12 SAB members are "Non-European or affiliated with international agencies". We also hope that this JPI will provide the context for collaboration between EC DG Research and DG Development. Since some IGFA members are engaged in the JPI, the Belmont Group may consider this as one priority activity, which could support a direct link between ESSP and this initiative. The French Institut National de la Recherche Agronomique (INRA) provides the interim secretariat for the JPI.

   In addition, the ESSP Joint Initiative Global Environmental Change and Food Systems, GECAFS, which is currently in its synthesis phase, was very much involved in organizing a meeting at the Royal Society in London last February on "Environmental Change and Agriculture" with several participants representing CCAFS. The meeting addressed the need for additional collaboration as GECAFS was entering into its wrap-up phase. The report from this meeting is enclosed as Annex 4. The meeting was organized in conjunction with a Royal Society Discussion Meeting on "Greenhouse gases in the Earth system: setting the agenda to 2030".

2. **The Global Research Alliance on Agricultural Greenhouse Gases** — launched at the Copenhagen climate summit in December 2009 — held its first meeting in Wellington, New Zealand, in April with 28 of the 29 member states in attendance. The Alliance aims to bridge gaps in research on agricultural greenhouse gas emissions, which account for around 14 per cent of the world's total emissions. It also seeks to coordinate such research on an international scale, ensuring that scientists share their findings with research communities and farmers in other countries as well as their own. Alliance members agreed on three research strands: crop management research led by the United States; livestock issues led jointly by the Netherlands and New Zealand; and rice paddy farming investigations led by Japan. A further research area to study the role of soil carbon in agricultural

emissions is also under consideration. This will be highly relevant for CCAFS Theme 6 and a representative of the Alliance was also present at the Royal Society meeting last February. Member states, including 13 developing countries, can decide which research groups are most relevant to their needs and join any of them. The work across all three strands will initially focus on mitigation of greenhouse emissions and research must be clearly defined to avoid overlap with existing knowledge. CCAFS secretariat is in close contact with the Danish representative to the Alliance, and Jean Francois Soussana, a member of the SAB of the JPI, attended the Wellington meeting as a member of the French delegation. There are thus excellent opportunities for strong CCAFS-JPI-Research Alliance collaboration and the Belmont Forum can again play an important role.
A draft charter for the Alliance will be finalised in 2011 and New Zealand will act as the interim secretariat.

3. **ICSU Programme on Ecosystems and Society (PECS**) will develop research sites to address linked ecological-social systems. CCAFS has discussed the possibility to engage in the discussion on site selection so that a few of its sites could also become part of the PECS network. This will also provide an excellent link between CCAFS and the plans to establish an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). PECS was established to fill some of the science gaps identified during the Millennium Ecosystem Assessment (Annex 5). Financial support to allow scientists from the South and the North to engage in research on agriculture and global change in the context of linked ecological-social systems would support science in the forefront of policy relevant research while strengthening the integrated, regional approach of the CCAFS science agenda. It would be interesting to consider the possibility of establishing a programme at the international level similar to the one set-up by DfID, ESRC and NERC on Ecosystem Services for Poverty Alleviation (http://www.nerc.ac.uk/research/programmes/espa/).

4. **CCAFS scenario work** will build on the experiences of GECAFS and initial work will be coordinated from the University of Oxford by John Ingram. Scenario work will be important in both CCAFS and for the MegaProgramme and will initially focus on the three CCAFS priority regions; East and West Africa plus the Indo-Gangetic Plain. Scenario work is important for guiding the science but also to engage stakeholders in participatory approaches to evaluate possible futures. Belmont Members could provide direct support to this component of CCAFS through the University of Oxford. The exercise will also build on experiences from IPCC and the Millennium Ecosystem Assessment scenario work and provide a link between CCAFS and the assessment community.

5. **Climate services.** The World Climate Conference – 3 in August-September 2009 decided to establish a Global Framework for Climate Services to strengthen production, availability, delivery and application of science-based climate prediction

and services (Annex 6). CCAFS has provided input to the initial planning on behalf of CGIAR (Annex 7). It is crucial for CCAFS and the MegaProgramme on Climate Change to link up with the climate research community at the international level (primarily though WCRP) and to foster links between national hydromet services and national agricultural research systems at the national level. WCRP will provide the research necessary for climate services (in collaboration with the national hydromet services) and will feed into the CCAFS scenario development. The Belmont Forum can assist in establishing such links through the support of relevant section of the CCAFS Workplan in collaboration with WCRP and the WMO Agricultural Meteorology Programme.

With the above five examples, we wish to put forward some initial ideas on how the Belmont Forum/IGFA can engage with CCAFS in moving the agenda on global change and food security forward. We are convinced that Members of the Belmont Forum will add additional suggestions and that we jointly can develop an agenda for specific discussions during the meeting of the Belmont Forum/IGFA in Cape Town in October or in another context that would be mutually agreeable.

We see your letter and our response as the first steps in an iterative process that can hopefully lead to discussions and concrete output from the October meeting. We are looking forward to your initial reactions and to move this dialogue forward.

With my best personal wishes,

Yours sincerely,

Thomas Rosswall
Chair, CCAFS Steering Committee

Thomas Rosswall
Chair, CCAFS Steering Committee
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06530 Le Tignet
France

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Annexes

1. Agriculture, Food Security and Climate Change. A Joint Programming Initiative of currently 20 European Members.
2. Members of the Scientific Advisory Board, JPI
3. Members of the Governing Board, JPI
4. Report from meeting on Environmentaal Change and Agriculture, Royal Society, London 25 February 2010
5. Carpenter, S. R. *et al.* Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. PNAS 106:1305-1312 (2010).
6. High-level declaration, World Climate Conference – 3
7. CCAFS reponse to WMO, on behalf of CGIAR, re. Climate services

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DRAFT

The CGIAR Challenge Programme on Climate Change, Agriculture and Food Security (CCAFS): An Opportunity for Collaboration between the CGIAR and the Belmont Forum/IGFA

Suggestions for Such Opportunities for Discussion at the Forum/IGFA Meetings in Cape Town, 25-29 October 2010

The Consultative Group on International Agricultural Research (CGIAR) has established and initiated planning and funding for a new program on climate change, agriculture and food security. This programme was adopted in response to a proposal whose preparation involved fifteen CGIAR centers and numerous research and development partners.

It may be of interest to note that major supporters of the CGIAR include eight major donor countries (Australia, Canada, the European Commission, Japan, Norway, Sweden , the United Kingdom and the United States); multilateral and global organizations, such as the World Bank; and foundations, such as the Bill and Melinda Gates Foundation.

The CCAFS and the Forum have begun exploring needs and opportunities for collaboration through exchanges of correspondence between Dr. Thomas Rosswall, the Chair of the CCAFS Steering Committee, and Dr. Albert van Jaarsveld, President of the National Research Foundation of South Africa. Dr. Jaarsveld was asked by the Forum in January 2010 to assume responsibility for interaction with the CCAFS (access to a key element of this exchange is available through the website for the Cape Town Meeting).

Dr. Rosswall, CCAFS, has suggested that "engagement of the Belmont Forum/IGFA can assist in moving the science agenda forward and result in strengthened collaboration between the global change and development research communities". He has identified five specific areas in which such engagement could be especially useful. These are, very briefly, as follows:

1. An initiative for priority actions in Sub-Saharan Africa, in conjunction with a Joint Programming Initiative (JPI) of European countries led by the EC and strongly supported by France. He has suggested that the Earth System Science Partnership (ESSP) might be an appropriate vehicle through which the Forum/IGFA could advance such an initiative.

2. An initiative under the Global Research Initiative on Agricultural Greenhouse Gases. Such an initiative might focus on the role of soil carbon in agricultural emissions. This is also a JPI activity, but with New Zealand playing an especially important role.

3. An initiative to "address linked ecological (and) social systems, especially through (identification of) research sites … that could become part of the PECS network (ICSU's Programme on Ecosystems and Society) … (and thus) fill some of the science Gaps identified during the Millenium Ecosystem Assessment". Such a programme could emphasize bringing together "scientists from the South and the North to engage in research on agriculture and global change in the context of linked ecological-social systems". This could "support science in the forefront

of policy-relevant research while strengthening the integrated, regional approach of the CCAFS science agenda". Such a programme might be particularly relevant to the UK effort in the area of Ecosystem Services for Poverty Alleviation.

4. CCAFS scenario-related activities in "the three CCAFS priority regions: East and West Africa and the Indo-Gangetic Plain. This would build on experience gained from the IPCC and the Millenium Ecosystem Assessment.

5. An effort could be undertaken under the Global Framework for Climate Services (GFCS) "for the CCAFS … to link up with the climate research community … primarily through the WCRP … and (thus) to foster links between national hydromet services and national agricultural research systems". It is suggested that the Forum/IGFA could assist in this area by encouraging interaction between research scientists working under the CCAFS Workplan; the WCRP and the WMO Agricultural Meteorology Programme.

It is suggested that the Forum discuss ways to pursue these possibilities, but perhaps focusing on the PECS network and the GFCS. With regard to the PECS, the linkages between climate change, ecosystems in general, and agricultural systems in particular, are strongly relevant to a wide range of Forum/IGFA members activities and to the objectives of the Belmont Agenda and the ICSU visioning exercise. With regard to the GFCS, it appears that there is great potential to forge new links between the global change research community and the WMO to enhance the WMO's efforts to develop the GFCS and to encourage the development of national climate services. The Forum/Council will be receiving a presentation from the WMO about their ongoing efforts regarding the GFCS.

It is proposed that these initiatives, in pursuance of the Belmont Challenge, also concentrate on regional cooperation. Africa in particular is a region of mutual interest to both the CCAFS and the Forum/IGFA; for this reason, among others, it is suggested that the Forum/IGFA offer to co-sponsor either one or both of the initiatives with the CCAFS and that the Forum/Council's activities be coordinated through the ad hoc task team under the leadership of Dr. Jaarsveld and the NRF.

In getting these initiatives underway, it is suggested that joint scientific planning activities such as the convening of scientific workshops or similar meetings, be undertaken. It is also suggested that the START program be invited to associate with these initiatives as this group is supporting ongoing scientific capacity-building activities which are directly related to CCAFS.

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COLLABORATIVE RESEARCH ACTIONS (CRAs): PROGRESS, OPPORTUNITIES AND CHALLENGES

Purpose of Paper

At the January meeting a number of collaborative actions were agreed, as a parallel strand of activity to the strategic planning of the Belmont Forum. The actions aimed to:

- Engage with other organisations seen as important stakeholders for the Belmont Forum, and/or;
- Promote collaboration between funding agencies by mapping existing activities and identifying opportunities for collaboration.

Some areas for CRAs were identified for taking forward immediately. These include:

- ISSC regional fora and CCAFS proposal (discussed on day one) and six actions to be discussed today: Climate Services, Coastal Zone Vulnerability, Water Security, Carbon Cycling- Forests and Agriculture, Carbon Cycling- Ocean Acidification, Securing the Biodiversity Baseline.
- In January some actions were deferred for initial consideration at this meeting: Human Health, Bio and Renewable Energy, GeoEngineering and Land Use Trade-offs.

Action

The objective of this session is to:

- NOTE progress on the individual actions any opportunities for funder-funder collaboration, and AGREE next steps
- IDENTIFY any overarching issues that may be limiting progress and AGREE actions to resolve them.
- DISCUSS the potential for collaborative actions deferred from January and AGREE how to take them forwards. This might include:
    - IDENTIFYING whether members already have significant activities in these areas which could be co-designed/co-aligned
    - WHICH members would be interesting in leading an action to scope opportunities for international collaboration

Papers for this item

See attached table of CRAs for discussion

Background papers

WMO background information: WCC-3 Declaration, Brief Note on the Global Framework for Climate Services, WCC-3 Summary Report, High-level Taskforce (HLT) Terms of reference and Membership of the HLT Membership

Water Security background information: NSF

Coastal Vulnerability background information: Australia and NSF

Biodiversity Baselines: Presentation

Human Health background information: ICSU planning ground on Heath and Wellbeing in the Changing Urban Environment

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COLLABORATIVE RESEARCH ACTIONS FOR DISCUSSION

Action from Jan 2010 D&A	BF Lead	Update	Paper
Social Sciences- Develop regional dialogues to frame environmental questions in a meaningful way for social scientists, so that they can engage in the Belmont Challenge	Heide	Discussed on day one	BF10/12
Food Security- Contact ESSP Challenge Programme on Climate Change Agriculture and Food Security (CCAFS) to inform them of Belmont and offer our cooperation on further development of priorities and opportunities	Albert	Discussed on day one	BF10/13
Climate Services- Contact WMO Global Framework for Climate Services Task Force to invite them to discuss research requirements with the Belmont Forum	Tim	Presentation (Ghassem Asrar, WMO)	BF10/14 (Background Paper)
Freshwater Security- Scope opportunities to align regional studies and modelling on water availability and extreme events	Tim	Presentation	BF10/14 (Background Paper)
Coastal Zone Vulnerability- Start two-pronged approach to plan new international research activity: • Programme Officers: Scope existing activities. Identify opportunities to align and twin, and gaps. • In consultation with Deliang – consider establishing ICSU-managed scientist task force to advise on research priorities (with help from Belmont Group, IHDP and IGBP)	Ian/Tim	Presentation	BF10/14 (Background Paper)
Securing Biodiversity Ecosystem Services Baseline- Scope opportunities to align and coordinate national sites to develop	Johannes	Presentation	BF10/14 (Background Paper)

international biodiversity-ecosystem function observation network. Identify common interests and opportunities for alignment.			
Carbon Cycling- Forests and Agriculture: Scope opportunities to align and co-design measurements and modelling of carbon stocks and fluxes.	Brito (Reynaldo)	Presentation	
Carbon Cycling- Ocean Acidification: Review existing coverage of Southern Ocean observatories (biodiversity and ocean acidification) and identify gaps	Steven	Presentation	
Most Vulnerable Societies- Engage IFORD and propose a Task Force to strengthen collaboration between funders, researchers and development agencies.	Margaret	NSERC wrote to IFORD proposing collaboration. They considered it at their annual Forum, but they decided not to become a more formal agency that could interact with other forums like the Belmont Forum. Therefore, that avenue does not appear to be open.	
Deferred Actions			
Land Use Trade-Offs			
Human Health			
Bio and Renewable Energy			
Geo-engineering			

World Climate Conference – 3

Geneva, 31 August – 4 September 2009

CONFERENCE DECLARATION

We, Heads of State and Government, Ministers and Heads of Delegation present at the High-level segment of the World Climate Conference-3 (WCC-3) in Geneva, noting the findings of the Expert Segment of the Conference:

Decide to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen the production, availability, delivery and application of science-based climate prediction and services;

Request the Secretary-General of the World Meteorological Organization (WMO) to convene, within four months of the adoption of the Declaration, an intergovernmental meeting of Member States of the WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors to be appointed by the Secretary-General of the WMO with due consideration to expertise, geographical and gender balance;

Decide that the task force will, after wide consultation with governments, partner organizations and relevant stakeholders, prepare a report, including recommendations on proposed elements of the Framework, to the Secretary-General of WMO within 12 months of the task force being set up. The report should contain findings and proposed next steps for developing and implementing the Framework. In the development of their report, the task force will take into account the concepts outlined in the annexed Brief Note;

Decide further that the report of the task force shall be circulated by the Secretary-General of WMO to Member States of the WMO for consideration at the next WMO Congress in 2011, with a view to the adoption of the Framework and a plan for its implementation; and

Invite the Secretary-General of WMO to provide the report to relevant organizations and to the UN Secretary-General.

Adopted by acclamation by the High-Level Segment of the Conferenceon 3 September 2009

Conference Declaration

We, Heads of State and Government, Ministers and Heads of Delegation present at the High-level segment of the World Climate Conference-3 (WCC-3) in Geneva, noting the findings of the Expert Segment of the Conference:

Decide to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen the production, availability, delivery and application of science-based climate prediction and services;

Working together towards a Global Framework for Climate Services

Request the Secretary-General of the World Meteorological Organization (WMO) to convene, within four months of the adoption of the Declaration, an intergovernmental meeting of Member States of the WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors to be appointed by the Secretary-General of the WMO with due consideration to expertise, geographical and gender balance;

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Invite the Secretary-General of WMO to provide the report to relevant organizations and to the United Nations Secretary-General.

World Meteorological Organization
Weather • Climate • Water

Report of the World Climate Conference-3

UN SYSTEM
DELIVERING AS ONE ON
CLIMATE KNOWLEDGE

WMO-No. 1048

Report of the
World Climate Conference-3
Better climate information for a better future

Geneva, Switzerland
31 August–4 September 2009

WCC · 3

WMO UNESCO IOC UNEP FAO ICSU International Council for Science

The World Climate Conference-3 was an initiative of the World Meteorological Organization (WMO) in partnership with the United Nations Educational, Scientific and Cultural Organization (UNESCO) in support of the United Nations system "Delivering as One on Climate Knowledge". It was co-sponsored by the United Nations system sponsors of the World Climate Programme, the International Council for Science (ICSU) and other governmental and non-governmental partner organizations.

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Report of the World Climate Conference-3
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"Now is the time to invest in science, and to commit to rigorous and sustained climate observation, research, assessments and the provision of information. The establishment of the Global Framework for Climate Services will be an important step toward strengthening the application of climate knowledge in local, regional, national and international decision-making".

Ban Ki-moon
Secretary-General of the United Nations

Foreword

from the Secretary-General of the United Nations, Ban Ki-moon

The World Climate Conference-3 (WCC-3) was a landmark event at which leaders and senior government officials discussed the scientific tools and services needed to improve the world's ability to adapt to a changing climate.

Scientific knowledge must be the basis for global climate policy on mitigation and adaptation alike. Now, more than ever, we need to invest in rigorous climate monitoring, assessments and information provision. The decision by more than 150 countries at WCC-3 to establish a Global Framework for Climate Services is an important step toward strengthening the application of climate science in decision-making at all levels. Tools such as this will enable governments to better prepare for and protect their populations from climate risks while safeguarding important development gains.

I thank the World Meteorological Organization, donor countries, international partners and the host country, Switzerland, for their generous contributions in ensuring a successful WCC-3. As this timely event demonstrated, and as this summary report also makes clear, it is imperative to work together with unity of purpose to meet one of the most fundamental challenges of our time, climate change.

Preface

from the Secretary-General of WMO, Michel Jarraud, and from the Director-General of UNESCO, Koïchiro Matsuura

The World Climate Conference-3 (WCC-3) saw an unprecedented response by world leaders and the international scientific community to the call by the World Meteorological Organization and its long-standing partners in the World Climate Programme for the establishment of a framework to provide society with the climate services it needs to address the challenges of climate variability and change, now and in the future. Climate has emerged as one of the most challenging issues for the global community in the twenty-first century. Coping with the impacts posed by climate variability and change will require countries and societies to be equipped with new tools and capacities, including better observation and understanding of climate variability and risks; increased awareness, education and dissemination of information; as well as improved prediction and information services to enable the identification and management of a wide variety of climate risks and opportunities, including for nationally appropriate mitigation actions and adaptation.

The Secretary-General of the United Nations has made clear that the United Nations system is committed to delivering as one on climate change. As the two United Nations specialized agencies assigned convening responsibility for the "climate knowledge" component of the United Nations system-wide strategy, the World Meteorological Organization (WMO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) were delighted to receive this strong support.

WMO and UNESCO have greatly welcomed the recent scientific advances to interannual prediction and multidecadal climate projection and the developments in high-resolution regional climate models which offer a sound basis for the continued development and application of new tools and climate services. It is recognized that improved climate prediction and information services and broad assessment of climate impacts are essential for targeted adaptation and risk management measures and strategies, and would facilitate the mainstreaming of adaptation into sustainable development strategies at local, national and regional scales.

Taking place some 30 years after the historic First World Climate Conference and 19 years after the Second World Climate Conference, WCC-3 represents another landmark in the practical application of climate science, giving birth to the idea of a truly global framework for climate services available to all people.

We have a very solid foundation for building on the great progress that has been made since the First and Second World Climate Conferences, in particular through the establishment, inter alia, of the World Climate Programme (WCP), the World Climate Research Programme (WCRP), the Intergovernmental Panel on Climate Change (IPCC) and the Global Climate Observing System (GCOS). The second Conference also provided decisive momentum to the negotiations leading to the establishment of the United Nations Framework Convention on Climate Change.

The Global Framework for Climate Services (GFCS), initiated by WCC-3, will address the challenges of climate variability and change both today and into the future. Successful implementation of the Framework will lead to enhanced climate observations, research, monitoring and modelling, a transformation of that information into sector-specific products and applications, and their widest possible use by all sectors of society in decision-making. In so doing, it will contribute to disaster risk reduction and socio-economic development, including achievement of

the United Nations Millennium Development Goals and be another concrete illustration of the United Nations system delivering as one.

Moreover, the Gender and Climate Forum of WCC-3 stressed that neither climate change nor climate information is gender-neutral. After considering an extensive body of knowledge and expertise in the area of gender and climate variability and change, the Forum concluded that the GFCS should reflect a gender perspective in all its components, from observation, monitoring, research, and modelling to outreach and capacity-building.

WMO and UNESCO are committed to following up the WCC-3 decisions, taken by over 150 governments, through the mechanism set down in the Conference Declaration. In this, the support of governments and strong partnerships across all sectors will be essential. Collaboration at all levels will be necessary to foster the development of sector-targeted climate services for decision-making.

Our sincere gratitude goes to the Swiss Confederation for hosting the Conference, and to the Heads of State and Government, and more than 100 ministers and agency heads, as well as user sector high-level representatives who, despite their busy schedules, felt it important to participate in the World Climate Conference-3. We also wish to thank the international scientific communities for their commitment, as well as all governments and institutions that sponsored the Conference. We look forward to their continued support in the further development and implementation of the Framework.

Conference Declaration

We, Heads of State and Government, Ministers and Heads of Delegation present at the High-level segment of the World Climate Conference-3 (WCC-3) in Geneva, noting the findings of the Expert Segment of the Conference:

Decide to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen the production, availability, delivery and application of science-based climate prediction and services;

Request the Secretary-General of the World Meteorological Organization (WMO) to convene, within four months of the adoption of the Declaration, an intergovernmental meeting of Member States of the WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors to be appointed by the Secretary-General of the WMO with due consideration to expertise, geographical and gender balance;

Decide that the task force will, after wide consultation with governments, partner organizations and relevant stakeholders, prepare a report, including recommendations on proposed elements of the Framework, to the Secretary-General of WMO within 12 months of the task force being set up. The report should contain findings and proposed next steps for developing and implementing the Framework. In the development of their report, the task force will take into account the concepts outlined in the annexed Brief Note;

Decide further that the report of the task force shall be circulated by the Secretary-General of WMO to Member States of the WMO for consideration at the next WMO Congress in 2011, with a view to the adoption of the Framework and a plan for its implementation; and

Invite the Secretary-General of WMO to provide the report to relevant organizations and to the United Nations Secretary-General.

Adopted by acclamation by the
High-level Segment of the Conference
on 3 September 2009

The Brief Note referred to above is at Annex 6.

Executive Summary

Peoples around the world are facing multi-faceted challenges of climate variability and climate change, challenges that require wise and well-informed decision-making at every level, from households and communities to countries and regions. World Climate Conference-3 (WCC-3), held in Geneva from 31 August to 4 September 2009, considered these challenges and guided the development of an international framework for climate services that will link science-based climate prediction and information with the management of climate-related risks and opportunities in support of adaptation to climate variability and change in both developed and developing countries.

The Expert Segment of WCC-3 reviewed the various challenges facing the climate service provider and user communities; considered the needs and capabilities for applying climate information in key climate-sensitive sectors, as well as for social and economic benefits; examined the scientific bases for climate information and prediction services; and concluded that:

- Great scientific progress has been made over the past 30 years, especially through the World Climate Programme and its associated activities, which already provide a firm basis for the delivery of a wide range of climate services; but that
- Present capabilities to provide effective climate services fall far short of meeting present and future needs and of delivering the full potential benefits, particularly in developing countries;
- The most urgent need is for much closer partnerships between the providers and users of climate services;
- Major new and strengthened research efforts are required to increase the time-range and skill of climate prediction through new research and modelling initiatives; to improve the observational basis for climate prediction and services; and to improve the availability and quality control of climate data.

The scientific community present at the Conference supported the development of the proposed Global Framework for Climate Services, and called for major strengthening of climate observing systems; the climate research programme; climate services information systems; climate user interface mechanisms; and capacity-building through education, training, and strengthened outreach and communication.

The Secretary-General of the United Nations opened the High-level Segment of the Conference, with supporting keynote addresses by Heads of State and Government and other dignitaries. The High-level Segment, noting the findings of the Expert Segment, adopted a Conference Declaration establishing a Global Framework for Climate Services. (See previous page for full text.) The High-level Segment also requested the Secretary-General of the World Meteorological Organization (WMO) to convene, within four months of the adoption of the Declaration, an intergovernmental meeting of Members of WMO to approve the terms of reference and to endorse the composition of a task force of high-level, independent advisors with due consideration to expertise, geographical and gender balance.

The task force shall, after wide consultation with governments, partner organizations and relevant stakeholders, prepare a report, including recommendations on proposed elements of the Framework, to the Secretary-General of WMO within 12 months of the task force being set up, along with the proposed next steps for developing and implementing the Framework. The report of the task force shall be circulated by the Secretary-General of WMO to WMO Members for consideration at the next WMO Congress in 2011, with a view to the adoption of the Framework and a plan for its implementation.

1. INTRODUCTION

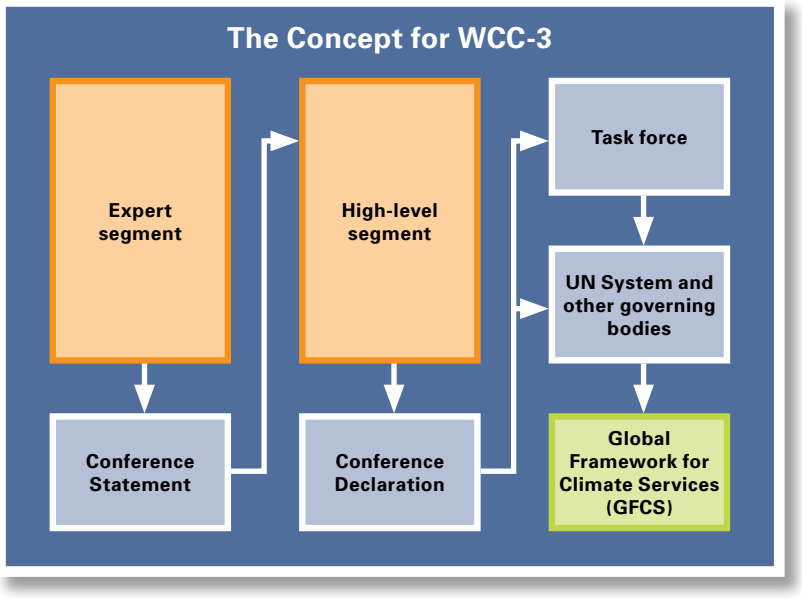
At the invitation of the Government of Switzerland, the World Climate Conference-3 (WCC-3) was held in Geneva, from 31 August to 4 September 2009. The Conference brought together some 2 500 participants, including delegates from more than 150 countries, 13 Heads of State and Government, 81 ministers, 34 United Nations organizations, and 36 other governmental and non-governmental international organizations. WCC-3 was organized by the World Meteorological Organization (WMO), in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the International Council for Science (ICSU) and other intergovernmental and non-governmental partners.

The theme of the Conference was "Climate prediction and information for decision-making" and its vision was for establishing "An international framework for climate services that links science-based climate predictions and information with the management of climate-related risks and opportunities in support of adaptation to climate variability and change in both developed and developing countries".

The Conference was organized in two parts, a three-day Expert Segment followed by a two-day High-level Segment. The Expert Segment of the Conference reviewed a wide range of individual and community-based papers and presentations from climate science, service, application and user communities as well as the results of deliberations by a number of other major climate service stakeholder and community groups. The High-level Segment was addressed by Heads of State and Government, major sponsors, ministers, and heads and representatives of international organizations.

1.1 Background

The World Climate Conference-3 (WCC-3) was the third such conference organized by the World Meteorological Organization and its United Nations system and other international partners in the last 30 years, and represented the first major initiative of the United Nations system "Delivering as One on Climate Knowledge".

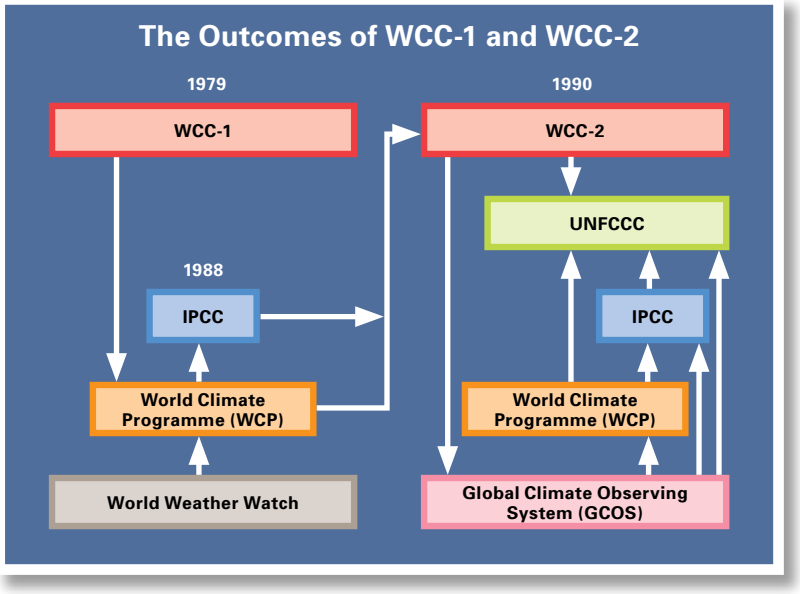


The First World Climate Conference (WCC-1), in 1979, examined the rapidly increasing influence of climate on society and called for urgent international action by all nations regarding the threat of climate change. This appeal led to the establishment by WMO, in May 1979, of the World Climate Programme (WCP), including the World Climate Research Programme (WCRP), co-sponsored by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the non-governmental International Council for Science (ICSU). In 1988, WMO and UNEP, on the basis of the early work under the World Climate Programme, jointly established the Intergovernmental Panel on Climate Change (IPCC) to take stock of the scientific knowledge of the threat of human-induced climate change.

The Second World Climate Conference (WCC-2), in October/November 1990, undertook a comprehensive evaluation of progress under the WCP and of the findings of the IPCC First Assessment Report. It found that the observational networks for monitoring the global climate systems were inadequate and deteriorating, and called for urgent political action to arrest the rapid build-up of greenhouse gases in the atmosphere. It triggered the establishment of the Global Climate Observing System (GCOS) as a joint initiative of WMO, UNEP, ICSU and the Intergovernmental Oceanographic Commission of UNESCO. The Conference also provided the scientific foundation and political endorsement for the negotiation of the United Nations Framework Convention on Climate Change (UNFCCC).

Over the 19 years since the Second World Climate Conference, international and national awareness of the need for comprehensive knowledge to address climate change has increased dramatically, along with a corresponding increase in awareness of the need for better application of that knowledge to decision-making in virtually every area of society.

Climate adaptation and risk management, in particular, became urgent and immediate priorities for all countries, especially developing countries, Least Developed Countries (LDCs), Small Island Developing States (SIDS) and other structurally weak and small economies that are highly vulnerable to the adverse impacts of climate variability and change. Coping with the consequences of climate variability and change challenged people, especially the poorest and the



most vulnerable, to become empowered with new tools and capacities. In response to this important need, WMO and its international partners decided to convene WCC-3.

1.2 Objectives

The ultimate objectives of WCC-3 were to accelerate global action on climate-related risks that threaten the well-being of society, and to capitalize on associated opportunities in support of sustainable socio-economic growth, especially in developing and Least Developed Countries. The specific objectives of the Conference were to:

- Identify and assess the global and sectoral end-user needs for climate information and prediction services;
- Mobilize climate science globally to advance the skill of seasonal-to-multidecadal climate prediction;
- Assess the current state of knowledge and adaptive capacity with regard to climate variability and change across communities;
- Identify principles and mechanisms for sharing new advances in science and information provision and application through a cooperative global framework;
- Propose solutions that will enable end-users to benefit from improved climate prediction and information services.

2. OPENING OF THE CONFERENCE

In welcoming the participants to the Opening of the Conference, the Secretary-General of WMO, Michel Jarraud, recalled the achievements of the First and Second World Climate Conferences and expressed his hope that WCC-3 would lead to an even more broadly based contribution to the wise handling of the climate issue by providing far-sighted guidance on the optimum arrangements for the provision of climate services in support of national and international decision-making over the coming decades.

The President of the Swiss Confederation, H.E. Hans-Rudolph Merz, President of the Conference, welcomed the participants to WCC-3, stressed the widespread impacts of weather and climate, and expressed his confidence that WCC-3 would lay the foundation for a better future due to better climate information.

Alexander Bedritsky, President of WMO and Chair of the Expert Segment of the Conference, noted that improved climate services are now capable of addressing a broad range of user needs. He urged the global community to come together to provide the needed information and predictions based on the best available science, and suggested that the large number of organizations attending the Conference should be seen as a testament to the high level of commitment that now exists to providing improved climate services. Dr Bedritsky emphasized that WMO Members have provided, and will continue to provide, data and predictions that are essential for climate services.

Gro Harlem Brundtland, the United Nations Secretary-General's Special Envoy on Climate Change, represented the Secretary-General at the opening of the Conference. She noted that the Secretary-General has called climate change the defining challenge of our generation and that, today, it is in our hands to make WCC-3 an important milestone in the quest for peace and security. Dr Brundtland advocated that climate politics be based on clear and credible scientific data, and encouraged WCC-3 Conference participants to make their voices heard as the world needs the knowledge and initiative of the scientific community now more than ever.

Kofi Annan, President of the Global Humanitarian Forum and former United Nations Secretary-General, spoke of the need for concerted political action on climate change. Saying that there was no room for complacency, Mr Annan noted that deliberations at

Opening of the Conference

From left to right: John Zillman, Kofi Annan, Michel Jarraud, Hans-Rudolf Merz, Alexander Bedritsky, Gro Harlem Brundtland, Sergei Ordzhonikidze and Buruhani Nyenzi (Director of the Conference)

WCC-3 must provide the impetus to help decision-makers reach a new agreement in Copenhagen. He observed that those most threatened by climate change have done the least to cause the problem, and therefore, developed countries should take the lead in cutting greenhouse gas emissions. Mr Annan suggested that Weather Information for All, a new initiative by the Global Humanitarian Forum, WMO, and the private sector to establish in African countries surface stations communicating by cell phone technology, will help facilitate the sharing of essential data and the provision of threat alerts.

2.1 Expert Segment

After the formal opening of the Conference, Dr Bedritsky invited participants to join in the opening of the Expert Segment. He welcomed the following representatives of WMO international partners who addressed the Conference:

- Walter Erdelen, Assistant Director-General, United Nations Educational, Scientific and Cultural Organization;
- Manzoor Ahmad, Director, Geneva Office, Food and Agriculture Organization of the United Nations;
- Joseph Alcamo, Chief Scientist, United Nations Environment Programme;
- Deliang Chen, Executive Director, International Council for Science;
- Julia Marton-Lefèvre, Director General, International Union for Conservation of Nature;
- Jean-Jacques Dordain, Director General of the European Space Agency;
- Houlin Zhao, Deputy Secretary-General, International Telecommunication Union (ITU);
- Reid Basher, Special Advisor to the United Nations Assistant Secretary-General for Disaster Risk Reduction.

Dr Bedritsky also acknowledged a message of support for the Conference from the World Health Organization (WHO). Thomas Stocker, Co-Chair of Working Group I of the Intergovernmental Panel on Climate Change, set the science scene for the Conference in terms of new approaches and methods that

Opening of the Expert Segment

From left to right: Buruhani Nyenzi, Thomas Stocker, Manzoor Ahmad, Walter Erdelen, John Zillman, Deliang Chen, Michel Jarraud, Alexander Bedritsky, Julia Marton-Lefèvre, Jean-Jacques Dordain, Houlin Zhao, Joseph Alcamo, Reid Basher (speaking)

will be available for use in the IPCC Fifth Assessment Report. These include:

- Improved short-term predictions that will be available to IPCC Working Groups II and III;
- Improved understanding of the several factors that influence sea-level rise;
- Reduced uncertainties on climate impacts;
- Improved understanding of hazards resulting from human-induced climate change.

John Zillman, Chair of the WCC-3 International Organizing Committee, concluded the opening session by elaborating on the Sponsors' Vision for the Conference.

2.2 High-level Segment

At the opening of the High-level Segment on 3 September 2009, the representative of the host country and Co-Chair of the Conference and the High-level Segment, Moritz Leuenberger, Minister of the Environment, Transport, Energy and Communications, Switzerland, underscored the conference goal of developing the Global Framework for Climate Services (GFCS) and called for an entry into a century of climate enlightenment.

United Nations Secretary-General Ban Ki-moon stressed the need for an ambitious, comprehensive and fair agreement in Copenhagen based on sound science, and reminded the participants that only 15 negotiating days remain before the fifteenth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP15). He reported that investment to meet climate targets represents 2 per cent of global Gross Domestic Product (GDP) between now and 2030. The Secretary-General said the answers lie in policies that put a price on carbon, that contemplate global public programs for renewable energy, and that offer creative solutions to protect forests and ecosystems. He called for action in the following areas: adaptation to impacts of climate change with fast-tracked funding for Least Developed Countries and Small Island

Opening of the High-level Segment
From left to right: Rajendra Pachauri, Alexander Bedritsky, Michel Jarraud, Armando E. Guebuza, Moritz Leuenberger, Sergei Ordzhonikidze, Ban Ki-moon (speaking)

Developing States; ambitious mid-term targets by developed countries; action by developing countries to slow emissions growth; predictable financial and technical support; and institutional relationships to address developing country needs.

Ban Ki-moon, Secretary-General, United Nations

Armando E. Guebuza, President of Mozambique

Rajendra Pachauri, IPCC Chair, stressed that climate information and observations need more detail and should be broader in focus. He also highlighted the need for continuous data, as well as the monitoring of climate impacts. Alexander Bedritsky, President of WMO and Chair of the Expert Segment, in presenting the Conference Statement, stressed the need for the establishment of linkages at the local, national and international levels, for continued capacity-building, and for outreach to the public. On the proposal of the host country Co-Chair, the participants adopted the Conference Declaration by acclamation.

Immediately after the formal opening and the adoption of the Declaration, the Conference was addressed by Heads of State and Government. H.E. Armando Emílio Guebuza, President of Mozambique and Co-Chair of the Conference and the High-level Segment, stressed the importance of strengthening early warning systems and improving water management. He urged developed countries to fulfil all relevant international commitments. H.E. Emomali Rakhmon, President of Tajikistan, discussed the impacts of climate change on water resources, particularly in central Asia. He stressed the need for an international effort to save glaciers, and for greater use of hydropower to meet energy needs.

Heads of State and Government with the United Nations Secretary-General and WMO Secretary-General
From left to right: Idi Nadhoim, Vice President of the Comoros; Girma Wolde Giorgis, President of Ethiopia; Prince Albert II of Monaco; Michel Jarraud, Secretary-General of WMO; Moritz Leuenberger, Minister of the Environment, Transport, Energy and Communications, Switzerland; Armando E. Guebuza, President of Mozambique; Ban Ki-moon, Secretary-General of the United Nations; Hui Liangyu, Vice Premier of China; Ali Mohamed Shein, Vice President of the United Republic of Tanzania; Sheikh Hasina, Prime Minister of Bangladesh; Toke Tufukia Talagi, Premier of Niue and Jim Marurai, Prime Minister, Cook Islands

H.S.H. Prince Albert II of Monaco noted that science had made many advances that allow for an expanded knowledge base for Copenhagen. H.E. Girma Wolde Giorgis, President of Ethiopia, noted areas for action, including the establishment of adaptation and mitigation efforts, and the preparation of national action plans. He stressed the need for effective communication of extreme weather events and for capacity-building. H.E. Danilo Türk, President of Slovenia, spoke of the importance of accurate and timely information, and called for user needs to drive the systems for addressing climate change. He noted that strong commitment and cooperation among stakeholders was imperative. H.E. Ali Mohamed Shein, Vice President of the United Republic of Tanzania, noted that the impact of disasters highlights the importance of climate services, and called for increasing the number of meteorological stations, for developing capacity and for creating effective and efficient interaction between providers and users.

H.E. Sheikh Hasina, Prime Minister of Bangladesh, highlighted the advantages that could be brought by enhancing the technological delivery and capacity of climate services, particularly in Least Developed Countries. She said US$ 2 billion is needed for adaptation funds for LDCs over the next five years.

H.E. Hui Liangyu, Vice Premier of China, stressed the need to improve climate service capabilities and systems. Emphasizing a commitment to the United Nations Framework Convention on Climate Change,

From left to right: Emomali Rakhmon, President of Tajikistan; Ayikoe Kossivi, on behalf of the President of Togo and Danilo Türk, President of Slovenia

Antouman Saho, on behalf of the President of The Gambia and Pierre Hele, on behalf of the President of Cameroon

he underscored the principle of "common but differentiated responsibilities". He also said that China will be firmly committed to sustainable development and will work with the international community to look after planet Earth – the common home of all mankind. H.E. Toke Tufukia Talagi, Premier of Niue, highlighted the urgent need for the Pacific Island States, already facing increased sea levels, to obtain adaptation funds. He also expressed concern for the future of Pacific Islanders, as many are dependent on the sea for their livelihoods. H.E. Jim Marurai, Prime Minister, Cook Islands, noted that Small Island Developing States need an urgent commitment to reducing greenhouse gases. He called for the Global Framework for Climate Services to address the vulnerability of SIDS to extreme climate events.

H.E. Antouman Saho, Minister of Fisheries, Water Resources and National Assembly Matters, The Gambia, delivered his statement on behalf of the President of his country. He stressed that adaptation measures to climate variability and change are a right for all people. H.E. Pierre Hele, Minister of Environment and Protection of Nature, Cameroon, on behalf of his President, highlighted Africa's vulnerability to climate change impacts and called for more financing for the support of technological innovations for conservation. Hon. Ayikoe Kossivi, Minister of Environment and Forestry Resources, Togo, on behalf of his President noted the challenges of accessing effective climate observation equipment.

3. THE EXPERT SEGMENT

3.1 Programme

The Expert Segment of WCC-3 consisted of 5 plenary sessions; 12 parallel working sessions; 3 plenary round-table sessions; 4 forums, in parallel with the working sessions; 4 workshops on implementing climate services; and 3 poster sessions. Annex 1 provides the full programme of the Conference. At the end of the Expert Segment on Wednesday, 2 September, the Conference Statement was finalized by the Conference International Organizing

Committee, Session Chairs, Theme leaders and Rapporteurs on the basis of the discussions that came from the various sessions.

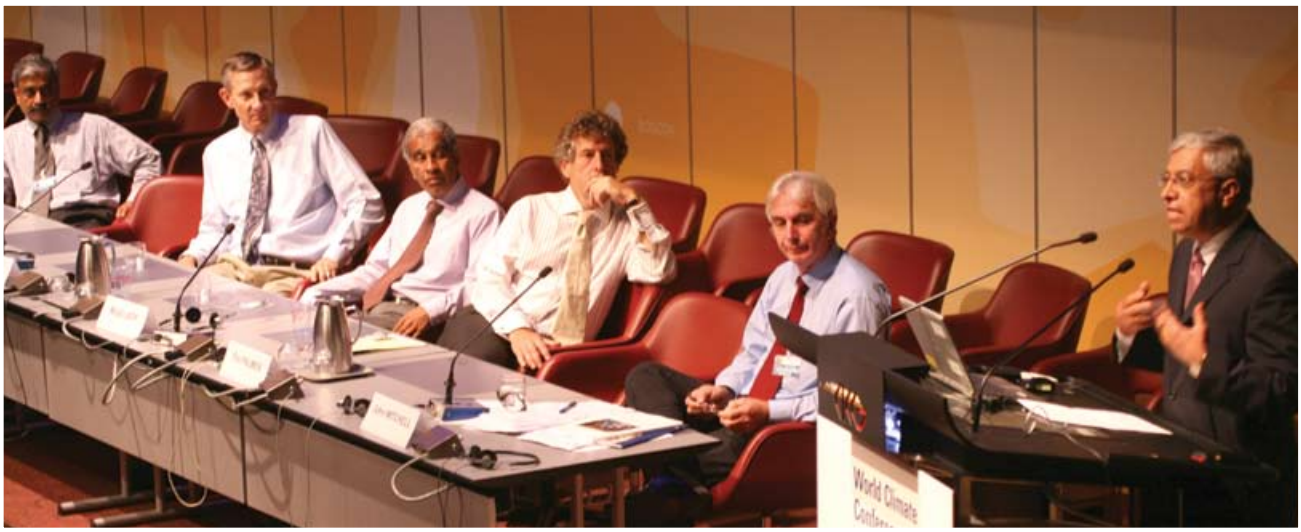
3.2 Outcomes

The outcomes of WCC-3 include a greatly increased understanding of the scientific and practical issues involved in the implementation of improved global, regional and national arrangements for the provision and application of climate services. In addition, WCC-3 generated a shared understanding of a strategy for implementing a new Global Framework for Climate Services that is built on the established international climate observation and research programmes, and that complements and supports the existing climate change assessment and policy mechanisms of the IPCC and the United Nations Framework Convention on Climate Change. The unanimous endorsement of the participants foreshadows vigorous national and international follow-up action on implementation of the GFCS leading to:

- Strengthened national observational networks and information management systems for climate and climate-related variables;
- Enhanced climate modelling and prediction capabilities through strengthened international climate research focused on seasonal-to-decadal timescales;
- Improved national climate service provision arrangements based on improved observation networks, enhanced prediction models and greatly increased user interaction;
- More effective use of global, regional and national climate information and prediction services in all climate-sensitive sectors in all countries;
- Widespread social, economic and environmental benefits through better informed climate risk management and improved capability for adaptation to climate variability and change.

3.3 Conference Statement

Peoples around the world are facing multi-faceted challenges of climate variability and climate change, challenges that require wise and well-informed decision-making at every level, from households



Plenary session 3: Advancing climate prediction science
From left to right: Arun Kumar, Jerry Meehl, Mojib Latif, Tim Palmer, John Mitchell, Ghassem Asrar (speaking)

and communities to countries and regions, and to international forums such as the United Nations Framework Convention on Climate Change. Wise and well-informed decision-making, in turn, will require, directly or indirectly, access to the best possible climate science and information, together with the effective application of the information through climate services.

The first two World Climate Conferences, in 1979 and 1990, laid the foundation for building research and observational activities to understand the nature of the climate challenges, and to provide the scientific bases for developing the comprehensive and sound climate services that are now being sought by all countries and in virtually every sector of society. The World Meteorological Organization and its partners convened World Climate Conference-3 to provide nations with the opportunity to consider together an appropriate global framework for climate services over the coming decades, a framework that would help ensure that every country and every climate-sensitive sector of society is well equipped to access and apply the growing array of climate prediction and information services made possible by recent and emerging developments in international climate science and technology.

The purpose of the Expert Segment of WCC-3 was to engage a wide cross-section of climate scientists, expert providers of climate information and the users of climate information and services in a wide-ranging discussion on the essential elements of a new Global Framework for Climate Services for consideration by the High-level Segment of the Conference.

The 200 speakers and 1 800 participants in the Expert Segment reviewed the various challenges facing the climate service provider and user communities; considered the needs and capabilities for applying climate information in key climate-sensitive sectors, as well as for social and economic benefits; and examined the scientific bases for climate information and prediction services. A number of scientific, environmental and socio-economic groups and organizations informed the Expert Segment of their needs and perspectives, and a wide range of countries and climate-sensitive sectors reported on their experiences in the implementation of climate services. On the basis of these deliberations, the Expert Segment concluded that:

- Great scientific progress has been made over the past 30 years, especially through the World Climate Programme and its associated activities, which already provide a firm basis for the delivery of a wide range of climate services; but that

- Present capabilities to provide effective climate services fall far short of meeting present and future needs and of delivering the full potential benefits, particularly in developing countries;

- The most urgent need is for much closer partnerships between the providers and users of climate services;

- Major new and strengthened research efforts are required to increase the time range and skill of climate prediction through new research and modelling initiatives; to improve the observational basis for climate prediction and services; and to improve the availability and quality control of climate data.

The Expert Segment then called for major strengthening and implementing, as appropriate, of the following essential elements of a global framework for climate services:

- The Global Climate Observing System and all its components and associated activities; and provision of free and unrestricted exchange and access to climate data;

- The World Climate Research Programme, underpinned by adequate computing resources and increased interaction with other global climate relevant research initiatives;

- Climate services information systems taking advantage of enhanced existing national and international climate service arrangements in the delivery of products, including sector-oriented information to support adaptation activities;

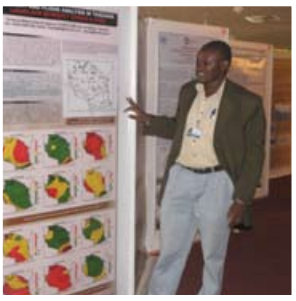
- Climate user interface mechanisms that are focused on building linkages and integrating information, at all levels, between the providers and users of climate services, and that are aimed at the development and efficient use of climate information products including the support of adaptation activities;

- Efficient and enduring capacity-building through education, training, and strengthened outreach and communication.

The Expert Segment concluded by supporting the development of the proposed Global Framework for Climate Services. The WCC-3 Sponsoring Agencies agreed, therefore, that the essential findings of the Expert Segment, as summarized in this Statement, should be transmitted to the High-level Segment of the Conference for the information of delegates and other Conference participants; and be referred to their individual and joint executive and coordination bodies for follow-up action, in particular, in the context of the United Nations Chief Executives Board initiative on the United Nations system "Delivering as One on Climate Knowledge".

Annex 5 presents the complete Conference Statement, including its detailed recommendations.

Poster participant: Raphael Jos



Poster participant: Ladislaus Chang'a

4. THE HIGH-LEVEL SEGMENT

The Secretary-General of the United Nations officially opened the High-level Segment. The Chair of the Expert Segment gave a brief report and the Co-Chair of the High-level Segment introduced the draft Conference Declaration, which was adopted by acclamation. This was followed by further addresses from Heads of State and Government, agency heads, ministers and senior representatives of end-user communities (see section 2.2).

4.1 Addresses by major Conference sponsors

H.E. Jane Lubchenco, Under Secretary of Commerce for Oceans and Atmosphere, United States of America, noted that improving the development and delivery of climate services offers benefits to society in such areas as health, economic development and food security. Hon. Åsa-Britt Karlsson, State Secretary, Ministry of the Environment, Sweden, on behalf of the European Union, welcomed the adoption of the Global Framework for Climate Services and highlighted the need for the provision of information to be driven by user needs, a strategy requiring coordination among agencies. Hon. Håkon Gulbrandsen, State Secretary for International Development, Norway, noted that efforts to address climate change should take a multi-sectoral approach. Hon. Gernot Erler, Minister of State at the Federal Foreign Office, Germany, stressed the need for a consensus on goals, and noted the potential for a follow-up conference in Germany.

Hon. Paavo Väyrynen, Minister for Foreign Trade and Development, Finland, underscored the need for climate services to enable long-term development and natural disaster preparation, and highlighted Finland's responsibility for sharing climate service knowledge. Roberto Menia, Under Secretary of State, Ministry of Environment, Italy, called for maintaining momentum to make the GFCS operational as soon as possible. Kunio Sakurai, Director-General, Japan Meteorological Agency, noted that the GFCS will promote the application of countermeasures against adverse climate events.

H.E. Teresa Ribera Rodríguez, Secretary of State for Climate Change, Spain, called attention to the link between addressing climate change and reaching the Millennium Development Goals and stressed that a Copenhagen agreement should be effective, equitable and flexible. Shailesh Nayak, Deputy Minister, Science and Technology and Earth Sciences, India, noted that his country had taken steps to improve its surface climate observation network. Brian T. Gray, Assistant Deputy Minister, Science and Technology, Environment Canada, stressed the importance of building stronger international linkages between the providers and users of climate information. Hon. Ishfaq Ahmad, Adviser, Minister of State, Pakistan,

From left to right: Jane Lubchenco, United States of America; Åsa-Britt Karlsson, Sweden; Gernot Erler, Germany; Paavo Väyrynen, Finland and Roberto Menia, Italy

From left to right: Kunio Sakurai, Japan; John Njoroge Michuki, Kenya; Alexander Bedritsky, Russian Federation; Ishfaq Ahmad, Pakistan and Peter Gooderham, UK

From left to right: Brian T. Gray, Canada; J.M. Silva Rodríguez, European Commission; Teresa Ribera Rodríguez, Spain; Stavros Kalogiannis, Greece and Shailesh Nayak, India

From left to right: Jean-Baptiste Mattéi, France and Håkon Gulbrandsen, Norway

said there was an urgent need to address the lack of climate information in the region. Gary Foley, the Permanent Representative of Australia with WMO, suggested that the objective of an effective climate service should be to ensure that the correct information reaches the correct users for effective decision-making.

Hon. John Njoroge Michuki, Minister for Environment and Mineral Resources, Kenya, called upon the international community to support global atmospheric weather stations, early warning systems, programs for enhancing forest cover, and development of national climate change strategies in developing countries. H.E. Jean-Baptiste Mattéi, Ambassador of France to the United Nations Office at Geneva, stressed the need of financing for national adaptation strategies and for observation and monitoring. He also stressed the key role WMO and NMHSs play in addressing the main components of the Framework. Alexander Bedritsky, Head of Roshydromet, Russian Federation, highlighted that the GFCS will act as the basis for specifying opportunities and risks for political decisions. H.E. Peter Gooderham, Ambassador of the United Kingdom of Great Britain and Northern Ireland to the United Nations Office at Geneva, noted that engagement between the users and providers of climate information would lead to the availability of new products. Ioannis Ziomas, Secretary General for International Economic Relations and Development Cooperation, Greece, suggested that adoption of sectoral targets could be a realistic short-term approach for Annex I countries under the UNFCCC, and stressed the need to strengthen financing and technology transfer for mitigation and adaptation.

4.2 Addresses by ministers

Several ministers spoke of the upcoming fifteenth session of the Conference of the Parties to the United Nations Climate Change Convention to be held in Copenhagen in December 2009. Hon. Humberto Rosa, Secretary of State for the Environment, Portugal, stressed the need for long-term adaptation financing and for accurate meteorological data as outcomes of COP15. Hon. Paul Magnette, Minister for Climate and Energy, Belgium, underscored that an agreement in Copenhagen should not be perceived as a burden or constraint but as an opportunity. H.E. Robert Persaud, Minister of Agriculture, Guyana, called for holistic approaches that strengthen climate services, increase adaptation, protect ecosystems and realize economic development, while providing incentives to avoid deforestation. Tumusiime Rhoda Peace, Commissioner, African Union, underscored the vulnerability of Africa and called attention to the decision that Africa would speak with one voice at COP15.

Robert Persaud, Guyana

Tumusiime Rhoda Peace, African Union

Heherson Alvarez, Secretary of Global Warming and Climate Change, Philippines, noted that adaptation will only be feasible if there is an agreement on mitigation. Hon. Mahinda Samarasinghe, Secretary of State for the Environment, Sri Lanka, suggested that the multi-stakeholder approach of the Global Framework for Climate Services will encourage a wide range of inputs that improve eventual outcomes. Jan Dusík, First Deputy Minister of the Environment, Czech Republic, spoke about the phased approach to establishing an adaptation framework adopted by the European Union in 2009. Hon. John Odey, Minister of Environment, Nigeria, stressed the need to mainstream climate change considerations into development policies, to increase climate data observations in Africa and to strengthen centres of excellence. Hon. Kawkab Al Sabah Daya, Minister of State for Environmental Affairs, Syrian Arab Republic, called for sustainable development, but stressed that developing countries cannot be asked to sacrifice their growth for the environment.

Hon. Carlos Costa Posada, Minister of Environment, Housing and Territorial Development, Colombia, called for more cost-effective measures to respond to climate change. Hon. Narmin Barzingy, Minister of Environment, Iraq, described plans to establish a national meteorological service and identified the need for financial and technical support. Maria Evarista De Sousa, Minister of Agriculture and Rural Development, Guinea-Bissau, called for strategic sustainable development policies that are based on low environmental impact and on the use of appropriate technology. Hon. Tibor Faragó, State Secretary, Hungary, noted that public awareness and the will to combat climate change have become global. H.E. Maria Nazareth Farani Azevêdo, Ambassador of Brazil to the United Nations Office at Geneva, said her country was prepared to engage in efforts at the local, national and international levels to improve climate information. H.E. Dian Triansyah Djani, Ambassador of Indonesia to the United Nations Office at Geneva, stressed that concerted efforts were needed to address long-term adaptation programs for coastal areas.

Heherson Alvarez, Philippines

Carlos Costa Posada, Colombia

El-Hadj Mamady Kaba, Minister of Transport, Guinea, called attention to the adverse impacts of climate change on African agriculture. Hon. Nicolae Nemirschi, Minister of Environment, Romania, emphasized the importance of the Global Framework for Climate Services in bridging the gaps among scientists, users, and policymakers. Hon. Khamis Bin Mubarak Bin Isa Al-Alawi, Minister of Transport and Communications, Oman, noted that the GFCS should boost current efforts, capabilities and research for combating climate change. Hon. Nicholas T. Goche, Minister of Transport, Communications and Infrastructural Development, Zimbabwe, spoke of the need to shore up efforts to bridge the information and awareness gaps that exist between the users and providers of climate information. Tan Yong Soon, Permanent Secretary, Ministry of the Environment and Water Resources, Singapore, stressed that the GFCS will aid countries to build up their knowledge bases and to enable more informed decisions and policies.

Gilbert Noël Ouédraogo, Burkina Faso

Catherine Namugala, Zambia

Hon. Catherine Namugala, Minister of Tourism, Environment and Natural Resources, Zambia, told the Conference that in Africa timely climate information can be the difference between life and death. Rahma Salih Elobied, Ambassador of Sudan to the United Nations Office at Geneva, presented mechanisms to enhance African and Arab coordination on climate change research and action. Eldana Sadvakassova, Vice-Minister for Environment Protection, Kazakhstan, underscored the importance of coordination and the utility of a road map for climate services. Siniša Stanković, Deputy Minister for Spatial Planning and Environment, Montenegro, expressed support for the GFCS and a readiness to offer concrete contributions to abating negative consequences of climate change. Hon. Nikola Ruzinski, State Secretary, Croatia, highlighted the principle of common but differentiated responsibility and action based on respective capabilities.

Hon. Lyonpo Pema Gyamtsho, Minister for Agriculture, Bhutan, questioned his country's capacity to adapt to climate impacts without assistance.

Hon. Jessica Eriyo, Minister of State for the Environment, Uganda, pointed out that a lack of climate data has led to greater uncertainty on climate forecasts for developing countries than for the rest of the world. Khomoatsana Tau, Ministry of Natural Resources, Lesotho, spoke of the limited ability to adapt to climate change without outside aid. Hon. Rashed Ahmed Ben Fahd, Minister of Environment and Water, United Arab Emirates, noted the cross-sectoral risks from climate change and adverse climate events. Hon. Nadhir Hamada, Minister of Environment and Sustainable Development, Tunisia, stressed that global initiatives undertaken for adaptation to climate change should place particular emphasis on developing countries. Sharifah Zarah Syed Ahmad, Deputy Secretary-General, Ministry of Science, Technology and Innovation, Malaysia, reported that Malaysia has mainstreamed climate information into their sectoral planning.

Lyonpo Pema Gyamtsho, Bhutan

Jessica Eriyo, Uganda

Hon. Gilbert Noël Ouédraogo, Minister of Transport, Burkina Faso, underscored the importance of information and noted that African countries have taken steps to emphasize this in their policies. Mustapha Geanah, Secretary-General, Ministry of Energy, Mining, Water and Environment, Morocco, stressed the importance of national strategies for climate change and water and called for mechanisms for national meteorological services to be integrated into regional and international efforts. Gideon Quarcoo, Deputy Minister of Communications, Ghana, reminded the Conference that addressing climate change requires global cooperation. Thomas Becker, Deputy Permanent Secretary, Ministry of the Environment, Denmark, said his country is eager to see the task force of the GFCS begin its work. Frits Brouwer, Permanent Representative of the Netherlands with WMO, advocated for international cooperation on information for policymaking and underscored the need for global climate monitoring. Julián Baez Benitez, Permanent Representative of Paraguay with WMO, called for cooperation to improve data-handling and for services to achieve the goal of better climate prediction for users. H.E. Selma Ashipala-Musavyi, Ambassador of Namibia to the United Nations Office at Vienna, stressed that the gender dimension of the impacts of climate change should not be overlooked.

Emile Ouosso, Congo

Tiémoko Sangare, Mali

J.M. Silva Rodríguez, Director-General of Research, European Commission, suggested that the common understanding of the impacts of climate change needs to be improved significantly. Hon. Lormus Bundhoo, Minister of Environment and National Development, Mauritius, informed the Conference that the impacts of climate change are already evident in his country, and he advocated for the consolidation of Regional Climate Outlook Forums, particularly in Southern Africa. Hon. Emile Ouosso, Minister of Transport and Civil Aviation, Congo, underscored the role of forests in climate change, and said that ensuring the preservation of the Congo Basin forest would require funding of US$ 25 billion. Hon. Tiémoko Sangare, Minister of Environment and Sanitation, Mali, emphasized the role for technology transfer in the implementation of climate strategies. Jean Marie Claude Germain, Minister of Environment, Haiti, reminded the Conference that his country was hit

by four tropical cyclones in 2008, and stressed that the financial crisis is affecting the capability of countries to respond to mounting climate impacts. Hon. Antoine Karam, Minister of Environment, Lebanon, noted that climate change affects all, and that there is a need for all to make an exceptional effort in the medium term. H.E. Glaudine Mtshali, Ambassador of South Africa to the United Nations Office at Geneva, noted that many developing country policies aim to deliver basic services, but that these efforts are being persistently undermined by the short-, medium- and long-term impacts of climate change.

H.E. Maged George Elias Ghatas, Minister of State for Environmental Affairs, Egypt, discussed regional vulnerabilities and offered to host a regional climate centre. Ali Mohammad Noorian, Vice-Minister of Roads and Transportation, Islamic Republic of Iran, called on the Global Framework for Climate Services to apply predictions to the management of climate-related risk, and to take account of the benefits resulting from financial and technical support. Hon. Nantsagiin Batsuuri, State Secretary of Nature, Environment and Tourism, Mongolia, reported on efforts to coordinate high-level climate-change meetings of East Asian nations. Nguyen Van Duc, First Vice-Minister of Natural Resources and Environment, Viet Nam, highlighted the role of cooperation in creating a successful GFCS. H.E. Idriss Jazaïry, Ambassador of Algeria to the United Nations Office at Geneva, pointed out that the implementation of the GFCS will enhance the level of regional climate modelling, and appealed for sufficient funding for the programme.

4.3 Addresses by heads and senior representatives of international organizations

Michel Jarraud, Secretary-General of WMO, discussed the importance of providing decision-makers with the climate tools they require to make decisions for effective action against climate change. Koïchiro Matsuura, Director-General of UNESCO, stressed that a key outcome of a Global Framework

From left to right: Michel Jarraud, Secretary-General, WMO; Koïchiro Matsuura, Director-General, UNESCO; Achim Steiner, Executive Director, UNEP; and Alexander Müller, Assistant Director-General, FAO

From left to right: Catherine Bréchignac, President and Director-General, ICSU; Margaret Chan, Director-General, WHO; Helen Clark, Administrator, UNDP; and Otaviano Canuto, Vice President, World Bank

for Climate Services should be the dissemination of climate information to enable effective action against climate change, and emphasized the importance of capacity-building.

Achim Steiner, Executive Director of UNEP, highlighted the role of science in informing management and decision-making. Alexander Müller, Assistant Director-General of FAO, called attention to the significant mitigation options offered by agriculture and to the benefits agriculture can receive from enhanced climate services. Catherine Bréchignac, President of ICSU, emphasized the need for North-South cooperation in establishing the GFCS.

Margaret Chan, Director-General of WHO, stressed the adverse health effects that climate change will have on humans, particularly those in marginalized communities. Helen Clark, Administrator of the United Nations Development Programme (UNDP), said UNDP believes that it is necessary to bring climate challenges into the heart of development strategies.

Otaviano Canuto, Vice President of the World Bank, noted that investment in knowledge improvement is most important as it greatly reduces uncertainties in climate prediction. Efthimios Mitropoulos, Secretary-General of the International Maritime Organization, suggested that the melting of polar ice caps is both an advantage in terms of increased tourism, transport and trade, and a disadvantage because the increased sea levels may adversely affect vital shipping lines. Francis Gurry, Director General of the World Intellectual Property Organization (WIPO), stressed that resolving intellectual property issues is a part of the solution for addressing climate change, not a part of the problem.

Hamadoun Touré, Secretary-General of ITU, argued that his organization's work on digital broadcasting and next-generation networks would aid the fight against climate change through reduced power consumption and increased efficiency. Yasemin Aysan, Under Secretary-General of the International Federation of Red Cross and Red Crescent Societies, noted that

From left to right: Margareta Wahlström, Special Representative of the Secretary-General of the United Nations, ISDR; Francis Gurry, Director General, WIPO; Efthimios Mitropoulos, Secretary-General, IMO; and Hamadoun Touré, Secretary-General, ITU

From left to right: Yasemin Aysan, Under Secretary-General, IFRC; Taleb Rifai, Secretary-General, UNWTO; Ján Kubiš, Executive Secretary, UNECE; and Harsha V. Singh, Deputy Director-General, WTO

preparedness for hazardous climate events results from helping communities to understand the problem, to trust the information provided and to know how best to react. Taleb Rifai, Secretary-General, United Nations World Tourism Organization, challenged the tourism sector to acknowledge its contribution to climate change. Ján Kubiš, Executive Secretary, United Nations Economic Commission for Europe (UNECE), informed the Conference that in assisting the establishment of the Global Framework for Climate Services, UNECE has legal instruments that can contribute to the timely access to information. Harsha V. Singh, Deputy Director-General of the World Trade Organization, underscored the importance of multilateral cooperation in combating climate change.

Anada Tiéga, Secretary General, Ramsar Convention, said that a better understanding of wetlands will contribute to climate prediction and modelling activities. Ahmed Djoghlaf, Executive Secretary, United Nations Convention on Biological Diversity, called for a greater understanding of the interaction of climate change and biodiversity loss. Grégoire de Kalbermatten, Deputy Executive Secretary, United Nations Convention to Combat Desertification (UNCCD), noted that UNCCD will contribute to GFCS through their thematic programme at the regional level, and by establishing desertification monitoring centres.

Grégoire de Kalbermatten, UNCCD

Roberto Acosta, UNFCCC

Laurent Corbier, World Business Council for Sustainable Development, called for an agreement at COP15 so that business has a clear framework

Some senior representatives of international organizations at WCC-3

From left to right: Jerry Lengoasa, Assistant Secretary-General, WMO; Jan Egeland, Director, Norwegian Institute of International Affairs; Efthimios Mitropoulos, Secretary-General, IMO; Hamadoun Touré, Secretary-General, ITU; Michel Jarraud, Secretary-General, WMO; Sergei Ordzhonikidze, Director-General, UNOG; Taleb Rifai, Secretary-General, UNWTO; and Hong Yan, Deputy Secretary-General, WMO

within which to make investment decisions. George Deikun, Senior Advisor, United Nations Human Settlements Programme (UN–HABITAT), noted the importance of recognizing that cities and urban residents are not only victims of, but also contributors to, climate change, and that cities should contribute to the solution as well. Roberto Acosta, Coordinator, Adaptation, Technology and Science Programme, UNFCCC, suggested that the GFCS can further develop climate models and predictions especially at the regional level. Gonzalo Pereira, Secretary General of the Permanent Commission for the South Pacific, reported on his organization's programme on the study of El Niño. René Dändliker, Representative, Council of Academies of Engineering and Technological Sciences, advocated for free exchange of climate data and information.

4.4 Outcome

The High-level Segment culminated with the adoption by acclamation of the Conference Declaration establishing the Global Framework for Climate Services. The complete Conference Declaration appears opposite the Executive Summary at the beginning of this report.

5. CLOSING OF THE CONFERENCE

Hon. Maciej Nowicki, Minister of Environment, Poland, and current President of COP14, highlighted the scientific contributions of the Conference and the importance of the Global Framework for Climate Services as a tool for connecting user groups to science. He called for delegates to do all they can to reach an effective agreement in Copenhagen. Marie-Louise Overvad, Ambassador of Denmark to the United Nations Office at Geneva, underscored the role of the GFCS in providing tools to empower people to assess vulnerability, to understand risk and to make well-informed decisions. She called for global leadership to realize an ambitious climate agreement. John Zillman, Chair of the WCC-3 International Organizing Committee, recalled that

Closing of the Conference

From left to right in the front: Alexander Bedritsky, Michel Jarraud, Armando E. Guebuza, Moritz Leuenberger, Maciej Nowicki (vignette), Marie-Louise Overvad and Buruhani Nyenzi

the Conference was organized to bring about a paradigm shift towards delivering user-oriented climate information and services. He welcomed the strong support from governments and international organizations for the proposed GFCS.

Michel Jarraud, Secretary-General of WMO, stressed that the declaration adopted at the Conference was concise and offered a clear path forward for establishing the Global Framework for Climate Services. He noted that the tools and services to be provided by the GFCS were cross-sectoral and would contribute to the achievement of the Millennium Development Goals.

H.E. Moritz Leuenberger, Minister of the Environment, Transport, Energy and Communications, Switzerland, noted that the Conference Declaration allowed for a structure that will enhance the ability to provide information to meet current needs. H.E. Armando Emílio Guebuza, President of Mozambique and Co-Chair of the Conference and the High-level Segment, noted that the GFCS demonstrates a commitment to address climate change and capacity-building in developing countries, contributes to the international commitment to reach the Millennium Development Goals, and establishes a foundation for a Copenhagen agreement.

6. ACKNOWLEDGEMENTS

The success of World Climate Conference-3 is directly attributable to the many individuals and organizations dedicated to advancing science-based climate prediction and services, and the WCC-3 co-sponsors gratefully acknowledge their contributions.

The high profile enjoyed by the Conference reflects the stature of the participants, and the co-sponsors deeply appreciate the overwhelming response and interest of the experts, user community representatives and policymakers who participated in WCC-3.

World Climate Conference-3 was more than 10 years in the making, and the Conference co-sponsors recognize the early contributions of the members of the provisional organizing committee. Through their constructive engagement and clear understanding of the climate challenges to society, they formulated the concept for WCC-3, and earned the approval of the WMO Congress for the organization of the Conference.

The dedication and commitment of purpose by the WCC-3 International Organizing Committee contributed immensely to the success of the Conference. Through the leadership, first of Don MacIver, and then of John Zillman, the committee did a wonderful job that led to the realization of one of the biggest events in the history of WMO. The persons responsible for each session also played important roles in coordinating the various experts involved in the development of white papers, and in representing the views of the sessions.

The generous financial contributions from governments and institutions to the WCC-3 Trust Fund were essential. These contributions also enabled experts from developing and Least Developed Countries to attend the Conference and to contribute to the discussions. The sponsors, the members of the WCC-3 International Organizing Committee and the session experts are listed in the Annexes.

The WCC-3 Secretariat

From left to right: William Nyakwada, Andreas Obrecht, Alessia Solari, Corinna Schermer, Buruhani Nyenzi, Narissa Carandang, Aeree Baik and Lisa Muñoz

Annexes

Annex 1 Programme of the World Climate Conference-3

Expert Segment programme

<table>
<tr><th></th><th>Monday, 31 August</th><th colspan="4">Tuesday, 1 September</th></tr>
<tr><td>9:00–10:30</td><td rowspan="2">Opening of the Conference</td><td colspan="4">Economic and social benefits of climate information</td></tr>
<tr><td rowspan="2">10:30–12:00</td><td colspan="4" rowspan="2">Advancing climate prediction science</td></tr>
<tr><td>Vision for the Conference</td></tr>
<tr><td></td><td>The shared challenge</td><td colspan="4"></td></tr>
<tr><td></td><td>Break</td><td colspan="3">Break</td><td></td></tr>
<tr><td rowspan="2">13:30–15:00</td><td rowspan="2">The shared challenge (continued)</td><td colspan="3">Working sessions</td><td>Forum</td></tr>
<tr><td>Climate and human health</td><td>Climate and sustainable energy</td><td>Seasonal-to-interannual climate variability</td><td>Gender and climate</td></tr>
<tr><td></td><td>Break</td><td colspan="4">Break</td></tr>
<tr><td rowspan="2">15:30–17:00</td><td rowspan="2">Round-table discussion
Climate risk management</td><td colspan="3">Working sessions</td><td>Forum</td></tr>
<tr><td>Climate and water</td><td>Climate, transportation and tourism</td><td>Climate observations</td><td>Climate and communities</td></tr>
<tr><td>17:00–19:00</td><td>Poster session</td><td colspan="2">Poster session</td><td colspan="2">Round-table discussion
Climate adaptation and the Copenhagen process</td></tr>
<tr><td>19:00–end</td><td>Reception</td><td colspan="4"></td></tr>
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Opening and closing sessions	Formal addresses and elaboration of the vision and objectives for the Conference; adoption of the Conference Declaration
Plenary sessions	Introduce the challenges and opportunities for various economic sectors and society at large to use climate predictions and information to adapt their activities to climate variability and change and manage the associated risks.
Working sessions (user focus)	Consist of two presentations: one on climate service needs and one on capabilities within the identified applications areas.
Working sessions (scientific focus)	Focus on needs and capabilities in specific scientific rather than application areas.

	Wednesday, 2 September				
	Climate extremes, warning systems and disaster risk reduction				
	Mainstreaming climate information				
	Break				
Implementing climate services	**Working sessions**			**Forum**	**Implementing climate services**
From observations to predictions	Climate and biodiversity and natural resource management	Climate and more sustainable cities	Decadal climate variability	Business and industry	Nations and regions
	Break				
Implementing climate services	**Working sessions**			**Forum**	**Implementing climate services**
Research engagement	Climate and food security	Climate of oceans and coasts	Regional climate information for risk management	Capacity-building, education and training	Nations and regions
	Poster session	**Round-table discussion** Communicating climate information			

	Forums	Provide an opportunity for individuals, groups and institutions, who may be outside the specific scientific and user communities organizing WCC-3, to enrich the Conference outcomes.
	Workshop on Implementing climate services	Focuses on the demonstration of the best practices in delivery and application of climate services.
	Round-table discussions	Focus on the processes and issues in the application and communication of climate information and services.
	Poster sessions	Organized to communicate scientific findings and other climate information to Conference participants. Posters are invited from interested university scientists and graduate students, scientists at government agencies and research laboratories and from other interested individuals or groups (e.g. non-governmental organizations).

High-level Segment programme

Thursday, 3 September	Friday, 4 September
09:00–10:00 **Opening**	09:00–11:30 **High-level addresses and national statements**
10:00–10:15 **Conclusions from Expert Segment** (by the Chair of the Expert Segment)	
10:15–10:30 **Introduction of draft Declaration** (by the Chair of the High-level Segment)	
10:30–12:00 **High-level addresses** Heads of State and/or Government	11:30–12:00 Break
12:00–12:30 **Addresses by end-user representatives**	12:00–13:00 **Conference Declaration and closing addresses**
12:30–13:00 Group photo	
13:00–15:00 Break	
15:00–18:00 **High-level addresses and national statements**	
Concert	

Annex 2 Sponsors and budget

1. Sponsors

The major financial sponsors of the Conference were Australia, Canada, China, the European Commission, Finland, France, Germany, India, Japan, Kenya, Norway, the Russian Federation, Saudi Arabia, Spain, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.

The other financial sponsors were Denmark, the Food and Agriculture Organization of the United Nations (FAO), Greece, Ireland, Italy, Namibia, Pakistan, the United Nations Environment Programme (UNEP) and the European Space Agency (ESA).

2. Contributions

Voluntary contributions to WCC-3
as of 9 October 2009
Amounts in Swiss francs (see table)

In addition to these financial contributions, WCC-3 also received in-kind contributions, including the following:

- The announcement of the first Conference was printed by Canada;
- The United States seconded Alan Thomas as a part-time expert to the WCC-3 Secretariat;
- Switzerland supported the office of the Chair of the High-level Subcommittee and seconded Andreas Obrecht as an expert to the WCC-3 Secretariat;
- Germany supported the office of the Chair of the Programme Subcommittee;
- Several other countries and international organizations supported the participation of their representatives to the WCC-3 International Organizing Committee meetings.

	Source	Pledge
1	Australia	100 000
2	Canada	158 128
3	China	104 800
4	Denmark	50 000
5	European Commission	485 758
6	FAO	22 980
7	Finland	116 565
8	France	100 000
9	Germany	243 779
10	Greece	45 738
11	India	100 000
12	Ireland	31 451
13	Italy	50 000
14	Italy (ESA-ESRIN)	30 674
15	Japan	660 364
16	Kenya	76 032
17	Namibia	10 000
18	Norway	100 000
19	Pakistan	1 108
20	Russian Federation	97 275
21	Saudi Arabia	100 000
22	Spain	149 642
23	Switzerland	1 400 000
24	United Kingdom	94 967
25	UNEP	10 890
26	United States	527 500
	Total	**4 867 651**

Annex 3 WCC-3 International Organizing Committee (WIOC)

Executive Committee

J. Zillman, Chair (Australia)
D. MacIver, Former Chair (Canada)
B. Nyenzi, Secretary (WMO)
M. Visbeck, Chair, Programme Subcommittee (Germany)
J. Romero, Chair, High-level Subcommittee (Switzerland)
M. Williams, Chair, Linkages and Interactions
Subcommittee (Group on Earth Observations)
M. Power, Chair, Resources Mobilization
Subcommittee (WMO)
M. Coughlan (Australia)
A.D. Moura (Brazil)

Other members

S. Wang (China)
P. Aakjaer (Denmark)
E. Lipiatou (European Commission)
S.B. Harijono (Indonesia)
A.M. Noorian (Islamic Republic of Iran)
K. Takano (Japan)
V. Kattsov (Russian Federation)
I. Niang (Senegal)
W. Nyakwada (Kenya)
L. Kajfez-Bogataj (Slovenia)
J. Mitchell (United Kingdom)
C. Koblinsky (United States of America)

Representatives of WMO technical commissions and co-sponsored scientific panels and committees

L.S. Rathore (WMO Commission for Agricultural Meteorology)
P. Bessemoulin (WMO Commission for Climatology)
C. Pearson (WMO Commission for Hydrology)
R. Pachauri (WMO/UNEP Intergovernmental Panel on Climate Change)
V. Ramaswamy (WMO/IOC/ICSU World Climate Research Programme)
S. Rösner (WMO/IOC/UNEP/ICSU Global Climate Observing System)

Partner organizations represented on WIOC

African Centre of Meteorological Applications for Development (ACMAD)
Food and Agriculture Organization of the United Nations (FAO)
International Chamber of Commerce (ICC)
International Council for Science (ICSU)
International Federation of Red Cross and Red Crescent Societies (IFRC)
Intergovernmental Oceanographic Commission (IOC) of UNESCO
International Civil Aviation Organization (ICAO)
International Maritime Organization (IMO)
International Research Institute for Climate and Society (IRI)
International Fund for Agricultural Development (IFAD)
International Strategy for Disaster Reduction (ISDR)
International Union for Conservation of Nature (IUCN)
United Nations Convention on Biological Diversity (UNCBD)
United Nations Convention to Combat Desertification (UNCCD)
United Nations Department of Economic and Social Affairs (UN-DESA)
United Nations Development Programme (UNDP)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
United Nations Environment Programme (UNEP)
United Nations Framework Convention on Climate Change (UNFCCC)
United Nations Industrial Development Organization (UNIDO)
United Nations Human Settlements Programme (UN–HABITAT)
United Nations World Tourism Organization (UNWTO)
Universal Postal Union (UPU)
World Bank
World Business Council for Sustainable Development (WBCSD)
World Food Programme (WFP)
World Health Organization (WHO)

Annex 4 Lists of the Expert Sessions and High-level Sessions

1. List of Expert Sessions

Many experts played different roles in the preparation of the Conference and the Expert Segment sessions. The following list shows the various sessions and experts that served them.

Plenary sessions

PS-1: The shared challenge – meeting user needs

Responsible Person	Martin VISBECK
Session Chair	Martin VISBECK
Speaker	Carlo SCARAMELLA
Speaker	Letitia OBENG
Speaker	Peter HÖPPE
Speaker	Guy BRASSEUR
Speaker	Shere ABBOTT

PS-2: Economic and social benefits of climate information

Responsible Person	Rick ROSEN
Session Chair	Gordon MCBEAN
Speaker	Don GUNASEKERA
Speaker	Holger MEINKE
Speaker	Matthias RUTH
Discussant	Mohammed Sadeck BOULAHYA
Discussant	Vladimir TSIRKUNOV
Discussant	Akimasa SUMI

PS-3: Advancing climate prediction science

Responsible Person	John MITCHELL
Session Chair	John MITCHELL
Speaker	Tim PALMER
Speaker	Mojib LATIF
Speaker	Jerry MEEHL
Discussant	B.N. GOSWAMI
Discussant	Arun KUMAR

PS-4: Climate extremes, warning systems and disaster risk reduction

Responsible Person	Maryam GOLNARAGHI
Session Chair	Margareta WAHLSTRÖM
Speaker	Paulo ZUCULA
Speaker	Hasan MAHMUD
Speaker	Maxx DILLEY
Speaker	Madeleen HELMER
Speaker	Ulrich HESS
Discussant	Maryam GOLNARAGHI
Discussant	Walter BAETHGEN
Discussant	Lianchun SONG

PS-5: Mainstreaming climate information

Responsible Person	Elisabeth LIPIATOU
Responsible Person	Lars MÜLLER
Session Chair	Martin PARRY
Speaker	Thomas E. DOWNING
Speaker	Laban OGALLO
Discussant	Amadou GAYE
Discussant	Anand PATWARDHAN
Discussant	Tara SHINE
Discussant	Jürgen LEFEVERE

Working sessions

WS-1: Climate and human health

Responsible Person	Steve ZEBIAK
Organizer	Madeleine THOMSON
Session Chair	Roberto BERTOLLINI
Theme Leader	Madeleine THOMSON
Speaker (Needs)	Judy OMUMBO
Speaker (Capability)	David ROGERS
Discussant	Samson KATIKITI
Discussant	Glenn MCGREGOR
Discussant	Giampiero RENZONI
British council global changemaker	Ellie HOPKINS

WS-2: Climate and sustainable energy

Responsible Person	Antonio MOURA
Session Chair	Lucka KAJFEZ BOGATAJ
Speaker	Ivan VERA
Speaker	Christopher OLUDHE
Discussant	Dolf GIELEN
Discussant	A.A. RAMADAN
Discussant	Alberto TROCCOLI
Discussant	Vladimir TSIRKUNOV
British council global changemaker	Amare Abebaw WORETA

WS-3: Seasonal-to-interannual climate variability

Responsible Person	Pierre BESSEMOULIN
Session Chair	Christof APPENZELLER
Theme Leader	Ben KIRTMAN
Speaker (Needs)	Lisa GODDARD
Speaker (Capability)	Tim STOCKDALE
Discussant	Leonard NJAU
Discussant	Jagadish SHUKLA
Discussant	In-Sik KANG

WS-4: Climate and water

Responsible Person	Avinash TYAGI
Session Chair	Pavel KABAT
Theme Leader	Taikan OKI
Speaker (Capability)	Kapil Dev SHARMA
Speaker (Needs)	Eugene STAKHIV
Discussant	Upmanu LALL
Discussant	Cecilia TORTAJADA
Discussant	Igor A. SHIKLOMANOV
Discussant	Ziniou XIAO

WS-5: Climate, transportation and tourism

Responsible Person	Luigi CABRINI
Session Chair	Luigi CABRINI
Speaker (Tourism)	Daniel SCOTT
Speaker (Transport)	Geoffrey LOVE
Discussant	Sibylle RUPPRECHT
Discussant	Alain DUPEYRAS
Discussant	Jean ANDREY
Discussant	Ulric TROTZ
Discussant	Jean-Paul CERON
Discussant	Margrethe SAGEVIK
British council global changemaker	Carolina FIGUEROA

WS-6: Climate observations

Responsible Person	Stefan RÖSNER
Session Chair	Carolin RICHTER
Theme Leader	Adrian SIMMONS
Speaker (Capability)	Thomas R. KARL
Speaker (Needs)	Alan BELWARD
Discussant	D. E. HARRISON
Discussant	Han DOLMAN
Discussant	Anthony Okon NYONG
Discussant	Gabriela SEIZ
Discussant	Jochem MAROTZKE

WS-7: Climate and biodiversity and natural resource management

Responsible Person	Michael J. COUGHLAN
Session Chair	Anne LARIGAUDERIE
Theme Leader	Brendan MACKEY
Speaker	Eduard MUELLER
Discussant	Jian LIU
Discussant	Eugene TACKLE
Discussant	Mike RIVINGTON
Discussant	Lynda CHAMBERS
Discussant	Mama KONATE
British council global changemaker	David LAWLESS

WS-8: Climate and more sustainable cities

Responsible Person	Pierre BESSEMOULIN
Session Chair	Matthias ROTH
Theme Leader	Timothy R. OKE
Speaker (Needs)	Gerald MILLS
Speaker (Capability)	Sue GRIMMOND
Discussant	Yinka ADEBAYO
Discussant	Zifa WANG
Discussant	Michael HEBBERT
Discussant	Paola DEDA
Discussant	Mathias ROTACH

WS-9: Decadal climate variability

Responsible Person	Vladimir KATTSOV
Session Chair	Vladimir KATTSOV
Theme Leader	James HURREL
Speaker (Needs)	Carolina VERA
Speaker (Capability)	James MURPHY
Discussant	Panmao ZHAI
Discussant	Rowan SUTTON
Discussant	Antony ROSATI

WS-10: Climate and food security

Responsible Person	Mannava SIVAKUMAR
Theme Leader	Jerry HATFIELD
Speaker (Needs)	Pramod Kumar AGGARWAL
Session Chair	Alexander MÜLLER
Discussant	Giampiero MARACCHI
Discussant	James SALINGER
Discussant	Jan DELBAERE
Discussant	Beatriz LOZADA GARCÍA
Discussant	Juan GONZALEZ-VALERO

WS-11: Climate of oceans and coasts

Responsible Person	Martin VISBECK
Session Chair	Ed HILL
Theme Leader	Martin VISBECK
Speaker (Capability)	Nathan BINDOFF
Speaker (Needs)	Thomas C. MALONE
Discussant	Poul DEGNBOL
Discussant	Ralph RAYNER
Discussant	Isabelle NIANG
Discussant	Keith ALVERSON

WS-12: Regional climate information for risk management

Responsible Person	Kiyoharu TAKANO
Session Chair	Yap Kok SENG
Theme Leader	Kiyoharu TAKANO
Speaker (Needs)	Edvin ALDRIAN
Speaker (Capability)	Rodney MARTINEZ
Discussant	Joanna WIBIG
Discussant	Christopher CUNNINGHAM
Discussant	Abdellah MOKSSIT
Discussant	Richard GRAHAM

Round tables

R-1: Climate risk management

Responsible Person	Martin VISBECK
Session Chair	Heidi CULLEN
Discussant	Steve ZEBIAK
Discussant	Kuniyoshi TAKEUCHI
Discussant	José ACHACHE
Discussant	Shourong WANG
Discussant	Daniel KEUERLEBER
Discussant	Thomas ROSSWALL
Discussant	Vicky POPE

R-2: Climate adaptation and the Copenhagen process

Responsible Person	José ROMERO
Organizer	Rocio LICHTE
Session Chair	Helen PLUME
Discussant	Minoru KURIKI
Discussant	Ko BARRETT
Discussant	Avinash TYAGI
Discussant	Jian LIU
Discussant	Veerle VANDEWEERD
Discussant	Richard MUYUNGI
Discussant	Roberto ACOSTA
Discussant	Alain LAMBERT

R-3: Communicating climate information

Responsible Person	Carine RICHARD-VAN MAELE
Session Chair	Claire MARTIN
Discussant	Gordon MCBEAN
Discussant	Susan POWELL
Discussant	Jay TROBEC
Discussant	Mario Sánchez HERRERA
Discussant	Patrick LUGANDA

Discussant	Dilrukshi HANDUNNETTI
Discussant	Donna CHARLEVOIX

Workshops on implementing climate services

I-1: From observations to predictions

Responsible Person	Michael WILLIAMS
Session Chair	José ACHACHE
Speaker	Wilco HAZELEGER
Speaker	Andi Eka SAKYA
Speaker	Stephen BRIGGS
Speaker	José ACHACHE
Speaker	Mikael RATTENBORG
Speaker	Lars PRAHM

I-2: Research engagement

Responsible Person	Ghassem ASRAR
Session Chair	Ghassem ASRAR
Speaker	Carlos NOBRE
Speaker	Antony BUSALACCHI
Speaker	Rik LEEMANS
Speaker	Anand PATWARDHAN
Speaker	John MITCHELL

I-3: Nations and regions

Responsible Person	Pierre BESSEMOULIN
Speaker	Aryan F.V. VAN ENGELEN
Speaker	Christopher GORDON
Speaker	Serhat SENSOY
Speaker	Philip OMONDI
Speaker	Paul BECKER
Speaker	Juddy OKPARA
Speaker	Colin JONES
Speaker	Fatima KASSAM
Speaker	Mohamed KADI
Speaker	Rodney MARTINEZ
Speaker	Roger PULWARTY
Speaker	Sri Woro B.HARIJONO
Speaker	Abdallah MOKSSIT
Speaker	Petteri TAALAS
Speaker	André MUSY
Speaker	Kumi HAYASHI

Forums

F-1: Gender and climate

Responsible Person	Saniye Gülser CORAT
Moderator	Joni SAEGER
Speaker	Thais CORRAL
Speaker	Emma ARCHER
Speaker	Ashbindu SINGH

F-2: Climate and communities

Responsible Person	Maarten VAN AALST
Moderator	Maarten VAN AALST
Speaker	Roger STREET
Speaker	Arame TALL
Speaker	Maksha Ram MAHARJAN
Speaker	Felipe LUCIO

F-3: Business and industry

Responsible Person	Jacqueline COTÉ
Organizer	Carlos BUSQUET
Organizer	Barbara BLACK
Session Chair	Jacqueline COTÉ
Speaker	Juan GONZALEZ-VALERO
Speaker	Dominique HÉRON
Speaker	Juan Carlos CASTILLA-RUBIO
Speaker	Christophe NUTTALL

F-4: Capacity-building, education and training

Responsible Person	Anathea BROOKS
Session Chair	Gordon MCBEAN
Speaker	Bruce HEWITSON
Speaker	Shailesh NAYAK
Speaker	Ehrlich DESA
Discussant	Maxx DILLEY
Discussant	Walter BAETHGEN
Discussant	Eduard MUELLER

Poster sessions

Chair Monday	Mamadou Lamine BAH
Chair Tuesday	Penehuro LEFALE
Chair Wednesday	Stefan RÖSNER

2. List of High-level Sessions

There were six plenary sessions during the High-level Segment which were co-chaired through observing regional balance.

Opening session

Co-Chair	Armando Emílio GUEBUZA (President of Mozambique)
Co-Chair	Moritz LEUENBERGER (Minister of the Environment, Transport, Energy and Communications, Switzerland)
Speaker	Ban KI-MOON (United Nations Secretary-General)
Speaker	Rajendra PACHAURI (IPCC Chair)
Speaker	Alexander BEDRITSKY (Chair of the Expert Segment)

First plenary session

Co-Chair	Armando Emílio GUEBUZA (President of Mozambique)
Co-Chair	Moritz LEUENBERGER (Minister of the Environment, Transport, Energy and Communications, Switzerland)

Second plenary session

Co-Chair	Batlida S. BURIAN (Minister of State in the Vice President's Office for Environment, United Republic of Tanzania)
Co-Chair	Yong ZHANG (Vice Minister, China)

Third plenary session

Co-Chair	Lyonpo Pema GYAMTSHO (Minister for Agriculture, Bhutan)
Co-Chair	Åsa-Britt KARLSSON (State Secretary, Ministry of the Environment, Sweden)

Fourth plenary session

Co-Chair	Robert PERSAUD (Minister of Agriculture, Guyana)
Co-Chair	Cristina Maria Fernandes DIAS (Minister of Natural Resources, Sao Tome and Principe)

Fifth plenary session

Co-Chair	Sheikh HASINA (Prime Minister of Bangladesh)
Co-Chair	Jane LUBCHENCO (Under Secretary of Commerce for Oceans and Atmosphere, United States)

Sixth plenary session

Co-Chair	Rashed Ahmed Ben FAHD (Minister of Environment and Water, United Arab Emirates)
Co-Chair	Brian T. GRAY (Assistant Deputy Minister, Science and Technology, Environment Canada)

Closing session

Co-Chair	Armando Emílio GUEBUZA (President of Mozambique)
Co-Chair	Moritz LEUENBERGER (Minister of the Environment, Transport, Energy and Communications, Switzerland)

Annex 5 Conference Statement of the World Climate Conference-3

Summary

Peoples around the world are facing multi-faceted challenges of climate variability and climate change, challenges that require wise and well-informed decision-making at every level, from households and communities to countries and regions, and to international forums such as the United Nations Framework Convention on Climate Change. Wise and well-informed decision-making, in turn, will require, directly or indirectly, access to the best possible climate science and information, together with the effective application of the information through climate services.

The first two World Climate Conferences, in 1979 and 1990, laid the foundation for building research and observational activities to understand the nature of the climate challenges, and to provide the scientific bases for developing the comprehensive and sound climate services that are now being sought by all countries and in virtually every sector of society. The World Meteorological Organization and its partners convened World Climate Conference-3 to provide nations with the opportunity to consider together an appropriate global framework for climate services over the coming decades, a framework that would help ensure that every country and every climate-sensitive sector of society is well equipped to access and apply the growing array of climate prediction and information services made possible by recent and emerging developments in international climate science and technology.

The purpose of the Expert Segment of WCC-3 was to engage a wide cross-section of climate scientists, expert providers of climate information and the users of climate information and services in a wide-ranging discussion on the essential elements of a new Global Framework for Climate Services for consideration by the High-level Segment of the Conference.

The 200 speakers and 1 800 participants in the Expert Segment reviewed the various challenges facing the climate service provider and user communities; considered the needs and capabilities for applying climate information in key climate-sensitive sectors, as well as for social and economic benefits; and examined the scientific bases for climate information and prediction services. A number of scientific, environmental and socio-economic groups and organizations informed the Expert Segment of their needs and perspectives, and a wide range of countries and climate-sensitive sectors reported on their experiences in the implementation of climate services. On the basis of these deliberations, the Expert Segment concluded that:

- Great scientific progress has been made over the past 30 years, especially through the World Climate Programme and its associated activities, which already provide a firm basis for the delivery of a wide range of climate services; but that
- Present capabilities to provide effective climate services fall far short of meeting present and future needs and of delivering the full potential benefits, particularly in developing countries;
- The most urgent need is for much closer partnerships between the providers and users of climate services;
- Major new and strengthened research efforts are required to increase the time range and skill of climate prediction through new research and modelling initiatives; to improve the observational basis for climate prediction and services; and to improve the availability and quality control of climate data.

The Expert Segment then called for major strengthening and implementing, as appropriate, of the

following essential elements of a global framework for climate services:

- The Global Climate Observing System and all its components and associated activities; and provision of free and unrestricted exchange and access to climate data;

- The World Climate Research Programme, underpinned by adequate computing resources and increased interaction with other global climate relevant research initiatives;

- Climate services information systems taking advantage of enhanced existing national and international climate service arrangements in the delivery of products, including sector-oriented information to support adaptation activities;

- Climate user interface mechanisms that are focused on building linkages and integrating information, at all levels, between the providers and users of climate services, and that are aimed at the development and efficient use of climate information products including the support of adaptation activities;

- Efficient and enduring capacity-building through education, training, and strengthened outreach and communication.

The Expert Segment concluded by supporting the development of the proposed Global Framework for Climate Services. The WCC-3 Sponsoring Agencies agreed, therefore, that the essential findings of the Expert Segment, as summarized in this Statement, should be transmitted to the High-level Segment of the Conference for the information of delegates and other Conference participants; and be referred to their individual and joint executive and coordination bodies for follow-up action, in particular, in the context of the United Nations Chief Executives Board initiative on the United Nations system "Delivering as One on Climate Knowledge".

Preamble

1. At the invitation of the Government of Switzerland, World Climate Conference-3 (WCC-3) was held in Geneva, Switzerland, from 31 August to 4 September 2009. It was organized by the World Meteorological Organization (WMO), in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the International Council for Science (ICSU) and other intergovernmental and non-governmental partners. The Conference was generously supported by the governments of Australia, Canada, China, Denmark, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Kenya, Namibia, Norway, Pakistan, Russian Federation, Saudi Arabia, Spain, Switzerland, the United Kingdom of Great Britain and Northern Ireland, and the United States of America, and by the European Union, the European Space Agency, the United Nations Environment Programme and FAO. Additional in-kind support was received from many other countries and organizations. Some 2 500 participants from 150 countries and 70 international organizations attended the Conference, with approximately 2 000 participating in the first three days of expert presentations and discussions.

2. The theme of the Conference was "Climate prediction and information for decision-making" and its vision was for "An international framework for climate services that links science-based climate predictions and information with the management of climate-related risks and opportunities in support of adaptation to climate variability and change in both developed and developing countries". In giving effect to the decision of the 2007 Fifteenth World Meteorological Congress to build on the legacy of the First (1979) and Second (1990) World Climate Conferences to establish a new international framework for climate services which will complement and support the work

of the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC), the WCC-3 sponsors agreed to partition the Conference into two segments:

- *Expert Segment* (31 August–2 September) at which climate scientists and other experts from climate service provider and user communities would examine global, sectoral and national needs and capabilities for the provision and application of climate services and identify the essential elements of a new global framework to be elaborated in a Conference Statement; and

- *High-level Segment* (3–4 September) at which Heads of State and Government and other invited dignitaries would express their views on the proposed framework and ministers and other national representatives would adopt a High-level Conference Declaration calling on WMO and its partner organizations to implement the proposed framework without delay.

3. The Expert Segment of the Conference reviewed a wide range of individual and community-based papers and presentations from climate science, service, application and user communities as well as the results of deliberations by a number of other major climate service stakeholder and community groups. The conclusions and recommendations from the various sessions, forums, workshops and round-tables of the Expert Segment of the Conference are summarized below. More details on the community-based input to the Conference and the discussions during the Expert Segment are included in the full Conference Proceedings.

I Opening of the Conference

4. In welcoming the participants to the Opening of the Conference, the Secretary-General of WMO, Michel Jarraud, recalled the achievements of the First and Second World Climate Conferences and expressed his hope that WCC-3 would lead to an even more broadly based contribution to the wise handling of the climate issue by providing far sighted guidance on the optimum arrangements for the provision of climate services in support of national and international decision-making over the coming decades.

5. The President of the Swiss Confederation, H.E. Hans-Rudolph Merz, President of the Conference, welcomed the participants to WCC-3, stressed the widespread impacts of weather and climate, and expressed his confidence that WCC-3 would lay the foundation for a better future due to better climate information.

6. Alexander Bedritsky, President of WMO and Chair of the Expert Segment of the Conference, noted that improved climate services are now possible to address a broad range of user needs. The global community must now come together to provide the needed information and predictions based on the best available science. The large number of organizations attending the Conference should be seen as a testament to the high level of commitment that now exists to providing improved climate services. Dr Bedritsky emphasized that WMO Members have provided, and will continue to provide, data, information and predictions that are essential for climate services.

7. Gro Harlem Brundtland, the United Nations Secretary-General's Special Envoy on Climate Change, represented the Secretary-General at the Opening of the Conference. She noted that the Secretary-General has called climate change the defining challenge of our generation and that, today, it is in our hands to make WCC-3 an important milestone in the quest for peace and security. Climate politics must be based on clear and credible scientific data, so WCC-3 Conference participants should make their voices heard. The world needs the knowledge and initiative of the scientific community now more than ever.

8. Kofi Annan, President of the Global Humanitarian Forum, noted the need for concerted political action on climate change. There is no room for complacency, and deliberations at WCC-3 must provide the impetus to help decision-makers reach a new agreement in Copenhagen. Those who are most threatened by climate change have done the least to cause the problem. Therefore, developed countries should take the lead in cutting greenhouse gas emissions. Weather Information for All, a new initiative by the Global Humanitarian Forum, WMO, and the private sector, to establish surface stations communicating by cell phone technology, will help facilitate the sharing of essential data and the provision of threat alerts.

9. Following the formal opening of the Conference, Dr Bedritsky invited participants to join in the opening of the Expert Segment. He welcomed the following representatives of WMO international partners who addressed the Conference:

- Walter Erdelen, Assistant Director-General, United Nations Educational, Scientific and Cultural Organization (UNESCO)
- Manzoor Ahmad, Director, Geneva Office, Food and Agriculture Organization of the United Nations (FAO)
- Joseph Alcamo, Chief Scientist of the United Nations Environment Programme (UNEP)
- Deliang Chen, Executive Director of the International Council for Science (ICSU)
- Julia Marton-Lefèvre, Director General of the International Union for Conservation of Nature (IUCN)
- Jean-Jacques Dordain, Director General of the European Space Agency
- Houlin Zhao, Deputy Secretary-General, International Telecommunication Union (ITU)
- Reid Basher, Special Advisor to the United Nations Assistant Secretary-General for Disaster Risk Reduction

Dr Bedritsky also acknowledged a message of support for the Conference from the World Health Organization (WHO).

10. Thomas Stocker, Co-Chair of Working Group I of the Intergovernmental Panel on Climate Change, set the science scene for the Conference in terms of new approaches and methods that will be available for use in the IPCC Fifth Assessment Report. These include:

- Improved short-term predictions that will be available to IPCC Working Groups II and III;
- Improved understanding of the several factors that influence sea-level rise;
- Reduced uncertainties on climate impacts;
- Hazards as a result of human-induced climate change.

11. John Zillman, Chair of the WCC-3 International Organizing Committee (WIOC), concluded the opening session by elaborating the Sponsors' Vision for the Conference.

II The shared challenge for climate science, services and applications

12. The Conference undertook a comprehensive review of the individual and shared challenges faced by those involved in advancing the frontiers of climate science, in turning scientific progress into useful climate services and in applying climate services for social, economic and environmental benefit.

13. It noted that the original 1979 World Climate Programme (WCP) was designed as an integrated framework for climate data, research, applications and impact assessment and that

much progress has been achieved over the past 30 years through the four components of the WCP, namely the World Climate Data and Monitoring Programme (WCDMP), the World Climate Applications and Services Programme (WCASP), the World Climate Impact Assessment and Response Strategies Programme (WCIRP) and the World Climate Research Programme (WCRP), and through the Intergovernmental Panel on Climate Change and the Global Climate Observing System (GCOS) in providing society with reliable and useful climate information. The Conference agreed, however, that apart from the role of the IPCC in providing comprehensive user-friendly assessments of the state of knowledge of climate change, less progress has been made in translating scientific progress into user-oriented climate services and their application for the benefit of society.

14. Climate science has a rich history of rising to the challenges of weather and climate prediction, providing the society irrefutable evidence on the reality of climate change and human contributions to it. Climate research is now tasked with even a greater challenge to understand the Earth as a complex, non-linear interactive system, and to assess the impacts of anthropogenic climate change on coupled human and natural systems. Important attributes of climate services include provision of balanced, credible, cutting-edge scientific and user-targeted information that effectively informs policy options.

15. Mitigation of, and adaptation to, climate change is a shared challenge and, in order to address the evolving vulnerabilities of human and natural systems, climate science needs to continue its efforts to resolve the outstanding uncertainties and support climate-resilient development. Assessments must be made of emergency preparedness and response systems; efforts are needed to raise awareness of climate risks and opportunities in climate-sensitive communities; and new tools and products, relevant to decision-making, are urgently needed.

16. Climate change is a risk multiplier, and actionable climate information is a great resource for society. Climate information is about people, and its key role is in saving lives and protecting livelihoods, and, therefore, it is important to integrate it into policy frameworks and development discourse.

17. Climate services are too complex to be undertaken with a fragmented approach, and it is crucial for all stakeholders to work closely together. Integrated water resources management, for example, must achieve balance among economic efficiency, social equity and environmental sustainability.

18. The insurance industry has, for decades, been concerned with climate change, climate extremes and catastrophic events, and is an important user of climate information. The risks of extreme weather and climate events are rising, especially in developing countries. Various insurance options are helping developing countries manage the impacts of climate change. High quality weather and climate data are the prerequisites for proper insurance risk management. In many developing countries lack of appropriate climate data is the main obstacle for introducing the required insurance systems.

19. The speakers in the session highlighted the following key issues:

- The challenge of climate modelling and prediction needs to be addressed by an unprecedented multinational effort, with massive supercomputing, infrastructural and human resource deployment, in order to produce reliable high-resolution climate information for the entire planet;

- The proposed Global Framework for Climate Services (GFCS) must address the shared challenge of climate change with due consideration to

all scientific and societal issues, closely involving all the stakeholders:

- Developing more climate-information based decision support tools to meet the needs of food security;
- Working with the climate and water resource management communities to ensure that climate information is integrated into planning activities at local, national and regional levels;
- Taking the needs of the insurance sector into account as an integral component of climate risk management.

Advancing climate prediction science

20. Climate services depend critically on predictions of time-evolving regional climate on timescales from seasonal-to-interannual, to multidecadal, century and beyond. Climate prediction science must be an important part of any organized climate service. The speakers on 'advancing climate prediction science' focused on current capabilities and plans for scientific research and climate predictions on these different timescales, and also emphasized the key role the World Climate Research Programme plays in organizing and coordinating the science behind these predictions and their application.

21. The experts directed particular attention to the current state of seasonal to interannual forecasting and the opportunities for improvement, and to the results from experimental decadal predictions. They uniformly agreed on the need to better understand the modes of natural climate variability.

22. The WCRP is organizing a new set of climate change simulations using mitigation scenarios. These experiments will rely on new climate modelling capabilities: initialized decadal predictions focusing on adaptation out to about 2035, and longer term experiments out to 2100 and beyond where the magnitude of climate change will be related directly to which mitigation scenario the world follows.

23. The experts identified a number of recommendations for advancing climate prediction:

- *Seamless prediction.* Adopt a more seamless approach to climate prediction by using a modelling framework that includes assimilation of high quality climate observations, which are required for the initial conditions. Where appropriate, these climate predictions should include coupling directly to applications (for example, hydrological models);
- *Reduction of model biases.* Reduce model biases through better representation of physical processes and higher spatial resolution;
- *Mechanisms leading to variability.* Improve the understanding of the mechanisms that lead to the variability on the different timescales;
- *Computing capacity.* Significantly increase the computing capacity available to the world's weather and climate centres in order to accelerate progress in improving predictions. The World Modelling Summit for Climate Prediction in 2008 recommended computing systems dedicated to climate at least a thousand times more powerful than those currently available;
- *Closer collaboration.* Ensure closer collaboration between scientific research, operations and users to ensure that climate services receive the benefits of research as soon as possible, and that research covers the needs of users;
- *Limitations and uncertainties.* Communicate clearly to users of climate services the limitations and uncertainties involved with climate change model predictions/projections.

Economic and social benefits of climate information

24. Climate information delivers economic value by providing users, whose activities are sensitive to climate conditions, with a basis for making decisions. The plenary presentations in the Expert Segment provided examples of the effective use of climate information to deliver economic value in different sectors. Seasonal climate prediction and information, for example, can prove valuable for agricultural planning and drought mitigation strategies. The estimates of the economic value of improved El Niño-Southern Oscillation predictions for the agricultural sector are not insubstantial.

25. With respect to longer timescales, the Conference was advised to consider climate change as a "threat multiplier", amplifying other potential stresses on economic and social systems. Climate variability and change can exacerbate existing vulnerabilities to the point of tipping systems into critical states. In this context, it is important to recognize costs associated not only with responding to climate change, but also with decisions not to act.

26. There are, however, many impediments to the effective use of climate information for socio-economic benefit. The Conference learned these impediments include a lack of understanding about climate impacts, what climate information is most relevant, and how best to engage with users to define the right questions and involve them in the solutions. Several speakers stressed the challenges associated with acquiring, and sustaining resources.

27. The speakers and discussants canvassed the various challenges in removing the impediments to delivering greater socio-economic benefits from the use of climate services. Among the approaches advocated are the systematic application of "adaptation science" that is solution-focused, and the encouragement of multidisciplinary research. In addition, there was strong support for the following recommendations:

- *Madrid Action Plan.* High priority should be given to completing the actions identified in the March 2007 Madrid Action Plan on the Social and Economic Benefits of Weather, Climate and Water Services, incorporating the principles of climate risk management developed at the July 2006 Espoo Conference on 'Living with Climate Variability and Change';

- *Economic valuation of climate services.* The international agencies participating at WCC-3 should collaborate on assessing the value of various types of climate services and on ways and means of enhancing that value in the various climate-sensitive sectors of society;

- *Connecting with users.* Boundary organizations with sufficient capacity to integrate information from producers and mainstream services to users should be provided with sustained, cross-institutional support. Regional support institutions like development banks and insurers should be mobilized.

Climate extremes, warning systems and disaster reduction

28. Nearly 80 per cent of disasters caused by natural hazards are linked to climate extremes. The IPCC Fourth Assessment Report has provided scientific evidence on the increasing risks associated with these hazards as a result of human-induced climate change. Traditionally, many countries have been reactive to disasters. The adoption by 168 countries of the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, however, has led to a new paradigm in disaster risk management focused on prevention and preparedness. The UNFCCC Bali Action Plan has stressed the need for disaster risk management as a critical component of climate risk management in all countries. Since the adoption of the Hyogo Framework for

Action, initiatives are underway to bring together the scientific and technical agencies, disaster risk management and other relevant ministries and sectors (such as agriculture, health, environment, development) to coordinate the development of national disaster risk management strategies.

29. The Conference discussed that effective disaster risk management must be founded on quantification and understanding of risks associated with natural hazards. In many countries, institutional capacities and cooperation for risk identification need to be developed. Climate information is critical for the analysis of hazard patterns and trends. This must be augmented, however, with socio-economic data and analysis for vulnerability assessment (for example, casualties, construction damages, crop yield reduction, water shortages). With this risk knowledge, countries can manage risks using: (1) early warning systems and preparedness; (2) medium and long-term sectoral planning (such as land zoning, infrastructure development, agricultural management); and (3) weather-indexed insurance and financing mechanisms. Early warning systems are effective tools for reducing loss of life. Climate forecasting tools could, however, be used to develop warnings with longer lead times for improved sectoral planning. Analysis of hazard patterns from historical data is necessary; but changing patterns of climate hazards are posing challenges with longer-term investments in areas such as infrastructure planning and retrofitting based on building codes and specifications, derived only from historical records (a 100-year flood may become a 30-year flood, for example).

30. In light of various experiences, the experts recommended:

- *Identification of requirements.* There is need for a systematic demand-driven approach to identify requirements of various user-communities including the level of integration of climate services in disaster management policies within different sectors of disaster risk management. This would require partnership and two-way cooperation between the climate information providers and targeted users. The coordinated framework of disaster risk management under the Hyogo Framework for Action is crucial for bridging the user interface;

- *Scaling up of pilot studies.* Development and utilization of relevant climate information for managing risks in some sectors have been piloted. These efforts need to be identified, evaluated and scaled up through a coordinated and operational institutional framework;

- *Increased investments in data.* Historical and real-time climate data are critical, but there is a pressing need for increased investments in National Meteorological and Hydrological Services (NMHSs) for strengthening observing networks, and data maintenance systems);

- *Climate forecasting technologies.* Climate forecasting technologies (seasonal, interannual, decadal) provide an unprecedented opportunity for improved sectoral planning for disaster risk reduction at different timescales (tactical to strategic planning). There is need, however, for coordinated research to improve these tools for providing relevant information for disaster risk management (such as predictions of trends and patterns of droughts, tropical cyclones, floods and heat waves at longer timescales). There is a need to make these tools operational to ensure sustainable delivery and utilization of information in sectoral planning;

- *Decision-maker awareness.* Utilization of climate information must be augmented with systematic public and decision-maker awareness programmes;

- *Developing tools to support the application of climate services in disaster risk reduction.* Appropriate tools to help decision-makers integrate climate services into disaster response

and prevention (disaster risk maps, indices for monitoring hazards, signals for appropriate response, for example) need to be developed.

Mainstreaming climate information

31. Climate information is already widely used in many countries and in many socio-economic sectors, and at many levels of society. Nevertheless, the urgency of adaptation to climate change, to which there is no alternative, elevates a need for climate information to a new level. In the absence of adaptation, scarce resources planned for national development activities will continue to be massively redirected to disaster response and recovery actions. Of paramount importance for policy and decision-makers are the following questions:

- What is the "adaptation field", that is, where are the likely impacts that can probably not be avoided by mitigation?
- How much of this adaptation field can we afford to adapt, and how much would different levels of adaptation cost?
- How should we handle 'residual impacts' not addressed by adaptation?

32. A broad framing of the adaptation processes from awareness to mainstreaming in current activities, together with reorganization due to transformations in risk, suggests different entry points for information for decision-makers and for vulnerable populations. Conditions of vulnerability and available financial mechanisms are relevant factors. This approach includes the practical involvement of communities and governments in the implementation of climate risk reduction strategies and in the improvement of resilience to climate risks. Each country will have to develop its own adaptation policies, actions plans, programmes and measures. These must be integrated into the ongoing development processes and might also involve the coordination of needs between neighbouring countries. The efficient use of climate information becomes an essential requirement in mainstreaming climate change into policy and development.

33. The experts in this session highlighted:

- *Mainstream climate information.* The urgent need to assist developing countries in mainstreaming local and regional information on climate change and variability into planning and policy development;
- *Availability of adequate information.* Existing challenges related to availability of adequate information for adaptation to climate change in the most vulnerable regions such as Africa, low-lying Asian mega-deltas, and small islands;
- *Learning from experience.* The importance of learning from the successes and positive and negative experiences of addressing challenges in the use of the available climate information;
- *Integrating knowledge.* The value of creating and integrating knowledge bases on local and regional climate hazards, on impacts, and especially on the economics of adaptation;
- *Improved understanding and data.* The central role of accurate and detailed prediction of the consequences of climate change at timescales and geographical scales corresponding to society and people's needs, and the corresponding requirement for improved understanding of the climate change and for sustained efforts in climate research and observation.

III User needs and applications

34. The climate services needed by society embrace past, present and future climate information, research, investigation, assessment and advice on climate-related issues. They include an extensive array of general and user-specific data, prediction, warning and advisory services

focused on the individual needs of the many climate-sensitive sectors of the community. All countries, all governments, all socio-economic sectors and almost all individual members of society are in need of climate services in one form or other.

35. Recognizing that individual countries' needs for climate services would be clearly expressed by national delegations in their Statements to the High-level Segment of the Conference, the Expert Segment focused particular attention on the overall needs and capabilities of the following set of climate-sensitive sectors:

- Human health;
- Sustainable energy;
- Water;
- Transport;
- Tourism;
- Biodiversity and natural resource management;
- Sustainable cities;
- Food security;
- Oceans and coasts.

Climate and human health

36. Good health status is one of the primary aspirations of human social development. As a result, health outcomes and indicators are key components of the Millennium Development Goals (MDGs). Many infectious and chronic diseases, including malnutrition, are directly or indirectly sensitive to the climate, and their control is a primary focus of the MDGs. Climate change is recognized as one of the defining challenges of the twenty-first century and protecting health from its impacts is a priority for the public health community as was recognized during the World Health Assembly in 2008.

37. New opportunities exist for better management of climate-related health risks in the context of both development goals and climate change. These opportunities are made available through advances in climate science, rapidly advancing communication technology (affecting the sharing of data and knowledge) and through a new global focus on effective management, and even elimination of, certain infectious diseases. New partnerships involving the public and private sectors and civil society, and a substantial increase in funding support these developments.

38. On the basis of the development of two white papers (on needs and opportunities), followed by substantive discussions and the working session on climate and human health, the experts proposed the following recommendations:

- *Climate services for the health sector.* There should be full engagement of the public health community, through the World Health Organization, in the establishment of a Global Framework for Climate Services in order to enable the inclusion of climate information in public health decision-making;
- *Capacity-building in use of climate information.* Research and training opportunities, designed to build capacity and provide evidence for policy and practice, should be developed through effective collaboration across relevant disciplines;
- *Cross-sectoral interaction.* Investment is required in a public service platform within WMO Member and partner institutions to encourage cross-sectoral interaction including cooperation on the establishment of observing and monitoring networks, the development of decision support tools and systems, and the development of "one stop" health sector advisory services that will

strengthen health surveillance and response systems;

- *Resource sharing.* The sharing of data, information and capacity (at local, regional and global scales) is necessary for improving health monitoring and surveillance systems to achieve "the most elementary public health adaptation" as stated in the IPCC Fourth Assessment Report. This effort is especially critical for Least Developed Countries (LDCs), which have the weakest surveillance systems. It is imperative that resources are provided for collecting, managing and applying climate data to the creation of evidence-based policy and practice in the development of early warning and adaptation strategies related to health;

- *Partnerships and priorities.* Existing programmes, initiatives and organizations working in climate and health should jointly prioritize the development of the Global Framework for Climate Services as it relates to health. Institutional mechanisms that link outputs and responsible actors to the recommendations above are required, and a clear framework for activities is essential. Partnerships are not always easy to establish, so new and innovative mechanisms should be envisioned to make this development possible at all levels.

Climate and sustainable energy

39. Climate information is essential for ensuring the most efficient production and consumption of essentially all traditional forms of energy including coal and gas-fired generation and the distribution and utilization of electricity, and is especially important for the design and operation of infrastructure and facilities for renewable energy sources such as hydro, wind, solar, tidal and bioenergy. Seasonal-to-multi-decadal climate variations give rise to changes in energy demand but also in energy availability and supply. Primary energy is traded globally and often delivered within complex energy grids. In particular, the generation of renewable energies is often itself climate dependent. Energy prices may also be affected by climate variations. The discussions on sustainable energy highlighted the climate information that is currently available, the extent to which it is already being used, and the current and future needs of climate information from the energy sector.

40. The energy and climate experts stressed the following needs:

- *Historical and quality observations.* Historical and high quality weather and climate observations are needed for the energy sector especially in developing countries;

- *Seamless predictions.* Seamless predictions from global climate models (monthly to seasonal to decadal timescales) with much improved resolution are needed;

- *Updated reanalysis.* There is need for quality reanalysis of meteorological data that is regularly updated;

- *Reliable access.* Reliable access to climate information using readily available servers and grid technology is important;

- *Joint partnerships.* Establishment of joint partnerships between the energy sector and climate service providers is desirable;

- *Mainstreaming climate information.* It is vital to mainstream climate information into long-term development plans, in particular for the energy sector;

- *Vulnerability assessments.* Assessments of vulnerability to severe weather and extreme climate events are needed for energy infrastructures including generation, transmission, transformation, processing, distribution, and extraction;

- *Strengthening partnerships.* Partnerships should be strengthened between the energy sector and the climate service community;

- *Active participation.* Active participation by civil society is needed to improve decision-making in issues linking climate services and energy;

- *Capacity-building and technical cooperation.* The transfer of energy and climate technology between developed and developing countries requires capacity-building and technical cooperation.

Climate and water

41. The increasing use of freshwater has greatly stressed the world water availability. Changes in freshwater availability and demand due to demographic, economic, and climatic changes will exacerbate existing problems in such areas as health, agriculture, sustainable energy, and biodiversity. Sea-level rise, temperature increase, and the changes in the hydrological cycle, including the cryosphere, as well as a risk of increased frequency of extreme events, such as flash floods, storm surges, and landslides, will all add stress.

42. Managing climate risks for humans and for ecological systems has attained an unprecedented urgency. Addressing these risks through provision of targeted information on seasonal to decadal and longer term climate variability must become a key element in a suite of climate services. Technological and societal innovations in how to use the evolving climate information to inform freshwater management are urgently needed and should be stimulated. Participants in the session agreed on the following main recommendations:

- *Hydrological networks.* The continuing degradation of hydrometeorological networks and databases has resulted in the crisis in our ability to generate information needed for managing climate risk in the water sector. Hydrological networks are the essential foundations for future adaptation to climate uncertainties. A focused priority effort is needed to reverse this decline and to develop reanalysis products so that a diverse suite of climate and hydrological information can be made available across much of the world;

- *Partnership and communication.* Full partnership and sustained communication between the climate community and the end users from the water sector such as flood managers, utilities operators, irrigation managers, and agriculture and health specialists, is a condition sine qua non for the development of the Global Framework for Climate Services. Under this partnership key attention should be placed on:

    - Data quality, availability and data sharing;

    - Climatic information with higher spatial and temporal resolutions, such as the catchment scale and monthly or weekly timescales;

    - Substantial improvements of forecasting skills for seasonal, interannual and decadal variability for better reservoir operation and flood and drought emergency preparedness;

    - Reduction and quantification of uncertainties and biases in future projections;

    - Quantification of climate impacts on both water quantity and water quality, including low flows, ground water, high surface water temperatures, salinity and pollution, sediment transport, and effects on aquatic ecosystems;

- *Integrated models.* There is need for development, benchmarking and application of integrated hydrological and water resource models that include natural and anthropogenic water cycles, and are coupled with crop models and reservoir

operation models to provide more realistic impact assessments and to support decision-making in designing adaptation measures;

- *User interface programme.* Existing programmes, initiatives, and organizations working in water resources management should join hands to facilitate the development of the Global Framework for Climate Services, particularly its User Interface Programme component.

Climate and transportation

43. Transportation is an important component of the tourism industry and represents a major economic sector. It contributes significantly to humankind's greenhouse gas emissions and is significantly affected by global warming. The implementation of a range of new climate-related services will be essential if implementers and managers of transportation systems are to make the best decisions. Furthermore, decisions made at one particular time, on the basis of the best available existing information, will need to be constantly re-evaluated. In essence, an adaptive management approach, underpinned by a Global Framework for Climate Services, will be required. This approach needs to be:

- Accessible to all;

- Driven by ongoing research and build on current collaborations between the meteorology and transport communities in dealing with chronic risks;

- Constantly improving climate forecasts for specific regions and localities and expressed in a way that makes them easily used by all manner of decision-makers;

- Improving the range and geographical extent of the collection of Earth system data, and the exchange of these data between agencies undertaking research and infrastructure development related to climate change;

- Creating information that facilitates accessibility and mobility options that are robust in terms of climate information, and also consider mitigation, both generally and in specific reference to travel related to tourism.

44. The experts in climate and transportation recommended the following:

- *Climate resilience.* Planning and design of infrastructure needs to account for climate uncertainties to enable more resilient responses to climate changes;

- *Multidisciplinary information.* It is necessary to inform professionals from a wide variety of disciplines such as meteorology, hydrology, engineering, statistics, ecology, biology, economics and financial management, and to inform the broad community as well;

- *Whole-of-life approach.* It is important to take a whole-of-life approach to the management of infrastructure;

- *Risk assessments.* Risk assessments and the cost-benefit analyses of adaptive strategies should be continually updated;

- *Extreme events.* It is necessary to strengthen emergency response planning and management for extreme events, which current science indicates are likely to increase in frequency under the range of generally accepted climate change scenarios.

Climate and tourism

45. Climate has a complex influence on the sustainability of the global tourism economy. It is an important driver of major international tourism flows and is the principal resource for some destinations, particularly Small Island Developing States (SIDS). Climate variability affects many facets of tourism operations and environmental conditions, and can either attract

or deter tourists from destinations. Climate also has broad significance for tourist decision-making, expenditures and travel satisfaction. Consequently, it is expected that the integrated effects of climate change will have profound impacts on tourism businesses and destinations in the decades ahead. The climate and tourism experts concluded that scientific understanding of the climate and tourism interface has improved in the last decade, especially in the research on climate change impacts and on adaptation and mitigation measures within the sector. Key knowledge gaps remain, however, and limit climate information from being used as effectively as it could be by travellers worldwide, and by the tourism industry in the pursuit of sustainable tourism and adaptation to climate change.

46. Upon assessing the present use and future needs of climate information by both tourists and the tourism sector in developed and developing countries, the tourism and climate experts agreed on the following main recommendations:

- *Interdisciplinary and sector-wide collaboration on research and practice.* Increased investment and strengthened collaboration between the climate and tourism and transport communities are required to address key knowledge gaps in the climate sensitivity of major tourism segments, in transport systems and destinations, in the salience of climate in travel decision-making contexts, and in the economic and non-market societal value of climate information for the sector. Cooperation is also vital to develop the decision support tools and standards for specialized climate products, to ensure consistent communication to international travellers and to facilitate objective destination comparisons in a global tourism marketplace;

- *Capacity-building in the application of climate information.* Major initiatives are needed to advance the application of climate information in the tourism sector significantly. These initiatives include a series of professional capacity-building workshops in major tourism regions around the world (in order to adequately represent specific end-user information needs and the capabilities of regional providers), and the development of climate information training modules for use by tourism and hospitality schools around the world;

- *Improved observation networks.* Investment is required to enhance observation networks and climate information provision in areas where tourism is vital to local economies, specifically rural areas and many developing countries, particularly Small Island Developing States, in order to improve climate risk management and climate change adaptation in the tourism sector.

Climate and biodiversity and natural resource management

47. Biodiversity, ecosystems, and the services they provide (climate regulation, food security, freshwater supply and disaster risk reduction, for example), are the fundamental units of life support on Earth.

48. Biodiversity and ecosystems play a vital role in both ecosystem based mitigation (carbon sequestration and storage) and ecosystem based adaptation (societal adaptation to climate change impacts). An example of a societal adaptation is the buffering of climate hazards such as flooding.

49. Climate change is significantly affecting biodiversity and ecosystems, and climate information is required to assess vulnerability and to identify adaptation options. Managing for current threats will increase ecosystem resilience and adaptive capacity.

50. To meet the expectations of the Global Framework for Climate Services, the experts on

biodiversity and natural resource management recommended:

- *Interdisciplinary dialogue between scientists.* It is important to organize a continuous dialogue between climate scientists and biodiversity and ecosystem scientists to translate climate data into impacts on biodiversity and ecosystem services (that is, climate services) for the benefit of users;

- *Model improvement.* Improving the representation of the functional role of biodiversity and ecosystem processes in Earth system models (research and modelling component of the GFCS) is needed;

- *Biodiversity monitoring.* It is necessary to enhance and integrate biodiversity observing and monitoring activities and systems, such as Long Term Ecological Research networks, through the GFCS, through support to the Group on Earth Observations (GEO) Biodiversity Observation Network (BON) and through other relevant initiatives;

- *Indigenous knowledge.* It is important to integrate data and knowledge from indigenous and local communities, including citizen based observations, about ecosystem responses and approaches to adaptation, into the design and implementation of climate information systems;

- *Sharing of information.* It is important to facilitate the sharing of information and good practices on ecosystem-based adaptation to climate change through collaborative international systems such as the UNFCCC *Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change*, and the proposed Global Adaptation Network.

Climate and more sustainable cities

51. Cities affect, and are affected by, climate change in many ways and at many scales. Climate knowledge should be used more effectively to ensure more sustainable cities.

52. The scientific understanding of urban climates has advanced substantially over the past two decades including conceptualization, field observations, analysis of processes and model building. The field is still young, however, and much more research is needed to equal the understanding of that acquired for other environments. At the same time, there is growing demand for urban climate information in the design and management of more sustainable cities. Implications of global climate change for cities have not been adequately assessed to date. In general, few National Meteorological Services (NMSs) have appropriate expertise in urban meteorology.

53. The experts in the session encourage WMO, through its NMSs, to introduce urban-related climate services by establishing relations to the political and socio-economic stakeholders and urban developers. These service should include:

- *Improving urban climate observation networks.* Urban climate stations and networks should be greatly improved, including vertical information, in all countries. This should be done in line with WMO urban guidelines. International archives of urban climate, morphological and land cover data should be established;

- *Climate research for hot cities.* Highest priority should be given to strengthening observational networks and establishing urban climate research programmes for tropical cities where population growth is greatest and vulnerability to excess heat and inundation is highest;

- *Urban climate modelling.* Improved numerical models should be developed to forecast weather, air quality and climate in cities. The focuses should be to incorporate urban land surface schemes into global climate models,

to downscale regional climate predictions and projections to the urban scale, and to assess their impact on urban health, safety and management;

- *Education, training and knowledge transfer in urban climatology.* Much greater effort should be directed to increase understanding among climatologists, NMSs and urban stakeholders.

Climate, land degradation, agriculture and food security

54. Food security is dependent upon many socio-economic and environmental factors, including agricultural systems which are resilient to climate variation and extremes in climate. The impact of climate on agricultural production is increased in fragile environments. The indirect impacts of climate on insects, diseases, and weeds increase when there is climate stress imposed on the plant or animal. Water and food are two sides of the same coin; hence, it is important to place emphasis on water management to enhance agricultural productivity. In order to reduce the risk of crop failure and increase the resilience of agronomic and horticultural systems for feed, food, fibre, and fuel production there is an urgent need to develop an improved understanding of the complex interactions between climate and agricultural systems and to implement production systems that can adapt to climate variation and climate extremes, especially in developing countries.

55. Agricultural and land management experts reviewed the needs to enhance the contribution of climate information to land management, agriculture and food security, and agreed on the following recommendations:

- *Risk evaluation and information delivery.* An intensive effort is needed on the use of climate forecasts to reduce the risks to crop and animal production, especially in areas where the risks are greatest. Such efforts should include the development of effective dissemination tools for timely provision of this information to decision-makers. Climate information should be adapted and actionable to meet the needs of users;

- *Cooperation and partnerships.* For a holistic management of climate risks in agriculture, new and innovative models of cooperation and partnerships are needed among several groups including WMO, FAO, NMHSs, the Consultative Group on International Agricultural Research (CGIAR), National Agricultural Research Systems and Extension Services, national entities dealing with agriculture, food security and policy issues, the United Nations Convention to Combat Desertification (UNCCD) and Soil Conservation Services. Linkages between producers of climate information and applications and various end users should be enhanced through appropriate mechanisms such as awareness raising, capacity-building for intermediaries and end-users and strengthening institutional partnerships, especially in developing countries;

- *Adaptation strategies for resilient agricultural systems.* Adaptation strategies to cope with climate variation and extreme events need to be developed and the information transferred to producers in a timely manner so they can adopt these practices to reduce their risk;

- *Climate change mitigation.* It is important to recognize that agriculture is also part of the solution to mitigate climate change and hence adequate investments should be made in strategies that reduce greenhouse gas emissions while maintaining agricultural productivity.

Climate in oceans and coasts

56. The ocean covers two thirds of the planet, and hosts the largest biosphere on earth. It plays a dominant role in the global climate system through the transport and storage of heat, water, nutrients and other climate variables such as carbon. The ocean mitigates surface

warming through the absorption of heat and greenhouse gases. It provides important living and non-living resources and other ecosystem services for humans. It contributes to the global economy, trade and food, and to national security. Its impacts on society are particularly strong within 100 kilometres of the coastline where 40 per cent of the world population live, and where ecosystem goods and services are most concentrated.

57. Climate change on timescales from decades to centuries has profound consequences for the marine, coastal and littoral environments with potentially devastating effects through: rising sea level; increasing heat content; increasing sea surface temperature; changes in strength and spatial distribution of the hydrological cycle; ocean acidification; ocean deoxygenation; and decreasing sea ice volume. Together these effects lead to changes in the distribution and abundance of marine life, altered food webs and changed biodiversity in marine ecosystems. Strategies and governance frameworks for risk management and adaptation responding to these changes need to be developed. This includes coastal defence strategies to cope with sea-level rise and storm surge rises; and responsive fisheries management, which rebuilds ecosystem resilience. The implementation of such strategies is critically dependent on climate, ocean and coastal observing, information, and prediction systems.

58. The global and coastal ocean experts at the Conference agreed that ocean information is integral and essential to the Global Framework for Climate Services and, in view of that, expressed strong support for the following key recommendations:

- *Comprehensive ocean observing system.* The Global Ocean Observing System (GOOS) should be a major part of the Global Framework for Climate Services and should be fully implemented in the open ocean and coasts, and further enhanced to include biogeochemical and ecosystem parameters, in line with international agreements and conventions (such as UNFCCC, GCOS, and the Convention on Biological Diversity) and including free and open data access. Such an observing system should be informed by the recommendations from the OceanObs'09 Conference;

- *Coastal and global ocean research.* National and international research should be strengthened to improve our understanding of ocean processes on global, regional and local scales, and should be an integral part of the Global Framework for Climate Services. There is a need for a better understanding of ocean–atmosphere interactions and the role of the ocean in predicting climate change on timescales from seasons to millennia. Further, quantification of the impact and interaction between climate and ecosystems, and particularly the connection between changes in the open ocean and their impacts on coastal systems, needs to be understood;

- *Assessments of ocean climate and marine ecosystems in response to user needs.* Sustained and timely operational assessments of the physical, biochemical and ecosystem states of the oceans should be implemented;

- *Comprehensive ocean climate prediction.* Operational systems should be developed and implemented for predicting changes in the ocean climate system on timescales of days to decades, including the development of operational marine ecology;

- *Capacity-building.* Developing nations and economies in transition need to be supported to develop national capabilities that contribute to and benefit from ocean observations, research, information, assessment and prediction. A particular need is to develop the local capability to take ocean observations, interpret the information and thus provide knowledge for local decision-making in support of creating

sustainable ecosystem goods and services for local social and economic benefit.

IV The scientific basis for climate services

59. For most of the past century, the main focus of climate services, whether provided by National Meteorological and Hydrological Services, research institutions or the meteorological private sector has been on the processing and provision of historical climate records for a wide range of planning and design purposes. Though genuine scientifically based attempts at climate prediction date back to the first half of the twentieth century, it is only since the establishment of the Global Atmospheric Research Programme (GARP) in 1967 and the World Climate Research Programme in 1980 that significant progress has been made on the scientific basis for climate prediction and the provision of integrated climate services in some countries.

60. The Conference reviewed the underpinning role of observations for essentially all types of climate services and the contribution of the Global Climate Observing System following its establishment in response to the exhortations of the 1990 Second World Climate Conference. It also reviewed the substantial progress under the auspices of the World Climate Research Programme over the past 30 years in providing a scientific basis for the climate prediction and information services already in place around the world under the general umbrella of the World Climate Applications and Services Programme and its Climate Information and Prediction Services (CLIPS) Project.

The essential role of climate observations

61. Long-term observation of the atmosphere, land and ocean is vital for all countries, and must be funded for the public good as economies and societies become increasingly affected by climate variability and change. The climate-relevant components of the various global, regional and national observing networks that have been incorporated under the auspices of the GCOS since 1991 have provided most of the data used for climate analysis, prediction and change detection. They have demonstrated that warming of the global climate system is unequivocal and have provided information on climate patterns and trends at regional and national scale.

62. The networks must be strengthened and sustained in order to monitor climate variability and change, and to evaluate the effectiveness of the policies implemented to mitigate change. Observations are needed to support improvement of climate models, to initialize and enable effective use of model predictions for decades ahead, and to guide the use of models for longer-term scenario based projections. Observations are needed to assess social and economic vulnerabilities and develop the many actions that must be taken to adapt to climate variability and unavoidable change. They must be recognized as essential public goods where the value of global availability of data exceeds any economic or strategic value of withholding national data.

63. Full implementation of GCOS is essential for supporting both the adaptation and the mitigation objectives of the UNFCCC, and for ensuring that all countries will be able to manage their response to climate variations and change through the twenty-first century.

64. The observational experts at the Conference accordingly agreed on the following recommendations:

- *Long-term sustenance of observing systems.* The established in situ and space-based components of GCOS should be sustained and operated with continued attention to data quality and application of the GCOS Climate Monitoring Principles;

- *Improvement of operation and planning.* The operation and planning of observing systems should be improved, so as better to identify deficiencies, achieve resilience, and assure reliable and timely delivery of good quality data, traceable to international standards;

- *Enhancement of observing systems.* Enhancements to observing systems should be implemented wherever feasible, filling gaps in spatial coverage and in the range of variables measured, improving measurement accuracy and frequency where needed, increasing use of operational platforms for satellite sensors, ensuring adequate monitoring of urban and coastal conditions, and establishing key high-quality reference networks;

- *Improvement of data services.* Improvements should be made to the rescue, exchange, archiving and cataloguing of data, and to the recalibration, reprocessing and reanalysis of long-term records, working towards full and unrestricted access to data and products;

- *Observations for adaptation planning.* All countries should give high priority to the observational needs for adaptation planning, identifying their needs in National Adaptation Programmes of Action where applicable;

- *Regional implementation of GCOS.* Developed countries should commit to assist developing countries to maintain and strengthen their observing networks through support for updating, refining and, most important, implementing the GCOS Regional Action Plans and other regional observational and service initiatives such as ClimDev Africa, GOOS Africa, and Pacific Islands GCOS.

Seasonal to interannual climate variability, predictability and prediction

65. Seasonal prediction is based on changes in the probability of weather events due to changes in slowly varying forcings such as sea surface temperature anomalies, as occurs during El Niño. Since seasonal weather is influenced by many factors, including internal variability of the atmosphere and not all sources of potential predictability are properly understood, forecast systems, based on comprehensive models, are still a long way from producing consistently useful results. Opportunities for progress exist through greater convergence of weather and climate forecast models.

66. The experts with a wide range of experiences made the following recommendations:

- *Model quality.* Seasonal prediction information depends critically on the quality of models, and current seasonal prediction models have serious deficiencies. Although these cannot be transformed overnight, long-term commitment of substantial resources for model and assimilation system development, and the supporting research, is required;

- *Climate prediction systems*. Developing and testing models and forecast systems across a range of timescales is essential. Indeed, it is critical that our climate prediction systems simulate the statistics of regional weather with sufficient fidelity. Provision of computer resources to allow development of extremely high-resolution global modelling should be pursued. In particular a priority is to implement the recommendations from the World Modelling Summit for Climate Prediction (2008). There is a compelling need for dedicated computational facilities that are 1 000 to 10 000 times more powerful than those available today;

- *Road map to quality improvement.* Seasonal forecast quality can also be improved by taking into account processes in the cryosphere, land surface, and stratosphere. In essence, the "road map" for improving seasonal prediction as developed at the first WCRP Seasonal Prediction Workshop (2007) in Barcelona should be implemented;

- *Improved observations and assimilation.* The maintenance and improvement of observing systems, data assimilation systems and reanalysis must also all be supported for improved seasonal prediction;

- *Local and regional forecasts.* Much more effort must be invested in demonstrating the use and increasing utility of these forecasts at the local and regional level;

- *Interpretation and tailoring of climate products.* The increased use and benefit of seasonal forecasts will occur only with the appropriate interpretation and tailoring of climate predictions, and the development of more explicit and real-time links with application models (such as crop yield prediction). This requires real-time access to model forecast data and relevant observations, both of which should be freely available as a public good;

- *Culture change.* Building a "chain of communication" that can benefit from advances in climate predictions to society is required. The chain must target decision-makers responsible for national infrastructures and welfare, and should include climate intermediaries and NMHSs, sectoral experts, government, business sectors, media and others. This will enable NMHSs and local climate services to respond to local users by providing locally relevant information.

Decadal climate variability, predictability and prediction

67. The indisputable evidence of global warming and the knowledge that surface temperatures will continue to rise over the next several decades under any plausible emission scenario is now a factor in the planning of many organizations and governments. It does not imply, however, that future changes will be uniform around the globe. Regional and seasonal variations in climate associated with natural variability will have large impacts, especially over periods of a few decades or less. An important challenge is, thus, to predict regional scale climate variability and change. The decadal timescale is also widely recognized as a key planning horizon for governments, businesses and many socio-economic sectors for which climate sensitivity and vulnerability are high.

68. Decadal prediction efforts are underway, but they are in their infancy and many challenges exist. The experts stressed these major recommendations to address the challenges:

- *Enhancement of observing systems.* Dedicated efforts are necessary to maintain and enhance the Global Climate Observing System, which is essential for initializing and validating decadal prediction systems. Of particular importance is the Global Ocean Observing System since the feasibility of decadal predictions largely stems from the role the ocean plays in the predictability of slowly evolving modes of variability;

- *Predictability and prediction on decadal timescales.* Increased investment in the research, computing and modelling systems to be used for decadal predictions is needed in order to reduce model biases that limit prediction skill and present significant difficulties in the development and testing of the data assimilation schemes; to improve the understanding and representation of the important mechanisms of decadal climate variability and change; and to establish the inherent predictability;

- *User–expert communication.* Mechanisms to increase dialogue between the climate information providers and those in the sector communities are required to make appropriate and best use of experimental predictions, to define requirements more effectively, and to drive improvements in predictive systems;

- *Cost-effective investment.* The cost of implementing these recommendations will be substantial. It is likely to be very small, however, in the context

of the overall costs of adaptation. Furthermore, reduced uncertainty in predictions can be expected to reduce the cost of adaptation.

Regional climate information for risk management

69. Because of regionally unique climate characteristic and socio-economic structures, focused and relevant climate information and services are needed for many purposes especially disaster risk reduction, protection against disease, environmental protection, enhanced agricultural production, water resource management and infrastructure planning. In order to meet end-users needs for climate information and services, it is necessary to improve technological capabilities continually through further research and development on key climate processes and climate prediction models and methods. This requires strong regional cooperation in capacity-building and provider–user dialogue.

70. The Regional Climate Outlook Forums (RCOFs) conducted in many regions over the past decade have contributed to the improvement of regional climate services through the production of consensus forecasts, exchange of technical information among National Meteorological and Hydrological Services and regionally based interaction between climate service provider and user communities. The emerging WMO framework for climate service provision includes the WMO Global Producing Centres (GPCs) and a network of regional centres including Regional Climate Centres (RCCs) supporting the role of the NMHSs.

71. In order to enhance the satisfaction of demands for regional climate information and services for risk management, regional climate services experts at the Conference expressed strong support for:

- *Provider-user partnerships.* Partnerships should be fostered between NMSs and user communities to promote effective user-oriented climate information and services and decision support system;

- *Integrated weather–climate information.* NMSs should be enabled to promote the production and provision of seamless weather and climate information on daily to centennial timescales;

- *Regional capacity-building.* Designation, establishment and development of mechanisms such as RCCs, RCOFs and participation in user planning forums such as Malaria Outlook Forums should be supported and strengthened as important means of providing user-tailored climate services including climate change projections for the development of adaptation strategies. Regional cooperation with a wide range of sectors is essential to improving the capacity to provide and use climate information;

- *Observation, monitoring and research.* Continued efforts on climate observation, monitoring and research are needed to improve the basis for provision of regional and national climate information and services continuously. Research efforts should be informed through dialogue with climate service providers and users.

V Adaptation to climate variability and change

72. The Conference recognized that the principal international forum for coordination of national action on both the adaptation and mitigation responses to climate change is provided by the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change and that the Intergovernmental Panel on Climate Change provides the critical role of analysing the available climate data and information and producing policy-relevant assessments for the Parties to the UNFCCC. It also noted that under the auspices of its Chief Executives Board, the United Nations system is committed to "Delivering as One on Climate Knowledge".

73. The Conference further noted the urgency of establishing a Global Framework for Climate Services as an effective means to address user needs for information on shorter term (seasonal to decadal scales) climate variability and change that affect societies at the national level, and for the development of common policies and actions internationally. The results of the three essential issues, discussed below, address factors to consider in providing effective national and international responses to climate variability and change.

Climate risk management

74. The most dominant message coming from the Conference Round Table on Climate Risk Management was that the proposed Global Framework for Climate Services must engage user communities in developing services tailored to meet their needs for climate risk management. If this is not done, a real danger exists that the services will not be used.

75. The Round Table also noted that there is a lack of critical data available for use in development of climate services. This includes data that are not collected as well as data that are collected but not exchanged because of inadequate data policies. Ownership of data at local scales was seen as being particularly important and this included, as a key priority, making data widely available to engineers and scientists in the developing world.

76. A number of speakers stressed that important science challenges must be overcome, including improved broad scale climate predictions and downscaling to regional and local spatial scales. Scientists and engineers in the developing world need access to and training in the use of models that assist in local climate prediction and the development of services to meet local needs. It was seen as particularly important that users of services provided through the proposed Global Framework for Climate Services understand the capabilities and limitations of this information and the concepts of probabilities and uncertainties associated with this climate information.

77. Climate was seen as only one component of environmental risk management, that is, as a compounding factor in an already stressed environment. Therefore climate scientists need to work with a broad community of engineers, social scientists, biologists and the like in developing information that fully meets the needs of decision-makers.

78. Finally, the participants in the Round Table noted that many climate services are already being provided to a broad range of users, and that the proposed Global Framework for Climate Services should build on, not duplicate, these activities.

Climate adaptation and the Copenhagen process

79. The Round Table on Climate Adaptation and the Copenhagen Process discussed how the proposed Global Framework for Climate Services could support the implementation of relevant elements on adaptation of a Copenhagen agreed outcome, in particular as they relate to the needs for climate information and services to inform decision-making on adaptation.

80. In order to enhance climate service support for the work of the UNFCCC, there was strong support for the following recommendations:

- *Priority on adaptation.* Adaptation has become an important priority, requiring enhanced action towards implementation at all levels and across all sectors, based on a solid knowledge and information base;

- *Action on adaptation.* A robust outcome on enhanced action on adaptation in Copenhagen that will catalyse action on adaptation will be of benefit to all countries, but, in particular, will help the most vulnerable to adapt to the impacts of climate change. Assessment, planning and

implementation of adaptation actions needs to be based on, and supported by, strengthened research; systematic observations; monitoring and modelling; and improvements to the collection, reliability, provision, dissemination and application of climate data, information and knowledge;

- *Information for adaptation.* Improved climate data and information, including data on extreme events, are critical to adaptation. This would enable more robust assessments of vulnerabilities and prediction of impacts, adaptation planning and practices, and reduction and management of risks through consideration of climate information in decision-making, and thereby enable a proactive approach for adaptation;

- *Need for international cooperation.* The UNFCCC has expressed a need for the type of information and services that a Global Framework for Climate Services is expected to deliver, in particular to support adaptation activities, and has made calls upon the international community to address those needs. In developing a Global Framework for Climate Services, existing global, regional and national initiatives and knowledge, including work and expertise of United Nations agencies as well as regional centres should be used. At the same time, cooperation needs to be fostered among all countries in sharing knowledge, data, methods and tools for adaptation purposes, as well as between the meteorological and broader climate change communities;

- *Benefits of a Global Framework for Climate Services.* A Global Framework for Climate Services can and should support many of the needs already identified under the UNFCCC. It has the potential to assist Parties to the Convention in their adaptation efforts in the upcoming years, including in the implementation of relevant elements under a Copenhagen agreement. At the same time, a Global Framework for Climate Services can address many of the needs and priorities identified by countries under the ongoing work on adaptation under the UNFCCC, such as on research and systematic global climate observations, the Nairobi Work Programme, and National Adaptation Programmes of Actions of Least Developed Countries;

- *User interface.* A Global Framework for Climate Services that facilitates strong linkages between developers and users of climate information can provide the information base that decision-makers at all levels and across sectors need to act upon, and as such can become a powerful tool to support adaptation efforts.

Communicating climate information for adaptation and risk management

81. The successful communication of climate change and variability information to the world's public remains one of the least resolved issues within climate change. Disseminators and communicators of climate change information come from a wide background within science and the humanities, but generally with a strong presence from the world of television broadcast meteorology. This group of people is made up primarily (but not exclusively) of broadcast meteorologists, skilled weather presenters, and environmental journalists. It is not, however, a cohesive group, and there are varying levels of comprehension of the core science within this group of people. It is, however, the daily broadcast meteorologist or weather presenter who is recognized as the most trusted, credible and talented person capable of delivering the complex message of climate change.

82. The Conference Round Table on Communicating Climate Information agreed that there was not enough dialogue between scientists and communicators, and that the development of climate services were not being advanced quickly enough, especially in light of the recent accelerated rate of climate change and variability noted by many climate scientists.

83. The Round Table participants, together with the audience, voiced agreement on the following main recommendations:

- *Climate communicators.* The NMHSs should involve those who communicate the daily weather messages from within their own organizations when planning for the mass distribution of timely climatological information. The climate change message must be delivered efficiently and effectively irrespective of any prevailing political persuasion;

- *Access to climate information.* There is a pressing societal need for climate change information. It is necessary to make sure that weather and climate communicators themselves remain at the very forefront of the science. Researchers, scientists, climatologists and academics within the field are urged to share their knowledge freely, willingly, and in a timely manner to further the process of dissemination. Access to information remains the single biggest hurdle for many weather and climate communicators;

- *Best practices and training.* Best practices in regards to "delivering the message" range widely from country to country, because of differences in the varying regional threats, and difference in the delivery mechanisms around the world. There are a few rules and techniques, however, that can aid effective delivery of the message. These techniques need to be shared among all broadcasters. Weather broadcasters should have access to training in these techniques and be empowered to use them. The World Meteorological Organization has a lead role in this task. It should tap into the professional broadcast organizations to facilitate broadcast and presentation training for those who require it;

- *Unbiased communication of climate information.* Communicators of climate change must remain independent. Every socio-economic sector will potentially be affected by our changing weather, and the communicator should not be aligned with any one single group. It is of the utmost importance that broadcasters who discuss climate change and variability are not perceived by the audience to be unduly influenced by political ideology nor economic considerations;

- *Dialogues with communicators.* There should be a much greater degree of dialogue between climate change scientists and those who communicate to end-users;

- *Outreach by climate communicators.* Weather broadcasters should take a lead in reaching out to other communities, in particular the education and health communities, in promoting discourse over climate change and variability.

VI Societal perspectives on climate services

84. Many different communities, in addition to the established climate service providers, have become increasingly engaged over the years since the 1990 Second World Climate Conference with the various scientific, operational, social and policy issues involved in providing and using climate services.

85. It was agreed that these diverse perspectives are extremely important to the design of an effective Global Framework for Climate Services and four different stakeholder groups were invited to conduct forums related to climate and gender; climate and communities; business and industry; and capacity-building, education and training. The most important conclusions from these forums were as follows.

Climate and gender

86. The experts and participants of the Gender and Climate Forum of the WCC-3, having considered an extensive body of knowledge and expertise in the area of gender and climate variability and change, recognized that women and men around

the globe are distinct carriers, providers and users of climate information, and that mounting evidence shows that drivers and consequences of climate change are not gender neutral. The experts placed priority on:

- *Mainstreaming gender equality.* Gender equality must be mainstreamed into climate science, mechanisms and activities, and into climate institutions, particularly the World Meteorological Organization and National Meteorological and Hydrological Services, and into the Global Framework for Climate Services.

87. The Forum participants concluded that the proposed Global Framework for Climate Services should reflect a gender perspective in all its components, namely:

- *Observation and monitoring.* Involvement of local communities, particularly local women in environmental change and climate observations, and the provision of adequate preparation and training of women and men is necessary for their full participation as providers and users of climate information;

- *Research and modelling.* Gender parity and equal participation of women researchers in climate research should be ensured at the national, regional and international levels. The role of social scientists and the human dimension in climate research should be enhanced;

- *Climate service information system.* Information on gender aspects of climate and health, energy, water and agriculture for mitigation and adaptation, particularly through the collection of gender disaggregated data, at both the country and regional levels needs to be enhanced. National statistics divisions should be trained in gender disaggregated data collection, in collaboration with United Nations agencies, and legal guarantees for the regular and continuous production of a minimum set of gender-specific data in situations of climate change, should be promoted;

- *Climate services application programme.* Recognizing the level of knowledge and taking into account the realities of access to information for women, it is necessary not only to ensure accessibility and benefits from climate information for scientists and decision-makers in all regions, but particularly for local communities, especially local women.

88. The Gender and Climate Forum further recommended:

- *User-oriented information.* Climate information and practical prediction services, including those designed by users, is important to assist in empowering local women;

- *Outreach and capacity-building.* It is important to ensure and support outreach and capacity-building for a broad user community, including local women and men of different age groups.

Climate and communities

89. Local communities are at the frontline of the impacts of climate change, climate variability and extremes. The community level is a key entry point for better climate risk management. The most vulnerable communities, however, rarely benefit from our growing ability to anticipate future conditions and are often missing in national adaptation plans and programmes.

90. The Forum on Climate and Communities was informed by practical experiences on community-based risk management from a range of perspectives, including people working directly with local communities and indigenous peoples, boundary organizations, development and humanitarian organizations, meteorological agencies and academia. They demonstrated that community-based risk management is a very effective, and in fact essential, component of national and international efforts to better manage climate variability and change.

91. Practitioners and experts at the Forum agreed that:

- Empowerment of communities is essential;
- Climate is seldom communities' first concern, so climate risk management needs to be integrated into community development, security and practice;
- Local communities are holders of complex knowledge about local weather, climate, biodiversity, ecosystems and have a history of adaptation to climate variations. Climate risk management should draw on socio-economic data and local vulnerability and capacity assessments to assess and address differential vulnerabilities among and within communities, including gender, age and income differences, and recognize potential trade-offs;
- Communities will accept and use external information when they trust the source and there is a supportive partnership context;
- Much can be achieved by adapting to the current climate, and reducing the current adaptation deficit by including short-, medium- and long-term risk planning.

92. The Forum agreed that science-based climate information can effectively support climate risk management at the community level, and made the following recommendations to achieve this at a wider scale:

- *Local knowledge and decision-making.* It is necessary to recognize the central role of local communities in decision-making at the local level, and to draw on their existing traditional knowledge, values, skills and cultural systems;
- *Build local capacity.* Building capacity at the local level empowers communities and strengthens the link between local practice and national policy frameworks;
- *Start now.* Better application of climate information can be generated right now, rather than just on longer-term efforts to enhance observations and predictions;
- *Context-specific climate risk management.* Provision of generic climate information is not enough. Climate risk management is highly context-specific. There is no one-size-fits-all climate information product, and actionable information, as well as guidance and tools, supportive rather than prescriptive, are needed;
- *Expectations of users.* It is essential to be transparent on uncertainties and inform local users on what can be expected. Effective communication can ensure that information gets to the right level and is understood, trusted and actionable;
- *Best practices.* Best practice examples and peer-to-peer learning should be fostered, including through modern media and stakeholder forums;
- *Partnerships.* Benefit can be gained by investing in partnerships and instituting effective engagement based on dialogues among users and suppliers of information and services, often through local champions and boundary organizations.

Climate and capacity-building, education and training

93. Capacity-building is much more than training. It requires institutional strengthening in governance, management and funding as well as human resources development, in areas such as weather, climate and water. Capacity-building activities for improving adaptation require that the stakeholders demand that they should be service-oriented and driven by the outcomes that stakeholders request. The capacity to use climate information then becomes part of a larger effort to achieve a specific goal. The capacity-building experts developed the following recommendations for action:

- *Capacity development.* Capacity development works best when politicians and scientific leadership have the same vision. Strong leadership is critical for effectiveness;

- *Climate change education.* Mainstreaming of climate change education in curricula at all educational levels is a priority;

- *Interaction between science and communities.* Due to the site-specific nature of resilience and adaptation to climate change, local community and indigenous knowledge of ecosystems, natural hazards and adaptation mechanisms has been developed over long time periods. Yet climate change and variability may overwhelm these traditional adaptation mechanisms. It is therefore urgent to enhance the human and institutional capacity to increase the interaction between scientific knowledge and local community and indigenous understanding at all levels;

- *Adapting to current variability.* Focusing adaptation to climate change scenarios that are far in the future (over 50 years) with large uncertainties strongly reduces the interest of most stakeholder groups. Climate change must be promoted as an issue of the present. Societies need to improve adaptation to current climate variability and extremes, and, by doing so, will improve their adaptive capacity to future climate scenarios. Efforts should therefore be focused in building the capacity to identify and promote actions that improve adaptation today and reduce vulnerabilities in the future;

- *Accessibility.* Climate information services should be accessible by users, useful in national and regional contexts, and assimilate local inputs and accept feedback. Such information services will be developed through capacity-building at the policy, institutional and individual levels. External players should abide by clear principles of engagement when undertaking capacity development work;

- *Long-term partnerships.* Capacity-building and training must be seen as a long-term provider–user relationship of listening and learning. Such a relationship requires access to data and information, the ability to generate knowledge, and community collaboration. It is essential that programmes are monitored and evaluated, and that lessons learned feed back into the programme and to demonstrated useful results;

- *Adapting to high risks.* Managing climate-related risks to sustainable development is already a requirement in high-risk environments. The tools developed for managing climate-related risks are relevant for climate change adaptation, and provide a useful and necessary starting point for capacity development;

- *Mainstreaming climate information.* Climate information products will be optimized when all links in the existing information chain, from information producers to users at various levels, are competent.

Climate, business and industry

94. Climate change is a cross cutting issue, threatening energy, food and water security; undermining human health and biodiversity; and affecting key economic sectors such as transport and tourism. Global coordination and collaboration between the private sector and the public sector are essential to address these interrelated challenges.

95. Better climate information helps business to focus our research and make the right long-term investments. The viability of businesses depends on their vulnerability to the impacts of climate change and their ability to adapt. Predictive services and climate modelling can help them adjust their business model and open the door to new opportunities. The WCC-3 will help raise awareness and develop climate-related services that can assist governments and businesses in making

better decisions. The business and industry experts made the following recommendations:

- *Public–private partnerships.* Innovative partnerships that foster rapid development of advanced technologies to reduce emissions are critical. It is important to bring in all key stakeholders including subnational actors, to find innovative solutions to climate change;

- *Role of the private sector.* The Global Framework for Climate Services will help companies benefit from enhanced climate services and provide better accessibility to climate information. The expertise of the private sector should be utilized to the fullest.

VII Implementing climate services

96. The Conference reviewed a wide range of experiences from developed and developing countries, from the research and operational communities and from many different parts of the world, in the implementation of climate services. The workshops on "Implementing Climate Services" were focused particularly on:

- The end-to-end process of making better use of climate observations in support of model development and use for operational prediction;

- The role of national and international research programmes in supporting the development and improvement of climate services;

- The diverse experiences of different regions, countries and institutions in the implementation of climate services.

From observations to predictions

97. This workshop explored the value chain leading from Earth observation data via processing and modelling to climate information services for decision-makers. It addressed climate adaptation services through two case studies on local and regional sea-level rise, and it highlighted climate mitigation services by presenting an emerging forest carbon monitoring system. It also explored the range of activities involved in converting raw satellite observations into final climate products and services for end-users.

98. The two case studies reached the following conclusions:

- For sea-level rise, global scenarios need to be translated into local and regional scenarios, requiring the incorporating of the impacts of topography, land subsidence, river and delta dynamics and other local variables. Developing more effective information services will also require improved observations, which in turn will lead to improved models and scenarios; more coordination of observations and integration of data; and rapid and effective dissemination of user-friendly information, including to the general public via warning systems.

- For a robust forest carbon monitoring with wall-to-wall coverage, governments, space agencies and other organizations are working through the GEO framework to integrate in situ observations, remotely sensed observations, and methodologies for estimating carbon content. The aim is to allow governments and the emerging carbon markets to measure and certify forest carbon flows more accurately than ever before.

99. End-users are not always fully aware of the vast amount of behind-the-scenes work that goes into preparing remotely sensed and in situ observations so that these data can be reprocessed, analysed and transformed into climate information products. Broadening the scope and cross-cutting nature of the data entering the processing stream, and strengthening and sustaining the world's diverse Earth observation systems, is critical for the future of climate services.

100. The experts at the workshop made the following recommendations:

- *Sustained observations.* The climate community should, as a top priority, seek to ensure that climate service providers obtain easy access to sustained and cross-cutting observations and information;

- *Robust scenario development.* Recognizing that predicting climate changes and impacts remains a real challenge, climate service providers should focus on delivering robust scenarios that allow decision-makers to consider a range of options and policy responses;

- *Sector-specific information.* Because both climate change science and the needs of decision-makers are so complex, climate information providers should craft their services to meet a diversity of needs, including for local scenarios with short timescales and global scenarios based on longer timescales.

Research engagement

101. Climate science has advanced significantly during the past three decades, yet many scientific challenges remain. The essential need is to make quantitative climate predictions on timescales from seasons to decades and spatial scales of local to regional to global. The ultimate goal is to create integrative science. This integration must include the identification of the users' needs from the outset. This will provide climate information and services in a timely manner to decision-makers and operational organizations.

102. The societal need for authoritative information on climate variability and change demands increased research and development efforts. These include: improved understanding of climate processes and feedbacks; better emissions scenarios; advanced modelling at high spatial resolutions to capture the regional aspects of climate variations and changes and for realistic representation of crucial climate processes; capacity for gathering, processing, and sharing observational data for model evaluation and initialization; development of hardware and software capabilities for analysing and interpreting the model and observational results; the quantification of uncertainties in a probabilistic manner including recognition of the high-impact-end of the distributions; streamlined transition to an operational mode including the generation of climate products and services; facilitation of feedback from the user community and providing inputs into the research priorities; and resources and skills to synthesize the information and meet user needs for decision-making at the global, regional and local levels.

103. There is a clear recognition that the full understanding of climate requires a holistic approach that accounts for all processes of the Earth system, including socio-economic processes. To meet the expectations of the proposed Global Framework for Climate Services, there is, therefore, a need for:

- *End-user focus.* The end-users should be identified, and the products and services should be re-evaluated to meet the needs of the user community more effectively;

- *Earth system approach.* An Earth system approach to observations, monitoring, modelling, analysis and prediction should be adopted. The coordination and acceleration of prediction research is essential;

- *Data integration.* Success requires the integration of space-based and in situ observational systems that accurately capture key climate variables, and are sustained over decades for a robust determination of trends and variations at the regional and global level;

- *Interactions between models and observations.* The synthesis of observations and model outputs to provide accurate regional and global

climate information, and the utilization of model-based uncertainties to plan better observing system strategies constitute important scientific underpinnings of any new climate information system and services (that is, linking research with operations, services and delivery);

- *Significantly enhanced high performance computing.* Significant enhancements (by at least a factor of 1 000) in high performance computing and telecommunications networks are necessary;

- *Capacity-building.* The infusion of highly skilled human scientific talent via training and capacity-building, especially through young scientists and, importantly, in the developing regions of the world is crucial. Developed countries must work with developing countries in transferring capacity, technology, education and computing. The initiative, however, should come from experts at the local level, where the service will be installed.

Nations and regions

104. The national and regional workshops on implementing climate services developed a set of recommendations as follows:

- *Communication strategies.* The development of strategies to communicate relevant and tailored climate information (including measures of uncertainties) effectively to stakeholders, decision-makers, the general public and the media are needed;

- *Ownership.* Development of "ownership" by the population and the users, including translation of products into local language, is important for the effective use of information;

- *Capacity-building.* To ensure sustainability of services, capacity-building and effective in-country training are necessary, as is funding for Climate Outlook Forums. The development of appropriate tools (such as numerical models) and adequate human resources to develop these tools is an important element in climate application;

- *National activities.* National level information on climate change as well as early warning services are needed for preparation of national adaptation strategies. Matching capability to user requirements requires effective dialogue;

- *Regional climate services*. These services are very important to contribute to enhanced social and economic resilience and decision-making in many climate-sensitive sectors (water resources, agriculture, fisheries, health, energy, and disaster risk management, for example);

- *Climate in development.* Climate information is essential for socio-economic development. Conscious efforts are needed by stakeholders and key players in climate-sensitive sectors to understand the full potential and usefulness of this information;

- *Integration.* Good linkages between Global Climate Prediction Centres (GCPCs) and Regional Climate Centres are needed for the best use of products at the regional and national levels. Regional coordination is needed to foster improvements at the national level. Lessons learned to tailor information from GCPCs, RCCs and National Climate Centres (NCCs) should be applied.

VIII Exploiting new developments in climate science and services

105. The Expert Segment of the Conference had the opportunity, through plenary poster sessions and other briefings, to preview a wide range of innovative research, service provision and application projects that promise to contribute to the quality, range and utility of climate services in future years. The Conference participants expressed appreciation to all those had contributed scientific and technical presentations during the Expert Segment and were especially

appreciative of the information provided on new developments.

106. The three poster sessions provided the opportunity for participants to communicate original scientific findings and other information.

Posters were invited from those experts who wished to contribute their ideas and work, including scientists at government agencies and research laboratories, climate service practitioners, students and other interested individuals or groups such as non-governmental organizations. Areas of special interest included the science base, information systems, computational needs, demonstration of successful best practices and regional issues.

One-page abstracts for the poster sessions had to be submitted to the Conference Secretariat before 15 June 2009. Poster submissions were reviewed and notice of acceptance was provided by 30 June 2009.

A total of 200 posters were grouped under three general topic areas:

- Community and environmental sectors
- Climate science
- National or regional examples of climate service provision and application

Those submitting abstracts had clearly indicated the category in which they would like their posters to be included and whether they wished to make a short introductory presentation (two minutes; one or two slides).

107. Areas of particular interest in the poster presentations on "Community and Environment" included:

- Climate issues that are already spurring a call to action, such as:
  - Analyses of complex systems showing subtle sensitivities to climate;
  - Application of the most basic weather and climate information as the season unfolds to natural resource utilization and management;
- Assessing how well communities were indeed adapting to climate change. The most vulnerable regions of a country, for example, were often not the most proactive in adaptation planning to a particular hazard, be it flood, storm or drought;
- The need for a systematic framework for climate services. The diversity of the posters suggested that effective adaptation to climate variability and change at country, regional and indeed the global level would benefit from a systematic framework for the delivery and uptake of generalized and targeted climate information services;
- The critical importance of ongoing climate data for the assessment of fluctuations and trends in risks arising from exposure and vulnerability to natural hazards.

108. Areas of particular interest in the poster presentations on "Climate Science" included:

- Use of climate observations to identify regional trends;
- High resolution modelling at global and regional scales;
- Studies of regional climate change and climate impacts.

109. Areas of particular interest in the poster presentations on "Regional and National Examples of the Provision of Climate Services" included:

- Variety of fields of services for ecological applications, including agriculture;

- The role of the media in communicating climate information (especially prominent in the hydrological posters);

- Existing activities at the national level to enhance a country's capacities to develop tailored user-oriented climate services;

- Good knowledge of the user needs on the spatial and temporal resolution for successful climate services. It was noted that the civil society could provide helpful guidance for the development of climate information and services at local levels;

- Demonstration that the good exchange of knowledge and experiences at regional and sub-regional levels would be beneficial for all involved in delivering climate services.

110. The Conference participants strongly encouraged all of those who had contributed their work to the Expert Segment to continue to support the progressive implementation of the proposed Global Framework for Climate Services over the coming years.

IX A Global Framework for Climate Services

111. The Conference recognized that great progress has been made over the past 30 years towards an integrated global approach to the development, implementation, operation and application of climate services in support of a wide range of societal needs in all countries and in all major socio-economic sectors. It particularly recognized the achievements under the World Climate Programme, especially its World Climate Applications and Services Programme and the Climate Information and Prediction Services Project in the successful implementation of the Regional Climate Outlook Forums and their support for enhanced national climate services in many countries.

112. The presentations and discussions made clear, however, that the present arrangements for the provision of climate services fall far short of meeting the identified needs and that there is vast, as yet largely untapped, potential to improve these arrangements and enhance the quality and utility of climate services for the benefit of all countries and all sectors of society. There was widespread agreement among both provider and user community representatives that a new global framework is required to enable better management of the risks of climate variability and change, and to promote the adaptation to climate change at all levels through development and incorporation of science-based climate information into planning, policy and practice.

113. The participants in the Expert Segment welcomed the extensive preparatory work by WMO and its partner organizations on the design of the proposed Global Framework for Climate Services and the consultations that had already taken place with governments through both technical and diplomatic channels. They were in full agreement that, from the scientific and operational perspective, the proposed Framework should reinforce and complement the established international organizations for the provision and application of weather, climate, water and related environmental information, forecasts and warnings; and should build on and integrate the existing international systems and programmes for climate observations and research that are co-sponsored by WMO, other United Nations system partner organizations, and ICSU. WMO and user sector organizations should enhance collaboration in the development of practical guidance on the preparation and use of climate products in different sectors and regions.

114. The participants in the Expert Segment of the Conference called for major strengthening and implementing, as appropriate, of the essential elements of the proposed global framework for climate services:

- The Global Climate Observing System and all its components and associated activities; and provision of free and unrestricted exchange and access to climate data;

- The World Climate Research Programme, underpinned by adequate computing resources and enhancing interaction with other global climate relevant research initiatives;

- Climate services information systems taking advantage of enhanced existing national and international climate service arrangements in the delivery of products, including sector-oriented information to support adaptation activities;

- Climate user interface mechanisms focused on building linkages and integrating information, at all levels, between the providers and users of climate services aimed at developing efficient use of climate information products, including the support of adaptation activities;

- Efficient and enduring capacity-building through education, training, and strengthened outreach and communication.

115. On the basis of the three days of discussion and deliberations during the Expert Segment, the participants supported the development and implementation of the proposed Global Framework for Climate Services.

Annex 6 Brief Note (Annex to the Declaration)

The World Climate Conference-3 proposes to create a Global Framework for Climate Services through which the developers and providers of climate information, predictions and services, and the climate-sensitive sectors around the world, will work together, to help the global community better adapt to the challenges of climate variability and change. This Brief Note presents an overview of the Framework, by answering a series of key questions.

Why is a Global Framework for Climate Services necessary?

1. Many socio-economic sectors, including water, agriculture, fisheries, health, forestry, transport, tourism and energy, are highly sensitive to weather and climate extremes such as droughts, floods, cyclones and storms, heat waves or cold waves. Decision-makers in these sectors are increasingly concerned by the adverse impacts of climate variability and change, but are not sufficiently equipped to make effective use of climate information to manage current and future climate risks as well as ecosystems. Consequently, there is not only an urgent need for enhanced global cooperation in the development of accurate and timely climate information but an equally urgent need for its exchange between the providers and users of climate services, thus ensuring that relevant climate information is integrated into planning, policy and practice at various levels.

2. Recent advances in science and technology offer the prospect of further improvements in the quality of climate information and prediction services. Integrating seasonal to multi-decadal predictions and long-term climate projections into decision-making in all socio-economic sectors, through an effective two-way dialogue between providers and users on the range, timing, quality and content of climate products and services, will ensure that decisions relating to managing climate risks are well informed, more effective and better targeted.

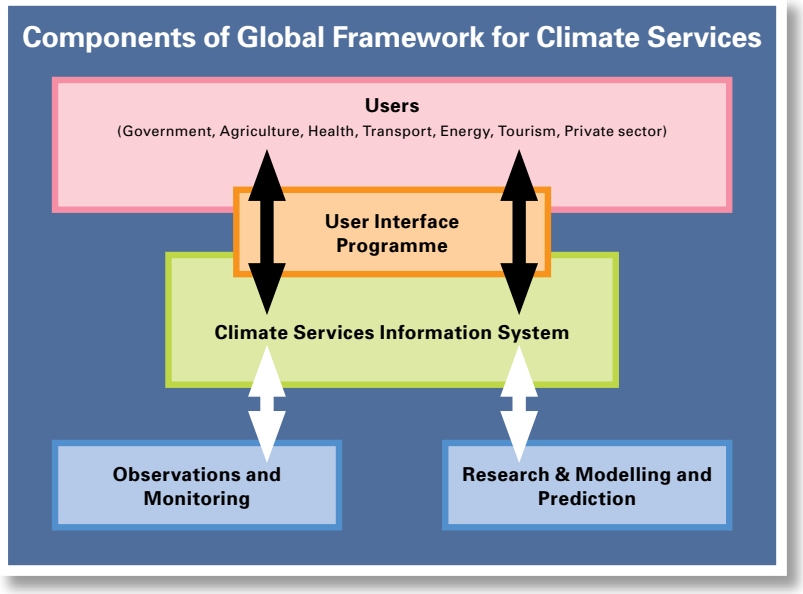
3. In order to address the need for improved climate information and to provide an effective interface between scientists, service providers and decision-makers, the World Meteorological Organization and its partner organizations for the World Climate Conference-3 propose the development of a new Global Framework for Climate Services (also referred to as the 'Framework') with the goal to: *"Enable better management of the risks of climate variability and change and adaptation to climate change at all levels, through development and incorporation of science-based climate information and prediction into planning, policy and practice".*

What is the Global Framework for Climate Services?

4. The Global Framework for Climate Services is proposed as a long-term cooperative arrangement through which the international community and relevant stakeholders will work together to achieve its stated goal.

5. The Framework will have four major components: Observations and Monitoring; Research and Modelling and Prediction; a Climate Services Information System; and a User Interface Programme (see figure). The first two components are well established but are in need of strengthening. The latter two components together constitute a "World Climate Service System".

6. The User Interface Programme, which presents a relatively new concept, will develop ways to



bridge the gap between the climate information being developed by climate scientists and service providers and the practical information needs of users. Recognizing that the needs of the user communities are diverse and complex, it will support and foster necessary institutional partnerships, cross-disciplinary research, innovation, development of decision support tools and climate risk management practices, generation and capture of knowledge, evaluation and establishment of best practices, education, capacity-building and service application for decision-making. The outcomes of the User Interface Programme will be reflected in the operational services of the Climate Services Information System (CSIS).

7. The Climate Services Information System will build on established global programmes such as the World Climate Programme and will reinforce, strengthen and better coordinate the existing institutions, infrastructure and mechanisms but, importantly, will focus on user-driven activities and outputs, while continuing to implement science- and technology-driven ones.

8. The CSIS, through a network of global, regional and national institutions, will synthesize information streaming from the Observations and Monitoring and Research & Modelling and Prediction components of the Framework, and will create information, products, predictions and services in an operational mode at various spatial scales. These services will be enhanced by feedback from users and other components of the system, and by the outputs of the User Interface Programme, thereby ensuring the development and delivery of user-oriented climate information and prediction services. It will focus, in addition, on standardization, exchange and quality assurance of information and on communicating the highest quality information, products and services possible to decision-makers from global to local scales. Through enhanced international cooperation for development and transfer of technology related to meteorological services and mobilization of resources, this System will also build capacity among national and regional meteorological service providers in developing and Least Developed Countries, whose contributions are essential for improved climate information products at global, regional and national scales.

What will be achieved through the Global Framework for Climate Services?

9. The Framework, when fully implemented, will support disaster risk management and climate risk management practices, and will contribute to achieving the objectives of various Multilateral Environmental Agreements such as the United Nations Framework Convention on Climate Change (UNFCCC), and of internationally agreed upon goals including the Millennium Development Goals. Effective implementation of the four components of the Framework would lead to the following:

- Strengthened local, national, regional and global observational networks and information management systems for climate and climate-related variables;

- Enhanced climate modelling and prediction capabilities through strengthened international climate research focused on seasonal to decadal timescales;

- Improved national climate service provision arrangements based on enhanced observation networks and prediction models, and greatly increased user interaction;

- More effective use of global, regional and national climate information and prediction services by all stakeholders in climate-sensitive sectors in all countries (leading to improved planning and investment in sectors vital to national economies and livelihoods); and thereby

- Widespread social, economic and environmental benefits through more effective climate risk management and increased capacities for adaptation to climate variability and change.

Who will participate in the Global Framework for Climate Services?

10. The Framework will build on and strengthen existing local, national, regional and global networks of climate observation, monitoring, research, modelling and service programmes, including those of WMO. It aims to achieve its goal through the enhanced role and involvement of national meteorological services and regional and global centres, as well as through greater participation of other stakeholders and centres of excellence across relevant socio-economic sectors, particularly those in developing countries, Least Developed Countries and Small Island Developing States.

11. To meet its objectives, the Framework would require extensive collaboration among national and local governments, agencies, non-governmental organizations, civil society, the private sector, as well as universities and research institutions around the world, and would also require outreach to communities in all socio-economic sectors benefiting from the application of climate data and information in planning, policy and practice. This outreach will be facilitated through participation of relevant organizations and institutions in coordination with governments. Implementing and operating the Framework will therefore require continuation and enhancement of the broad collaboration and partnerships, centred around these entities, which underpin and improve on its technical strengths. As such the Framework will be supported by the entire United Nations system and other organizations.

What are the next steps in developing a Global Framework for Climate Services?

12. Taking into account the outcomes of WCC-3, the Framework will be further developed under the guidance of an ad hoc task force consisting of high-level independent advisors, with inputs from a broad-based network of experts and in consultation with governments, partnering organizations and relevant stakeholders. The outcomes of the fifteenth session of the Conference of the Parties to the UNFCCC (COP15), as well as the special requirements

and vulnerabilities of developing countries, especially Least Developed Countries and Small Island Developing States, will also be taken into consideration in further development of the Framework.

13. An Action Plan with timelines for establishment and implementation of the components of the Framework will be developed along with measurable indicators for the progress in the implementation of the framework. It will also address aspects of governance and resource requirements. The Action Plan will also address the development, deployment and transfer of technology and capacity-building of meteorological services in developing and Least Developed Countries.

How will the Global Framework for Climate Services be supported?

14. The ad hoc task force to be established to further develop the Framework following WCC-3 will examine and make proposals on resource implications related to the implementation of the Framework and the cooperation of governments, organizations, institutions and relevant stakeholders in the mobilization of resources.

Acronyms

BON	Biodiversity Observation Network
CGIAR	Consultative Group on International Agricultural Research
CLIPS	Climate Information and Prediction Services
COP	Conference of the Parties (to the UNFCCC)
CSIS	Climate Services Information System
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
GARP	Global Atmospheric Research Programme
GCOS	Global Climate Observing System
GCPCs	Global Climate Prediction Centres
GEO	Group on Earth Observations
GFCS	Global Framework for Climate Services
GOOS	Global Ocean Observing System
GPCs	Global Producing Centres
ICSU	International Council for Science
IFRC	International Federation of Red Cross and Red Crescent Societies
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunication Union
IUCN	International Union for Conservation of Nature
LDCs	Least Developed Countries
MDGs	Millennium Development Goals
NCCs	National Climate Centres
NMHSs	National Meteorological and Hydrological Services
NMSs	National Meteorological Services
RCCs	Regional Climate Centres
RCOFs	Regional Climate Outlook Forums
SIDS	Small Island Developing States
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNOG	United Nations Office at Geneva
UNWTO	United Nations World Tourism Organization
WCASP	World Climate Applications and Services Programme
WCC-1	World Climate Conference-1
WCC-2	World Climate Conference-2
WCC-3	World Climate Conference-3
WCP	World Climate Programme
WCRP	World Climate Research Programme
WHO	World Health Organization
WIOC	WCC-3 International Organizing Committee
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization
WTO	World Trade Organization

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WORLD CLIMATE CONFERENCE – 3

31 August – 4 September 2009, Geneva, Switzerland

Global Framework for Climate Services

BRIEF NOTE*

The World Climate Conference – 3 proposes to create a Global Framework for Climate Services through which the developers and providers of climate information, predictions and services, and the climate-sensitive sectors around the world, will work together, to help the global community better adapt to the challenges of climate variability and change. This BRIEF NOTE presents an overview of the Framework, by answering a series of key questions.

Why is a Global Framework for Climate Services Necessary?

1. Many socio-economic sectors, including water, agriculture, fisheries, health, forestry, transport, tourism and energy, are highly sensitive to weather and climate extremes such as droughts, floods, cyclones and storms, heat waves or cold waves. Decision-makers in these sectors are increasingly concerned by the adverse impacts of climate variability and change, but are not sufficiently equipped to make effective use of climate information to manage current and future climate risks as well as ecosystems. Consequently, there is not only an urgent need for enhanced global cooperation in the development of accurate and timely climate information but an

equally urgent need for its exchange between the providers and users of climate services, thus ensuring that relevant climate information is integrated into planning, policy and practice at various levels.

2. Recent advances in science and technology offer the prospect of further improvements in quality of climate information and prediction services. Integrating seasonal to multi-decadal predictions and long-term climate projections into decision-making in all socio-economic sectors, through an effective two-way dialogue between providers and users on the range, timing, quality and content of climate products and services, will ensure that decisions relating to managing climate risks are well informed, more effective and better targeted.

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> ***"Enable better management of the risks of climate variability and change and adaptation to climate change at all levels, through development and incorporation of science-based climate information and prediction into planning, policy and practice."***

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4. The Global Framework for Climate Services is proposed as a long-term cooperative arrangement through which the international community and relevant stakeholders will work together to achieve its stated goal.

5. The Framework will have four major components: Observation and Monitoring; Research, and Modelling and Prediction; a Climate Services Information System; and a User Interface Programme (Fig. 1). The first two components are well established but are in need of strengthening. The latter two components together constitute a 'World Climate Service System'.

6. The User Interface Programme, which presents a relatively new concept, will develop ways to bridge the gap between the climate information being developed by climate scientists and service providers and the practical information needs of users. Recognizing that the needs of the user communities are diverse and complex, it will

support and foster necessary institutional partnerships, cross-disciplinary research,

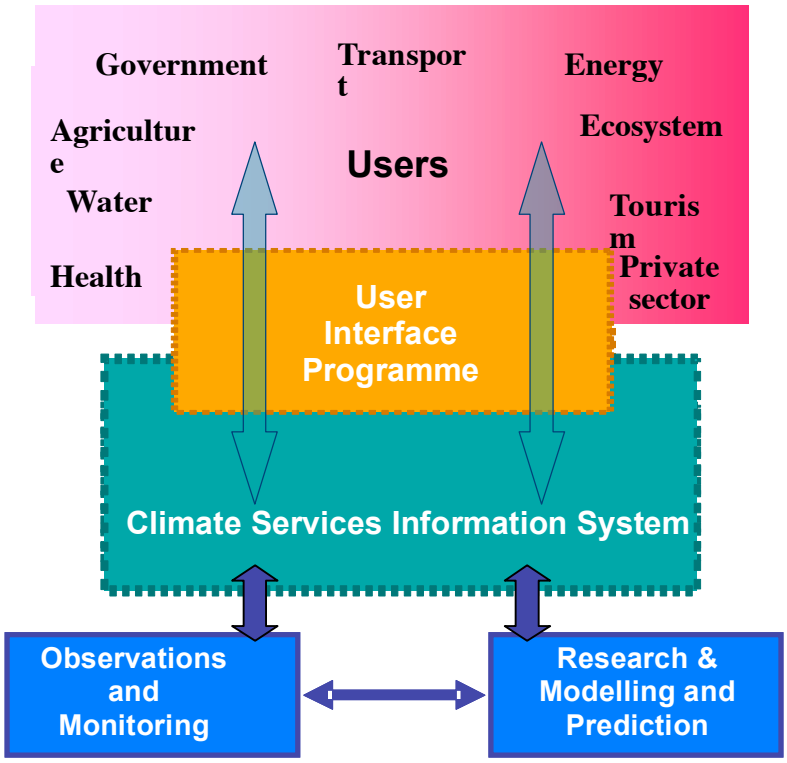

Figure 1: Components of Global Framework for Climate Services

innovation, development of decision support tools and climate risk management practices, generation and capture of knowledge, evaluation and establishment of best practices, education, capacity building and service application for decision making. The outcomes of the User Interface Programme will be reflected in the operational services of the Climate Services Information System.

7. The Climate Services Information System (CSIS) will build on established global programmes such as the World Climate Programme and will reinforce, strengthen and better coordinate the existing institutions, infrastructure and mechanisms but importantly, will focus on user-driven activities and outputs, while continuing to implement science-and technology-driven ones.

8. The CSIS, through a network of global, regional and national institutions, will synthesize information streaming from the Observation/Monitoring and Research/Modelling components of the Framework, and will create information, products, predictions and services in an operational mode at various spatial scales.

These services will be enhanced by feedback from users and other components of the system, and by the outputs of the User Interface Programme, thereby ensuring the development and delivery of ***user-oriented*** climate information and prediction services. It will focus, in addition, on standardization, exchange and quality assurance of information and communicating the highest quality information, products and services possible to decision-makers from global to local scales. Through enhanced international cooperation for development and transfer of technology related to meteorological services and mobilization of resources, this System will also build capacity among national and regional meteorological service providers in developing and least-developed countries, whose contributions are essential for improved climate information products at global, regional and national scales.

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11. To meet its objectives, the Framework would require extensive collaboration among national and local governments, agencies, non-governmental organizations, civil society, the private sector, as well as universities and research institutions around the world and outreach to communities in all socio-economic sectors benefiting from the application of climate data and information in planning, policy and practice. This outreach will be facilitated through participation of relevant organizations and institutions in coordination with governments. Implementing and operating the Framework will therefore require continuation and enhancement of the broad collaboration and partnerships, centered around these entities, which underpin and improve on its technical strengths. As such the Framework will be supported by the entire United Nations System and other organizations.

What are the Next Steps in Developing a Global Framework for Climate services?

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developing States, will also be taken into consideration in further development of the Framework.

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How will the Global Framework for Climate Services be supported?

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[*] Background paper prepared by WMO secretariat, dated 2nd September, 2009

Belmont Forum Water Resources and Water Security

Near-term activity:

Belmont Forum co-alignment with NSF's Water Sustainability and Climate (WSC) program:

- The GOAL of WSC is to understand and predict the interactions between the water system and climate change, land use (including agriculture), the built environment, and ecosystem function and services through place-based research and integrative models.
- Critical criterion: projects must be truly interdisciplinary rather than multi-disciplinary, with social science as a key component
- Studies of the water system using models and/or observations at specific sites singly or in combination that allow for spatial and temporal extrapolation to other regions, as well as integration across the different processes.
- FY10 awards (totaling $25M) were a combination of exploratory, incubation projects and full projects that involved either (1) new observations and model development or (2) synthesis projects which will employ existing data
- The next solicitation will be issued in FY11 (FY13) and awards to be made in FY12 (FY14).

Longer-term Vision:

Through WSC and co-aligned efforts, and new complementary activities, develop calibrated models that can address a range of coupled climate-hydrologic processes that can be adapted by appropriate organizations for use in developing countries.

Belmont Challenge

Australian Efforts to Develop Information to Guide Coastal Adaptation

Many coastal regions are already experiencing the effects of relative (local) sea level rise from a combination of factors. Into the coming decades, coastal areas will be exposed to increasing risks due to sea level rise and climate change. Exacerbating the risk is the increasing human pressures on coastal areas – location of settlements, increasing intensity of infrastructure and modification of shorelines.

There is significant regional diversity in how coastal areas will respond to a changing climate. Populated deltas, especially the Asian mega deltas, low lying coastal urban areas and atolls have been identified as key global hotspots.

We are at a turning point in developing the systems and modelling capacity to key turning point in getting tools however, there are still key knowledge gaps in our ability to provide information to decision makers that can help to inform the range of adaptation options that need to be considered and the timeframes and implications of those options. Investment and collaboration in the right priorities can help to deliver this capability.

This paper provides a structure to consider the knowledge and science base required to support coastal adaptation. The state of Australia's capability is identified against each category as an example.

1. Coastal observations and monitoring (data) Key questions: Is there adequate knowledge about the behaviour of individual system components, and can we measure rate of change? Access to reliable data on key climate parameters will underpin models of change and our understanding the climate change contribution to risk into the future. While data across a broad spectrum of parameters would be desirable there are a number of priority areas: sea level rise, wave climates, geomorphological response and coastal assets exposed to climate change impacts.			
Priority elements	**Achievements to date and near term priorities**	**Medium term priorities (over next 20 years)**	**Regional focus for investment priority**
Sea level rise	29 locations, good observations of regional sea level rise variability	Adequate global observation capacity on major ice sheets	Australia Pacific and East Timor
Wave climate including direction and energy	Instrument network of wave rider buoys (strong focus SE coast)	Need to assess adequacy of coverage and importance wave monitoring particularly in context of global linkages	Australia Pacific and East Timor
Extreme events - storms & cyclones	National storm tide data set (for cyclonic and non cyclonic coastline) Tropical cyclone database repair and review		Australia Pacific and East Timor
Geomorphological response	Nationally consistent database of coastal geomorphology (identifying erodible areas) GIS line map format (queriable) and polygon format (spatial representation) Example sites of historic shoreline change Estimates of sensitivity to change wave climate for a variety of shoreline types	Increased knowledge sand transport/ sediment budgets Bathymetry for priority areas Estuary morphology	Australia
Exposed coastal social, economic and environmental assets	Nationally consistent elevation data (mid resolution with priority areas at high resolution) working towards seamless DEM from land to ocean Dataset of exposed infrastructure (residential, road/rail, commercial and industrial) Variable datasets of environmental assets of national significance		Australia

2. Coastal analysis and prediction systems (modelling)

Modelling global and regional climate change has traditionally focused on incremental change (change to the mean), however adaptation requires a better knowledge on the change to the extremes – as that is where the greatest risks lie and where planning needs to be implemented to manage risk. An improved understanding of high end risk of ice sheet dynamics/melt and improving predictions of hazardous weather including storm surges and cyclonic storms are key priorities.

At smaller scales coupled climate and hydrological and morphodynamic modelling will be need to identify risk to coastal areas. Downscaled projections to run these models will be needed as well as the ability to consider multiple stressors and identifying thresholds of systems.

Priority elements	**Achievements to date and near term priorities**	**Medium term priorities (over next 20 years)**	**Regional focus for investment priority**
Climate system modelling and projections:	Downscaling of modelling results at relevant resolutions	Second generation downscaling	Australia Pacific and East Timor
Sea level rise	Understanding regional sea level rise variability	Remain engaged with global effort to reduce the uncertainties around the response of the major ice-sheets to warming in order to improve estimates of timing and magnitude of global and regional sea level rise	Pacific and East Timor
Wave climate	Modelling framework developed using the south east coast of Australia as a case study	Engage through a WCRP/JCOMM supported workshop (Geneva April 2011)to to establish a coordinated framework for global wave climate projections	Australia Pacific and East Timor
Extreme events - storms & cyclones	Initial research underway to develop and test techniques for modelling likely changes in the frequency and intensity of extreme events and coincident extreme events, such as flooding and storm surge at appropriate resolution		Australia Pacific and East Timor
Coupled climate and hydrological /morphodynamic models	Initiate work: Identify likelihood and timing of breaching key thresholds/shoreline stability Modelling sediment pathways inc disturbed systems Model interaction with flooding/protective measures	Deliver capacity for integrated modelling of hydrological and geomorphic systems and in context of coincident events Modelling framework to assess coincident risks from changes in offshore wave climate, in shore storm surge and estuarine flooding	Australia

Social economic modelling	Damage curves (relationship between hazard, event and cost) Understanding of coastal responses to key management actions	Develop National Integrated Assessment modelling capability	Australia
3. Information and communication How to present information so it is useful to relevant decision makers and what decision support tools will be required.			
Priority elements	**Achievements to date and near term priorities**	**Medium term priorities (over next 20 years)**	**Regional focus for investment priority**
Scenario development	Development of storylines for different climate change scenarios for geographic regions		Australia
Identify most vulnerable coastal systems	Coastal risk assessment report identifies vulnerable areas at a national scale – (flooding and erosion for residential properties)	Second generation knowledge	Australia Pacific and East Timor
Visualisation tools to help communicate risks	Sea level rise mapping – interactive and static map formats to help communicate risk across range of coastal stakeholders	Second generation tools that build on modelling advancements	Australia
Cost and benefits of adaptation options	Early work on developing information on the costs and benefits of adaptation pathways		Australia
4. Coastal capacity building capability			
Priority elements	**Achievements to date and near term priorities**	**Medium term priorities (over next 20 years)**	**Regional focus for investment priority**
Platform for knowledge data sharing	National Elevation Data Framework web portal – facilitate discoverability and accessibility to Australian Government elevation data	Web portal extended to include state and territory elevation data Develop National Climate Services capability in line with global efforts agreed at the World Climate Conference 2009	Australia
Building capacity in developing countries to access global science/tools	Engagement with scientists and decision-makers to enhance sharing of knowledge and facilitate its incorporation in planning		Pacific and East Timor

Belmont Forum Coastal Collaborative Research Action

Belmont Forum co-alignment with NSF's burgeoning program on coastal systems:

- This initiative is still in the planning stages but discussions within NSF GEO have focused on ways to address broad challenges concerning how coastal systems respond to environmental threats, especially those caused by climate change and increased population pressure.

- Important objectives include but are not limited to:

    1. Collaborativwell-being and the health of our planet;

    2. predict the effects of sudden events upon the coastal system and the rates of recovery from them; and

    3. develop models that link together the diverse physical, chemical, biological, and human processes in coastal areas.

The overall program would likely:

- focus on to regional or global issues;
- provide a basis for sound management strategies and policy;
- contain fully integrated component of outreach or education that is accessible to a wider audience and connects to issues of importance to coastal communities and society at large;
- encourage partnerships between academic institutions and government agencies or laboratories to use existing data, build predictive models, or share resources.

Some general areas suitable for consideration might involve:

- determining the sustainability of sensitive and productive coastal, estuarine, and wetland environments and ecosystems vital for societal well-being and the health of the planet and how these will be affected by population growth or changing climate;

- predicting the effects of sudden events such as coastal storms, tsunami, or oil spills on shoreline geomorphology, biogeochemical processes, ecosystems and environments;

- developing predictive models that link geological, atmospheric, oceanographic, and biological processes in coastal areas;

- enabling more effective systems-based resource management in coastal regions over a range of scales in space and time;

- evaluating trends or patterns in coastal processes over long time periods as a key to potential future changes.

Collaborative Activity

Securing Biodiversity – ecosystem services baseline

Belmont Forum, 26./27.10.10
Cape Town, J. Karte

Aim

To form a network of program officers to find out the potential for opportunities to align and coordinate national sites to develop international biodiversity-ecosystem observation networks

Members of the Network

- R. Schönwitz, K. Hartig (DFG)
- P. Mathy (EC)
- C. Joly (FAPES)
- T. Parr (NERC)
- J. Pauw (NRF)

Agenda

- Definition of observation networks to be discussed, focus on the interoperability and interconnection of existing terrestrial platforms for biodiversity research
- Needs of Alignment / Cooperation from a scientific point of view
- Boundary conditions, criteria, scientific strategies for the establishment of sites and their potential for alignment
- Discussion of an international open Access Agreement to open existing sites for international cooperation
- Exchange of information on monitoring concepts
- → Meeting of Program Officers

Background and Terms of Reference for an ICSU Planning Group on Health and Wellbeing in the Changing Urban Environment

Brief background

Human Health is an identified priority in the ICSU Strategic Plan 2006-2011 with the overall goal (p32-33):

to ensure that health considerations are duly taken into account in the planning and execution of future activities by building on the relevant strengths of Scientific Unions and Interdisciplinary Bodies.

And the following specific actions:

- *ICSU will establish an ad hoc Scoping Group to more clearly define how it might contribute to science for human health taking into account the ongoing development of two new research initiatives:*
  - *Science for Health and Wellbeing (SHWB) is an ambitious initiative, bringing together the perspectives of many ICSU Unions in an integrated approach to human health;*
  - *Global environmental change and Human Health is a new project that is being planned as part of the Earth Systems Science Partnership; and*
- *New Partnerships will be developed as necessary…… to ensure that any ICSU initiatives are needs-based and policy-relevant.*

The prescribed *ad hoc* Scoping Group was established by the Committee on Scientific Planning and Review (CSPR) in 2006 and liaised with the aforementioned ICSU initiatives to produce its report "Towards a Systems Analysis Approach to Health and Wellbeing in the changing Urban Environment". This report was sent out to Members for consideration and presented at meetings of the Scientific Unions and ICSU Executive Board in April 2007. It was positively received and the decision of the Board was:

To request CSPR to establish a Planning Group in consultation with the Inter-Union initiative and ICSU membership, to take forward the recommendations of the ad hoc Scoping Group.

In making this decision, the Board emphasised that the aim should be to develop a single integrated interdisciplinary ICSU programme in this area and that the planning process should be designed so as to ensure ongoing consultation with the Membership and with the Unions in particular. In the light of the Scoping Group report, the Unions participating in the SHWB initiative had already begun to plan for a workshop in January 2008 on Urban Health. It was agreed to have this co-organised with CSPR/ICSU and thus incorporated into the planning process for the new programme. To this end, a member of CSPR was appointed as co-chair

of the workshop organising committee. The International Institute of Applied Systems Analysis (IIASA) was subsequently approached and agreed to host the workshop in Austria.

Planning Group Draft Terms of Reference

Taking into account the report of the CSPR *ad hoc* Scoping Group on Human Health – Towards a Systems Analysis Approach to Health and Wellbeing in the changing Urban Environment, and

the workshop jointly organised by ICSU, IIASA and the International Scientific Unions on this topic (Vienna, January, 24-25, 2008),

to:

1. consult with the relevant stakeholders (WHO, city policy-makers, business and NGOs) and define the key health policy questions to be addressed in relation to the changing urban environment;

2. define in detail the short, medium and long-term goals and deliverables for a new interdisciplinary programme in this area;

3. develop an inventory of existing (sub-system/sectoral) models applicable to the urban environment;

4. develop an overall systems analysis model framework that incorporates 1, 2 and 3 and also takes into account the interactions between key external drivers and sectoral factors (see report of the *ad hoc* Scoping Group);

5. define the data and information sources necessary to carry out an informative systems analysis using this framework;

6. identify a small number of cities in which this model could be tested and refined;

7. define the structures and identify possible funding sources that would be necessary to ensure the initial implementation of the programme in the identified cities;

8. develop a mechanism that, during both the planning itself and subsequent programme implementation, ensures the full involvement of all interested ICSU constituents (Unions, National Members, IBs and Regional Offices);

9. provide an interim progress report to the ICSU General Assembly in October 2008.

Planning Group composition/profile

All ICSU Members and IBs were consulted for nominations for the Planning Group. Areas of relevant expertise for which nominations were sought included:

- Systems analysis/modelling

- Specific urban sectoral areas, including:
  - water,
  - food,
  - sanitation,
  - health systems,
  - energy,
  - transport
- Public health, including:
  - Epidemiology/health monitoring
  - Health care delivery
  - Medical sociology
  - Health policy/policy studies
  - Statistics/indicators
- Social sciences, including:
  - Behavioural science
  - Political science
  - Social innovation, vulnerability and change
- Human geography, including:
  - demography
  - Urban planning
- Environmental change
- Economics

For reasons of cost and efficiency, the maximum size of the Group was fixed at 15 members and so individuals who had cross-disciplinary expertise were likely to be particularly valuable. The importance of ensuring different regional perspectives, including developing and developed countries, was also recognised. It was important also to try and ensure some continuity with the Scoping Group, SHWB and GEC-Health initiatives.

Timetable

July 2007	Consultation with members and nominations for Planning Group
July-Oct. 07	SHWB coordinating committee proceeds with plans for workshop
September 07	CSPR agrees final ToR, establishes programme Planning Group and approves plans for workshop co-organised with the Scientific Unions
Nov 07	Planning Group Members and workshop participants invited
Jan 25-26, 08	2-day Workshop, IIASA, Vienna
Jan 27-28	1st Planning Group meeting
Jun/July, 08	2nd Planning Group meeting
Oct 08	Interim report to the ICSU General Assembly
2009-2010	Continue planning, publish programme plan and launch programme

Resources

ICSU will cover the costs of Planning Group meetings (economy class travel and accommodation). The costs of January workshop will be jointly covered by the SHWB grant that was awarded to the Unions in 2006, ICSU and IIASA. Some grant funding from NSF has also been secured.

ICSU Planning Group on Health and the Urban Environment:
"A Systems Analysis Approach to Health and Wellbeing in the Urban Environment"

Name	Nationality	Institution
*Francoise Barten	Netherlands	Urban poverty, Environment and Health, Radboud University of Nijmegan, Netherlands
Bruce Beck	UK/USA	Water quality and environmental engineering, University of Georgia and IIASA
Susan Bennett-Johnson	USA	Department of Medical Humanities and Social Sciences, Florida State University
Tony Capon	Australia	Australian Health Policy Institute, University of Sydney
Osman Galal	Egypt	Nutrition, UCLA School of Public Health, Los Angeles, USA
Edgar Gutierez	Costa Rica	Statistics, University of Costa Rica
Dov Jaron	USA	School of Biomedical Engineering, Science and Health Systems, Drexel University
*Landis MacKellar	USA	International Institute of Applied Systems Analysis, Laxenburg, Austria
Elijah Ogola	Kenya	Medicine, University of Nairobi, Kenya
Sue Parnell	S Africa	Environmental and Geographical Sciences, University of Cape Town
Eduardo Reese	Argentina	Urban Planning, National University of Buenos Aires
Pierre Ritchie	Canada	Psychology, University of Ottawa
Gerard Salem	France	Geography and Health, Institut National du Cancer, 92100 Boulogne Billancourt, France
Wuyi Wang	China	Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing

*Francoise Barten and Landis MacKellar were appointed as co-chairs for the Group after the first meeting.

BELMONT FORUM **BF10/15**
OCTOBER 2010

INTRODUCTION TO THE IGFA MEEETING

Purpose of Paper

The objective of this paper is to prepare Belmont Forum Members for their role in the October IGFA meeting.

Paper will be tabled by NSF

BELMONT FORUM **BF10/16**
OCTOBER 2010

REFLECTION ON THE BELMONT FORUM/ COUNCIL OF PRINCIPALS MEETING

Purpose of Paper

At the end of this third Belmont Forum meeting, it is timely to consider whether the Forum is on track. What will be the critical success factors in addressing this major challenge? Will we be able to mobilise the necessary resources? Are any changes needed to the way the Forum is operation?

Action

- DISCUSS these issues, taking a broad and honest look at the Belmont Forum
- AGREE any actions required including schedule of meetings needed

BELMONT FORUM **INFORMATION PAPERS**

Annex A	Belmont Forum/Council of Principals Terms of Reference
Annex B	Members Details
Annex C	2009 Belmont Forum Meeting Decisions and Actions
Annex D	2010 Belmont Forum Meeting Decisions and Actions
Annex E	x2 maps V&A Waterfront

ANNEX A
October 2010

BELMONT FORUM

Proposed Terms of Reference for the Council of Principals of the International Group of Funding Agencies for Global Change Research (IGFA):

The Council of Principals is composed of:

- Senior agency administrators from a core set member countries especially active in the funding of global change research and modelling (Australia, Canada, France, Germany, Japan, the United Kingdom and the United States of America);
- Senior representatives of science funding bodies from several newly industrialized countries (currently Brazil, China, South Africa); and
- The Executive Director of the International Council for Science (ICSU).

The Council is the senior consultative and policy-setting body in IGFA. Its role is to:

- Identify strategic priorities for international collaboration on global change research (GCR) based especially on input from its members; and
- Identify approaches to address these priorities.

The Council will focus its activities on addressing the overarching Belmont Challenge that faces the agencies that support global change research and the international scientific community that conducts this research. This Challenge is:

To Deliver Knowledge to Support Human Action and Adaptation to Regional Environmental Change.

The Council recognizes that to address this challenge requires employing regional and decadal prediction, advanced observing systems, and integration of social sciences; and addressing the synergy of multiple stressors, including extreme events, for, in particular:

- coastal zones;
- water cycle and water resources;
- ecosystem services - food security;
- carbon cycling; and
- the most vulnerable societies.

The Council of Principals will meet at regular intervals, at least annually, and, initially, more frequently. The meetings will be oriented to concrete action and measurable outcomes to address the Belmont Challenge.

As a member of the Belmont Forum, it is expected that you will participate in person whenever possible in meetings of the forum. This is to ensure continuity and that the forum's discussions are frank and open and benefit from the working relationships established through the forum. If you must miss a meeting, it is your responsibility to identify an alternate from your organization that is at the appropriate level. The co-

Chairs of the Forum, in consultation with the co-Chairs of the Working Group will evaluate and approve alternates on a case-by-case basis

The activities of the Council will be directed to, in cooperation with ICSU, joint activities leading to early-phase engagement by scientists and funders on setting international strategies and assigning priorities, leading to improved co-design and alignment of international research. Its actions will complement and be underpinned by the ongoing actions of the full IGFA membership, including sharing of GCR information and best practices; dialogue with international GCR programmes and intergovernmental GCR offices; and coordinating collaborations or funding partnerships in theme areas.

These actions will be directed to development of integrated, multinational plans for short-term and long-term projects (This statement is intended to be general enough to allow different sets of member agencies to be involved in various projects). These plans (Some have suggested adoption of a single overall strategic plan, but this wording is proposed in order to provide enough flexibility to allow for projects to be undertaken without being formally approved as part of a single overall "Plan".) would constitute the core of IGFA's strategy and the foci would include:

- identifying emerging needs or issues;
- co-designing one or more initiatives of international scope;
- developing a coordinated approach and consensus on action;
- developing ways to communicate more vigorously; and
- maintaining dialogue with appropriate decision makers on GCR issues.

The role of the full IGFA will not change (see http://www.igfagcr.org/about.html); the full membership will be invited to provide input to, development and implementation of the above plans (and to other issues to be addressed by the Council); and will be encouraged to align their actions with these plans.

IGFA will meet every two years. Both Council and full IGFA meetings will be scheduled as much as possible in conjunction with major meetings of international bodies concerned with GCR. Both the Council and the full IGFA may invite scientific and science-related organizations to participate in their meetings and other activities in accordance with the agenda(s) being addressed.

The Council will elect Co-Chairs from among the core members of the Council with each Co-Chair to serve for a two-year period on a rotating basis (should the Council have the authority to re-elect one or more of the Co-Chairs for a second term?). One of the Co-Chairs will serve as Chair of the full IGFA (should there be a special role for the other Co-Chair as well?). The Chair is expected to provide overall leadership for IGFA; bring emerging new issues to the agenda; propose initiatives for priority setting; and make proposals for achievement of common goals.

The Chair's institution will also host and support a small Secretariat that will serve the Council of Principals and the full IGFA. The Secretariat will obtain broad input to its work by chairing a small Working Group that would work with the Secretariat in identifying issues for consideration by the Council and the full IGFA; support the planning, convening of Council and full IGFA Meetings; and assist with the Council

and the full IGFA's interactions with the international global change research programmes.

In between IGFA's biannual plenary meetings, the Council will maintain focus and momentum through vigorous communications; through its meetings and related activities; and through additional meetings, as appropriate, drawn from the larger membership around specific themes (these meetings could include academic scientists designated by ICSU, since they are a member of the Council).

If accepted, the new structure will take effect immediately, enabling IGFA to benefit from the second meeting of the Belmont forum in January 2010 and from progress in both the current ICSU visioning process and the ICSU analysis of international research capability to respond to the Belmont Challenge.

Revised Text prepared by Lou Brown, 12/19/09, based on a draft prepared by Gina Adams in November, and on the papers prepared for the January meeting by the Chair of IGFA and the Chair of the IGFA Staff Group in December.

ANNEX A
October 2010

Belmont Forum- Members Details as at Oct 2010

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International Collaboration on Global Change Research: Outcomes from the Belmont Conference

(Draft v0.4; 27 September 2009)

Introduction

The challenges being presented to the Global Change Research (GCR) agenda are changing and intensifying. For example: evidence of accelerating rates of global change beyond IPCC 4AR predictions; changes in the funding landscape as a result of the economic downturn, with some communities facing public spending constraints and others receiving fiscal stimuli for science; and international organisations such as the International Council for Science (ICSU) and International Group of Funding Agencies for Global Change Research (IGFA) undertaking refocusing exercises. The community must also anticipate further changes resulting from new political imperatives that may emerge from UNFCC COP 15 in December 2009.

In recognition of this shifting landscape, in June 2009, the US National Science Foundation (NSF) and UK Natural Environment Research Council (NERC) hosted a small conference of the principal officials of key environment and geosciences funding agencies, at Belmont USA. The objectives of the 'Belmont Conference' were to identify GCR priorities that might benefit from better cooperation and how best to achieve this.

Participants at the Belmont Conference agreed on the need for an improved forum for engagement between the research funding agencies and ICSU, and for an improved process to coordinate early phase engagement on GCR strategies and priorities, in order to increase co-design and co-funding of major research programmes. They agreed that the Belmont Group, augmented by members from emerging economies, provided an ideal structure to provide this, because its small and specific membership promotes frank discussion and rapid decision-making about significant amounts of GCR resources. The group agreed that a Belmont-style forum should continue and meet at least annually, and more frequently at the outset. A second meeting will be held in London, in January 2009.

The Conference recognised the benefits of working with IGFA. They noted that IGFA is currently refocusing its activities and that one element of this establishes a new high-level consultative and policy group to guide its activities. Members agreed that with modest adjustments, the revised IGFA structure could satisfy the goals of the Belmont Group.

Therefore, the two main actions from the meeting are:
(1) Establish an ongoing Belmont-type forum to take forward the identified challenges
(2) Inform IGFA of the establishment of the Belmont-type forum, and invite IGFA to consider adopting this forum as its proposed 'Council of Principals'.

Annex I provides further information on the conclusions and outcomes of the Belmont Conference.

Annex II provides a proposal for a new governance structure for IGFA, that could satisfy the needs for a Belmont-style forum.

Annex I

Conference on Global Challenges for Environmental Research Funders
June 10th and 11th, 2009
Belmont Conference Center, Elkridge, Maryland, U.S.A

Conclusions and Actions

The objectives of this Conference were primarily to identify priority GCR challenges that might benefit from better international collaboration, and mechanisms to achieve this. The Conference was organized by the US NSF and the UK NERC. Participant numbers were limited in order to promote full and frank discussion. Invitees included principal officials from the most active national agencies that fund global change research, the Executive Director of ICSU and the Chair of IGFA.

The conference identified the:

- Reasons to collaborate, including the most urgent scientific and socio-political drivers;
- The primary 'Belmont Challenge' for research in order to address these drivers; and
- Actions required to take the 'Belmont Challenge' forward.

Further information on each of these outcomes is provided below.

REASONS TO COLLABORATE

Scientific drivers identified include the need to:

- Address the many issues and actions that have global impacts (e.g., carbon sequestration, rain forest functioning);
- Address the new challenges being presented to the traditional academic research agenda, through a new focus on "adaptation and mitigation", which will require;
    - global efforts to advance predictions and provide decision-support to policy-makers;
    - sharing practical knowledge, which may involve new partnerships with industry and local leaders;
    - building expertise in multidisciplinary and translational research;
- Leverage national research capabilities through access to complementary or shared expertise and facilities.

Socio-political drivers identified include the need to:

- Counter a view among policy-makers that the science is done;
    - Lay out a science agenda and call for action for international research – responding to the research questions the IPCC produces;
    - Pose research questions and costs in an appropriately broad, global and urgent way;
- Anticipate new political imperatives that will require a heightened research response;
    - Economic realities could be convincing in the near term, for example, sea-level rise/coastal inundation, with implications for infrastructure and land use;
- State more clearly the priority for helping the most vulnerable countries,
    - e.g. potential national security implications of GC driven conflict and instability;

- Engage with and influence public opinion, which may drive investments;
    - Promote dialogue on effective and acceptable solutions – to bridge the 'valley of death' from research to action;
    - Demonstrate efficiency and impact through leveraging research and shaping decision support.

THE BELMONT CHALLENGE

In order to respond to these drivers the conference identified an overarching challenge for the GCR community – to deliver knowledge to support **Human Action and Adaptation to Regional Environmental Change.**

This will require **regional and decadal prediction, advanced observing systems**, and inclusion of social sciences; and synergy of multiple stressors, including extreme events, for:

- coastal zones,
- water cycle and water resources;
- ecosystem services - food security;
- carbon cycling (including ocean acidification, deforestation, land use and soils)
- most vulnerable societies (geographic areas) – with low capacity and high societal impact

It will also require coordination mechanisms (these have a low cost but are a high priority).

MULTILATERAL COLLABORATION: SOLUTIONS

The Conference concluded that in order to address the Belmont Challenge with the required urgency, it was necessary to develop a new forum for funders and ICSU to work more closely together than ever before.

This purpose of the Forum would be to:

- Identify strategic priorities for international collaboration on GCR
- Identify mechanisms, research bodies and funding options for engagement in GCR

Limited, high-level membership (principals of the most active GCR funding bodies and those from some emerging economies, ICSU and IGFA) would be required, to promote:

- increased engagement at the early phase of strategy development, generating opportunities for co-design and co-funding of major programmes;
- frank discussions;
- strategic, targeted focus on a limited number of priorities and simplified structures;
- regular meetings, with strategic actions between meetings to sustain momentum and interest (Next meeting January 2010, London);
- an action-oriented approach, generating an integrated multinational plan for both long-term and short-term projects.

ICSU is the natural partner through which GCR funders can engage with the international science community in delivering the goals of the Belmont forum. Where research tasks need to be undertaken, the funders may ask ICSU to deliver these through its programmes.

CONCLUSIONS AND ACTIONS

The conference unanimously concluded that a continuation of the Belmont-type forum was required.

Recognising benefits of working with IGFA, and noting that IGFA is currently restructuring and establishing a new high-level consultative and policy group to guide its activities, the Conference agreed to invite IGFA, at their next meeting in October 2009, to consider structuring its 'Council of Principals' to satisfy the needs for this forum.

The Conference also asked ICSU, through their Executive Director, to conduct an analysis of international research capability to respond to the Belmont Challenge, focusing on:

- Solvability of problems;
- Infrastructure and personnel.

The Conference asked NERC to:

- Prepare a White Paper on the "Belmont Challenge" that would include a list of opportunities for funding and for major international meetings to inform;
- Host the second meeting of a Belmont-type forum, to take place in the UK in January 2010.

All participants were asked to:

- Identify opportunities for collaboration:
    - In the next six months, point to each others' aligned funding opportunities;
    - For 2010/11 – identify opportunities for co-design of support;
- Discuss the 'Belmont Challenge' and proposed White Paper with home institutions – "reality check'.

Annex II

International Collaboration on GCR: A Proposal for a new IGFA Governance Structure

In response to IGFA's identified need to establish a high level consultative and policy group to guide its activities, it is proposed that an IGFA Council of Principals is structured to meet the needs for a 'Belmont-style' forum, identified above. The structure and role of this new governance body, including its proposed interaction with the full IGFA membership, is summarized below.

What

An IGFA ***Council of Principals (COP)***, composed of:

- senior administrators from member agencies most active in the funding of GCR (Australia, Canada, France, Germany, Japan, UK, and USA)
- Executive Director of ICSU
- Chair of IGFA
- senior representatives of science funding bodies from some newly industrialized countries (Brazil, China, South Africa)

The Council would be the senior consultative and policy oriented body in IGFA. Its role would be to:

- Identify strategic priorities for international collaboration on GCR;
- Identify mechanisms, research bodies and funding options for engagement in GCR.

By enabling more frequent meetings of the most active GCR funders and ICSU, the Council of Principals would increase early-phase engagement on international strategies and priorities, leading to improved co-design and co-funding of international research. Its actions would complement and be underpinned by the ongoing actions of the full IGFA membership (including sharing of GCR information and best practices; dialogue with international GCR programmes and intergovernmental GCR offices; and coordinating collaborations or funding partnerships in theme areas).

How

The *Council of Principals* would meet at regular intervals, at least annually and, initially, more frequently. The meetings would be oriented to concrete action and measurable outcomes, articulated in an Action Plan – an integrated, multinational plan for short-term and long-term projects. The Plan would constitute the core of IGFA's strategy, and incorporate ideas for funding co-alignment. The foci would include:

- identifying emerging needs or issues;
- co-designing one or more initiatives of global scope;
- developing a coordinated approach and consensus on action;
- developing ways to communicate more vigorously;
- maintaining dialogue with appropriate decision makers on GCR issues.

The role of the full IGFA membership would not change (see http://www.igfagcr.org/about.html) but members would be encouraged to align their actions with, and provide input to, the development and implementation of the Action Plan, and to

track the extent to which this Plan influences global GCR policy. However, full IGFA plenary meetings would take place less frequently, every two years.

The Chair of the IGFA Council of Principals, would also act as Chair of the full IGFA, The Chair would be elected for a two-year term, and the position would rotate among the Core members of the Council of Principals. The Chair would provide overall leadership for IGFA; bring emerging new issues to the agenda; propose initiatives for priority setting; and make proposals for achievement of common goals. The Chair's institution would also support and host a small Secretariat for the IGFA Council of Principals.

When

The above proposal to IGFA for it to adopt the Belmont Group structure as its new high-level policy body will be presented to IGFA at its next full Plenary Meeting now scheduled for October 20-23, 2009. If accepted, the new structure will take effect immediately, enabling IGFA to benefit from the second meeting of the Belmont-style forum, planned for January 2010, and from progress in the current ICSU visioning process.

Full IGFA meetings will be held biannually and scheduled as much as possible in conjunction with major meetings of international bodies concerned with GCR.

In between the biannual plenary meetings the focus and momentum of the organization will be maintained through more vigorous communications activities, the meetings of the Council of Principals and occasional meetings drawn from the larger membership, around specific themes.

ANNEX D

Second Meeting of the Belmont Forum of Global Change Research Funders
6 – 8 January 2010, London, UK
DRAFT Decisions and Actions

1. Framework for meeting the Belmont Challenge.

(Presentation by Tim Killeen: http://www.nerc.ac.uk/research/international/secure/documents/belmont-tim-killeen.ppt).

- The current structures linking funders and stakeholders are sub-optimal.
- The Belmont Forum (BF) can help address this by strengthening links between international funders and between funders and ICSU.
- The BF partnership provides an opportunity for funders and researchers to align priorities and make links work. It could be encapsulated as "Working together to link human and financial capital to address societal needs"
- The partnership also needs to make connections outwards – links with policy and society are needed.
- It should also engage with other comparable international bodies in related spheres (e.g. IFFA).

Actions:

1 **Tim, David** - Further develop the diagram:

- Simplify diagram – include stakeholder types (but not acronyms)
- Show how working together (may need two diagrams: one for internal audience; one to convey message simply to external audience).
- Reflect how the landscape is now and where we want to get to (may need two diagrams).

2. ICSU Study of Capability for Belmont Challenge

(Presentation by Deliang Chen: http://www.nerc.ac.uk/research/international/secure/documents/belmont-deliang-chen.ppt).

Early Panel Findings:

- Community willing but does not yet have capability to address Belmont Challenge
- Preliminary capability requirements for addressing Belmont Challenge.

Belmont Forum requested that the study address the following:

- Requirements should include:
  - What needs to be done to create community readiness for big gutsy project (capability – international collaboration; human capital; infrastructure)
  - assessment of why a given priority is needed (e.g. it is not sufficient to simply advocate for 'more supercomputing', but must provide case for how a given challenge can be addressed by a given computing

system/capability, and what specific investment that would require from international funders).
    - Prioritisation
- Identify institutional barriers to be dealt with
- Focus on needs for knowledge for mitigation and adaptation – i.e. applications focused

Actions:

2(a) **BF Members**: Provide Gina with any additional feedback to be communicated to the ICSU panel

2(b) **ICSU Panel:** circulate early draft (February) report to the Belmont Forum (through Gina).

3. ICSU Visioning

(Presentation by Deliang Chen (as above)).

The ICSU Visioning Process is identifying the grand challenges for sustainability research (including scientific; structural, and transitional challenges).

It is being undertaken with reference to complementary visioning exercises in Europe, USA, and other regions.

It has identified five grand challenges (See Deliang's presentation) for which:

- societal relevance is central;
- social sciences are included;
- more detailed scientific 'questions' are clustered under each of the challenges;
- there is good alignment with the Belmont Challenges.

Actions:

3(a) **BF Members (as individuals):** Invited to input to the ICSU Consultation on Grand Challenges (closes 21 Feb)

3(b) **Deliang**: Consider engaging Belmont Forum in the Visioning Open Forum on Institutional Needs (June)

3(c) **ICSU (Deliang):** Consider rephrasing challenges to be more 'exciting'

3(d) **BF-ICSU**: Plan to produce joint statement at end of Visioning process

4. White Paper

(Discussion Paper: http://www.nerc.ac.uk/research/international/secure/documents/belmont-white-paper.pdf)

It was agreed that the paper represented a common understanding of the Belmont Challenge:

- Overarching Challenge;
- Two axes – capability and thematic priorities;
- Levels of Collaboration – Alignment, Co-design, Co-production;
- Emerging priorities.

However, there was more to do to develop an internal, and then an externally-facing paper that articulates our vision for the 'Apollo mission' and mechanisms for working together to get there.

Actions:

4(a) BF Members input to **Steven** by end of February (names in parentheses indicate members from whom further information on particular points raised at the meeting would be appreciated):

- candidate mechanisms for working together **(Margaret);**
- perspectives on requirements for convergence (between funders, researchers and users) **(Manuela);**
- strengthening of social science elements (**Heide** lead, for ISSC);
- continue to refine as internal statement of understanding – including 'Apollo mission' vision **(Ian);**
- BAMS article **(Tim).**

4(b) Prepare for second step of developing outward-facing paper, possibly as part of joint BF-ICSU statement (see 3(d)):

- **Steven** – consider requirements for working group that could develop external paper
- **Deliang:** Share the BAMS article (in press) authored by Shapiro et al. with BF members.

5. Discussion Sessions on Opportunities for Collaboration in Priority Areas of the Belmont Challenge

(Introductory Presentations by Discussion Chairs and Reports from Rapporteurs http://www.nerc.ac.uk/research/international/secure/documents/belmont-discussion-chairs.ppt and http://www.nerc.ac.uk/research/international/secure/documents/belmont-rapporteurs.ppt)

6. Agreed actions to take forward collaborative opportunities (Names in parentheses indicate lead BF member).

(For more details on the nature of the Actions, see the Reports from Rapporteurs, above. NB: The 'Potential Countries' listed are those that expressed interest at the meeting, and other BF member countries may also be interested in participating)

Capability

6(a) Accelerate integration of Social Sciences into environmental research:

- **Heide** – Develop regional dialogues to frame environmental questions in a meaningful way for social scientists, so that they can engage in Belmont Challenge – expand beyond 'usual suspects' and engage IGFA and IFFA

6(b) Increase capability for seasonal, decadal and regional predictions

- **Deliang** - ICSU Capability Study to provide suggestions **(Deliang)**

6(c) Climate Services

- Tim - Letter to WMO Task Force to invite them to discuss research requirements with Belmont Forum

Coastal Zone Vulnerability

6(d) Start two-pronged approach to plan new international research activity (**Ian**; by August 2010):

- Programme Officers: Scope existing activities. Identify opportunities to align and twin, and gaps.
- In consultation with **Deliang** – consider establishing ICSU-managed scientist task force to advise on research priorities (with help from Belmont Group, IHDP and IGBP)
- Potential Countries: Wide interest of many countries

Water Cycle and Resources (Freshwater Security) (**Tim**)

6(e) Bring together national/regional observations and modelling to develop global picture (**Tim**)

- Programme Officers: Scope opportunities to align regional studies and modelling on water availability and extreme events
- Potential countries: Australia, China, S. Africa, UK, USA

Ecosystem Services

6(f) Food Security (**Albert**)

- Letter from Belmont Forum to new ESSP Challenge Programme on Climate Change Agriculture and Food Security (CCAFS) (Chair Thomas Roswell, Director Bruce Campbell) to inform them of Belmont Challenge (White Paper) and offer our cooperation on further development of priorities and opportunities
- EU, France, ESSP (CCAFS), S. Africa, UK, USA.

6(g) Securing Biodiversity-Ecosystem Services Baseline (**Johannes**)
Recognising that many funders are supporting national biodiversity-ecosystem functioning observation and monitoring sites:

- Programme Officers: Scope opportunities to align and coordinate national sites to develop international biodiversity-ecosystem function observation network. Identify common interests and opportunities for alignment.
- Potential Countries: Australia, Brazil, EU, France, Germany, ICSU (DIVERSITAS, PECS), S. Africa, UK, USA

6(h) Human Health - Defer further consideration to future meeting

- Interim action to circulate two ICSU documents on scoping and planning of an ICSU programme focusing on Human health to members (**Deliang**).
- Potential Countries: Australia, EU, France, ICSU (IIASA), S. Africa, UK, USA, (WHO).

Valuation (See action 6(i) on Carbon-Cycling Land Use Trade-offs)

Carbon Cycling

6(i) Land Use Trade Offs – environmental and economic assessments needed to inform management responses to environmental change. Defer further consideration to future meeting

- Interim action - In recognition that BF have identified this as potential for future development, Programme Officers start networking and sharing information on developing priorities and activities. (**Steven**)
- Potential Countries: Australia, Brazil, EU, Germany, S. Africa, UK, USA, (IFFA?).

6(j) Ocean Acidification – assessment of capability in Southern Ocean (**Steven**)

- Programme Officers: Review existing coverage of Southern Ocean observatories (biodiversity and ocean acidification) and identify gaps.
- Potential Countries: Australia, France, S. Africa, UK, USA

6(k) Forests and Agriculture – measurements and modelling of carbon stocks and fluxes (**Brito**)

- Programme Officers: Scope opportunities to align and co-design activities .
- Potential Countries: Australia, Brazil, Canada, EU, Germany, S. Africa, UK, USA.

Most Vulnerable Societies

6(l) Strengthen collaboration between funders, researchers and Development Agencies (Margaret)

- Engage ISSC, ICSU, IFFA in letter to IFORD to propose task force to strengthen collaboration
- Potential Countries: Australia, Canada, EU, S. Africa, UK, USA

New Issues

6(m) Carry forward to future meeting (**Gina, David**)

- Bio and Renewable energy
- GeoEngineering

7. Terms of Reference
(See presentation by Tim Killeen (insert weblink))

Decisions:

- BF to continue and act as IGFA Council of Principals
- Meeting Intervals: BF – 6 monthly (initially); IGFA 2 yearly.
- Next meeting (joint IGFA and BF) October 2010. Potential location – Paris (tbc).
- IGFA to provide mechanism for broad engagement with smaller countries and programmes
- ICSU and ISSC to become full members of BF.
- IGFA to nominate from broad membership a rotating 'small country' member of Belmont Forum – member must be a 'principal' of their organisation.
- All existing IGFA Steering and Working Groups to be stood down. New BF/IGFA working-level staff group to be established, with officers from each Belmont Forum member organisation..
- Chairs: For BF, Alan and Tim will act as Co-Chairs. For IGFA Tim will be Chair, Alan will be Vice-Chair.
- For BF/IGFA Working Group – David will be Chair, Gina will be Vice Chair, with special responsibility for BF.

Actions:

7(a) **BF Members:** Provide name and contact for working group member from your organisation
7(b) **Tim**: IGFA membership to nominate 'small country' member
7(c) **Tim/Alan**: Invite India and Russia to join Belmont Forum
7(d) **David:** Produce summary of decision and new structure
7(e) **David/Gina**: Trawl for dates for October meeting and confirm location

discover

V&A WATERFRONT VISITOR'S GUIDE

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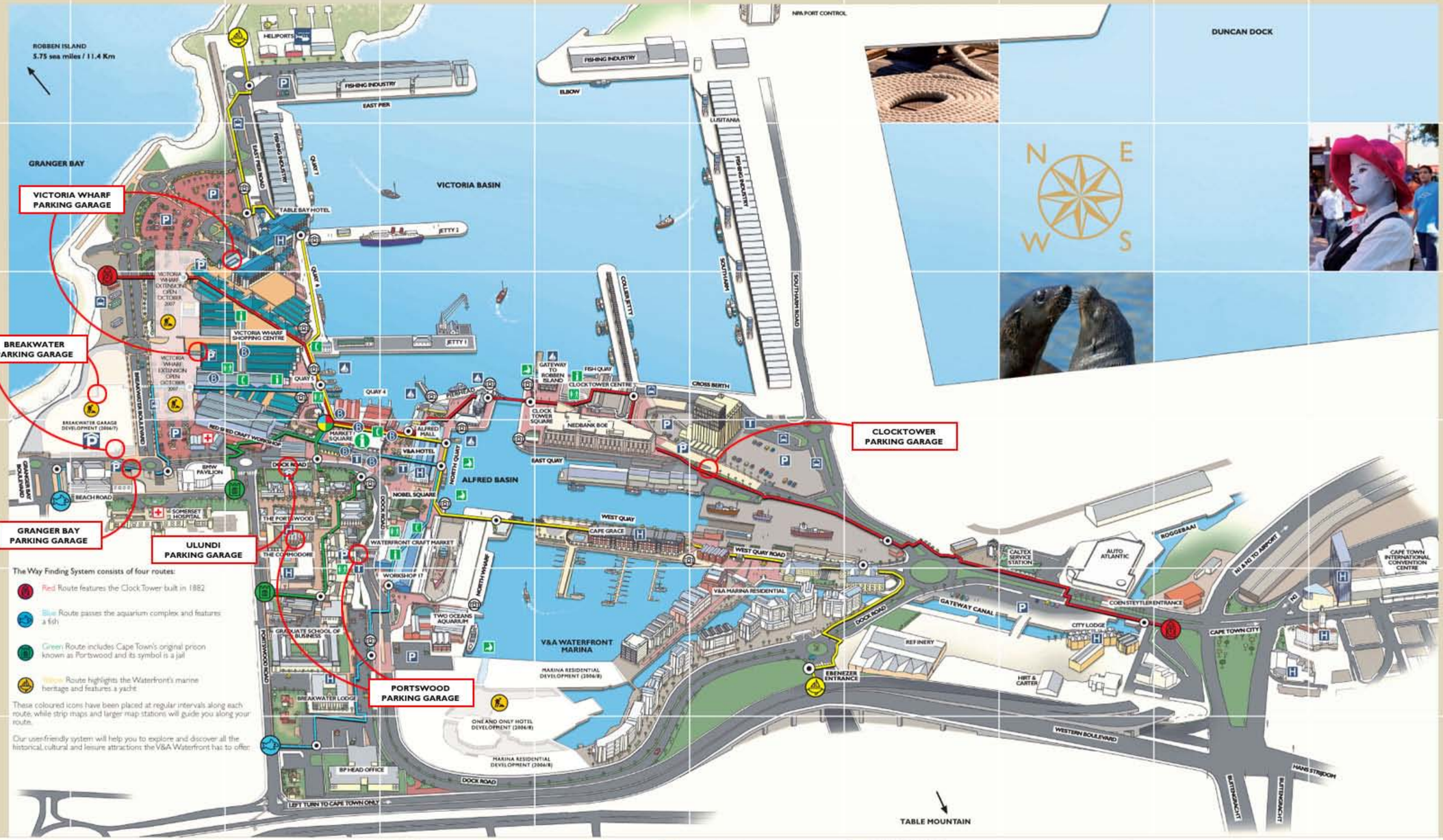
V&A WATERFRONT · CAPE TOWN

- E5 ALFRED MALL SHOPPING CENTRE
- D4 AMPHITHEATRE
- F4 AVIS CAR RENTAL
- E5 BASCULE BRIDGE
- C5 BEACH ROAD
- C5 BMW PAVILION
- F5 NEDBANK BOE SQUARE & OFFICES
- D7 BP HEAD OFFICE
- C5 BREAKWATER BOULEVARD
- D6 BREAKWATER LODGE
- F5 CAPE GRACE HOTEL
- D4 CAPE UNION MART ADVENTURE CENTRE
- F5 CITY LODGE HOTEL
- F5 CHAVONNES BATTERY
- F4 CLOCK TOWER (BUILT 1882)
- F4 CLOCK TOWER SHOPPING CENTRE & OFFICES
- F6 COEN STEYTLER ENTRANCE
- D5 COMMODORE HOTEL
- E5 MUSICA MEGASTORE
- D5 CROQUET LAWNS
- D5 DOCK HOUSE
- D5 DRAGON TREE
- D3 EAST PIER ROAD
- G6 EBENEZER ENTRANCE
- D5 FERRYMANS & MITCHELL'S BREWERY
- F4 GATEWAY TOURISM CENTRE
- D6 GRADUATE SCHOOL OF BUSINESS
- B5 GRANGER BAY BOULEVARD ENTRANCE
- B5 GRANGER BAY BOULEVARD
- C5 GRANGER BAY COURT
- D2 HELIPORTS
- D5 IZIKO SA MARITIME MUSEUM
- D4 JETTY 1
- D3 JETTY 2 & PASSENGER SERVICES TERMINAL
- D4 KING'S WAREHOUSE
- E5 MARINA RESIDENTIAL SHOW HOUSE

KEY

- PARKING
- UNDERCOVER PARKING
- HOTEL
- BUS STOPS
- TAXI RANKS
- HELICOPTER CHARTERS
- BOAT CHARTERS
- BANK / ATM'S
- WATERFRONT INFORMATION CENTRE
- WATERFRONT INFORMATION KIOSKS
- TELEPHONES
- TOILETS
- RED ROUTE
- GREEN ROUTE
- YELLOW ROUTE
- BLUE ROUTE
- CENTRAL STATION
- PHOTO OPPORTUNITY
- SEALS
- MAP STATIONS
- FIRST AID



The Way Finding System consists of four routes:

- Red Route features the Clock Tower built in 1882
- Blue Route passes the aquarium complex and features a fish
- Green Route includes Cape Town's original prison known as Portswood and its symbol is a jail
- Yellow Route highlights the Waterfront's marine heritage and features a yacht

These coloured icons have been placed at regular intervals along each route, while strip maps and larger map stations will guide you along your route.

Our user-friendly system will help you to explore and discover all the historical, cultural and leisure attractions the V&A Waterfront has to offer.

- D5 MARKET PLAZA
- D5 MARKET SQUARE
- D4 NATIONAL SEA RESCUE INSTITUTE
- F4 NELSON MANDELA GATEWAY TO ROBBEN ISLAND
- D5 NIKE CONCEPT STORE
- E5 NOBEL SQUARE
- E5 NORTH QUAY
- E5 NORTH WHARF
- E4 OLD PORT CAPTAINS BUILDING
- E4 PIERHEAD
- D5 PORTSWOOD HOTEL
- D7 PORTSWOOD ROAD ENTRANCE
- D5 PORTSWOOD SQUARE OFFICES
- D4 QUAY 4
- D4 QUAY5
- D3 QUAY6
- D5 RED SHED CRAFT WORKSHOP
- B5 ROBBEN ISLAND MUSEUM AND FERRIES
- E5 ROBINSON DRY DOCK
- B5 ROTUNDA ENTRANCE (VICTORIA WHARF)
- H6 REFINERY
- C4 SCHOOLBUS PARKING
- D5 SCRATCH PATCH
- E4 SEAL LANDING
- Q5 SOMERSET HOSPITAL
- C4 SOUTH ARM ROAD
- F4 SWING BRIDGE
- G5 SYNCHROLIFT
- D3 TABLE BAY HOTEL
- D5 TIMEBALL TOWER
- Q5 TOUR COACH PARKING (CLOCK TOWER)
- C4 TOUR COACH PARKING (VICTORIA WHARF)
- E4 TWO OCEANS AQUARIUM
- D5 UNION CASTLE BUILDING
- G6 V&A MARINA RESIDENTIAL
- D5 VAUGHAN JOHNSON'S WINE SHOP
- E5 VICTORIA & ALFRED HOTEL
- D4 VICTORIA WHARF SHOPPING CENTRE & FOOD COURT
- G6 VILLAGE & LIFE
- G5 WATERFRONT INFORMATION CENTRE
- E5 WATERFRONT CRAFT MARKET & WELLNESS CENTRE
- E6 WORKSHOP 17