International Geosphere-Biosphere Programme

ANNUAL REPORT 2010

GLOBAL CHANGE
IGBP International Geosphere-Biosphere Programme

ICSU International Council for Science

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IGBP Research

IGBP began in 1987 and is sponsored by the International Council for Science (ICSU). Our vision is to provide essential scientific leadership and knowledge of the Earth system to help guide society onto a sustainable pathway during rapid global change.

The vision has three key elements:

- the planet
- the planet under pressure
- transformation in an era of rapid global change

IGBP is a world-class provider of expertise, coordination and communication. Our research is organised around:

- major international projects representing the Earth system – the land, atmosphere, oceans and their interfaces
- synthesis, integration and modelling of the whole Earth system, including societies past and present
- past climate change

We help coordinate and drive joint projects with our international partners on the carbon cycle, water cycle, food security, and the environment and human health; and we sponsor projects such as the International Nitrogen Initiative.

Core projects*

- Analysis, Integration and Modelling of the Earth System (AIMES)
- Global Land Project (GLP)
- Global Ocean Ecosystem Dynamics (GLOBEC)
- International Global Atmospheric Chemistry (IGAC)
- Integrated Land Ecosystem – Atmosphere Processes Study (iLEAPS)
- Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)
- Land–Ocean Interactions in the Coastal Zone (LOICZ)
- Past Global Changes (PAGES)
- Surface Ocean–Lower Atmosphere Study (SOLAS)

Joint projects and studies**

- Global Carbon Project (GCP)
- Global Environmental Change and Human Health (GECHH)
- Global Water System Project (GWSP)
- Global Change System for Analysis, Research and Training (START)
- Monsoon Asia Integrated Regional Study (MAIRS)

Major endorsed projects

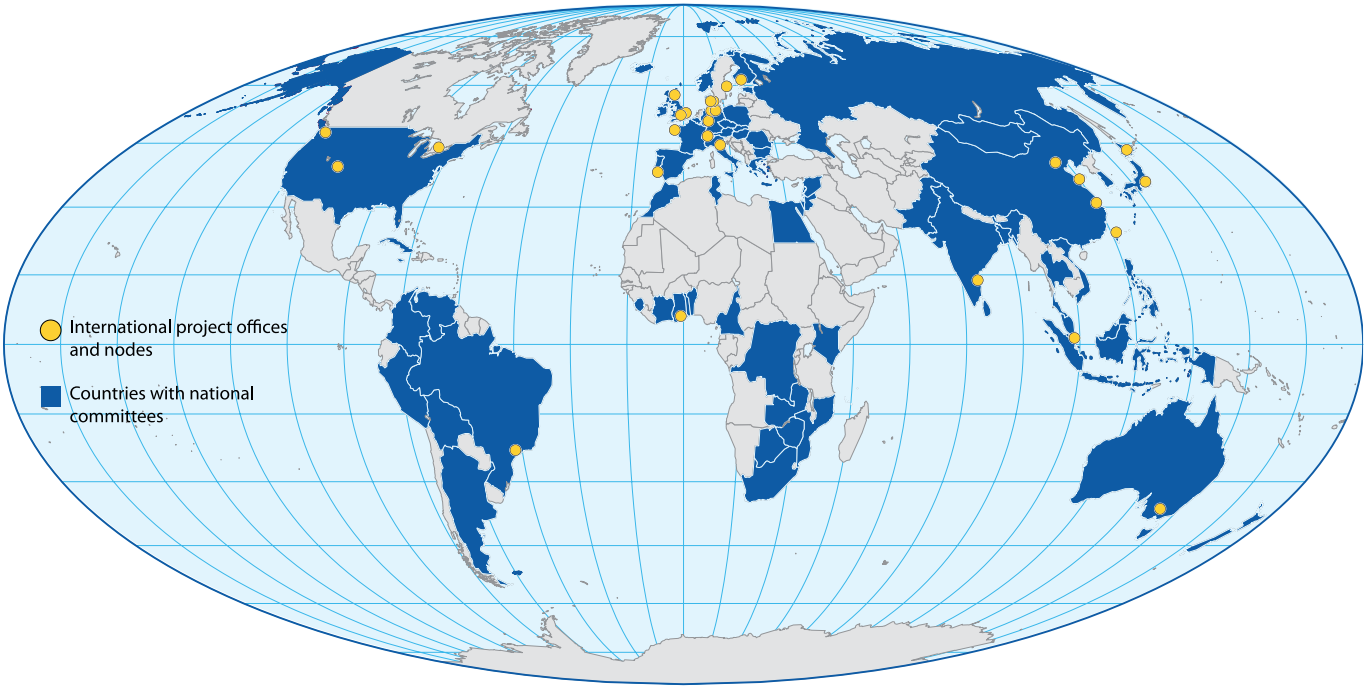
- African Monsoon Multidisciplinary Analysis (AMMA)
- International Nitrogen Initiative (INI)
- Northern Eurasia Earth Science Partnership Initiative (NEESPI)

Fast-track initiatives

- Upper-ocean nutrient limitation: processes, patterns and potential for change (2009-2011) in collaboration with the Scientific Committee on Oceanic Research (SCOR)
- Regionalisation of the nitrogen visualisation tool (2009-2011)
- Megacities and the coastal zone: air-sea interactions (2009-2011) in collaboration with the Scientific Committee on Oceanic Research (SCOR)

* see page 42 for co-sponsors

** with ESSP partners



IGBP's global network includes 29 international project offices, including their nodal offices, and 70 national committees.

THE YEAR IN REVIEW

In 2010, we completed the process of updating IGBP's vision to better reflect the changing landscape of global-change research and funding. The new vision takes cognisance of the thrust towards global sustainability research by the International Council for Science (ICSU) and many science funders around the world. It also expresses our acknowledgment of the need for a new era of transdisciplinary research that focuses on solutions to the most pressing problems facing the planet.

Along with the other global-change research programmes, we made substantial progress last year in developing the contours of the open science conference, Planet Under Pressure: New knowledge towards solutions, which will be held in London in 2012. At the meeting of the scientific organising committee late last year, there was a determined effort to fully engage a wide and diverse group of individuals with a stake in the planet's future.

As a result, we have good buy-in from the scientific community, industry, policymakers and civic society. The conference agenda is even more ambitious than we had originally anticipated, and we have had a very positive response to the call for sessions that went out in January this year.

We also initiated the search for a new chairperson to lead IGBP's Scientific Committee from 2012 onwards. The process assumed a bit more significance in light of the responsibilities that the chair would be expected to shoulder in a rapidly changing research and funding landscape. The search culminated early this year in the selection of James Syvitski as chair-elect. James is Executive Director of the Community Surface Dynamics Modeling System at the University of Colorado, Boulder.

Through all of these developments IGBP remained firmly committed to top-quality research, helping to refine the terrestrial carbon budget, probe the palaeoclimate of South America and explore the links between marine ecosystem changes and climate. IGBP's core projects and Scientific Committee members produced important publications in global-change science in 2010. Well over 70 members of the IGBP community have been selected to contribute to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC).

IGBP's second synthesis consists of a set of policy-relevant topics that seeks to involve a community wider than that traditionally associated with IGBP. The synthesis continued to move forward as several topic leaders set up their steering committees and planned workshops. These workshops (two of which have now been held) are expected to result in a variety of publications, which will feed into the IPCC process and lead to sessions at the 2012 Planet Under Pressure conference.

In 2010 we stepped up our efforts to communicate global-change science to a diverse readership. Our new *Global Change* magazine provided in-depth but lucid analysis of policy-relevant topics ranging from future emissions scenarios and geoengineering to phosphorus availability. We fostered close links with UN Secretary-General Ban Ki-moon's Global Sustainability Panel. And several of us gave talks and published commentaries in high-profile magazines and journals.

IGBP has been at the forefront of highlighting the pressures our planet is facing. We now need to work towards finding creative solutions to easing this pressure. This means that humans will need to figure more centrally in our research, and we will need to work more closely with other communities. This is a challenge, but if 2010 is any indication, we are gearing up to face it.

IGBP Chair Carlos Nobre and Executive Director Sybil Seitzinger, May 2011.

Generous support from 70 nations ensures the continued success of IGBP. We particularly thank the Royal Swedish Academy of Sciences, which has hosted IGBP's secretariat for 24 years, and the many nations hosting IGBP's international project offices and regional offices: Brazil, China, Denmark, Finland, France, Germany, Japan, Malaysia, Switzerland, Taiwan, UK and US.

IGBP remained firmly committed to top-quality research.

Executive Director Sybil Seitzinger

Chair Carlos Nobre

DEVELOPING THE NEW IGBP VISION

In 2010, IGBP began a process to update its vision with a view towards responding to emerging challenges. Since the launch of IGBP in 1987, great strides have been made in Earth system science. Researchers have shown the current rapid global change is unprecedented and, if it continues unabated, could have severe consequences for societies everywhere.

In 2010, funding agencies and IGBP's sponsor, the International Council for Science, initiated visioning exercises to develop new priorities for international global-change research. There was an emphasis on the need for interaction with policymakers and other stakeholder groups. As part of these developments, IGBP created a consultation process to strengthen its own vision in light of two decades of research.

IGBP's new vision is to provide essential scientific leadership and knowledge of the Earth system to help guide society onto a sustainable pathway during rapid global change.

The previous vision states: "The vision of IGBP is to provide scientific knowledge to improve the sustainability of the living Earth. IGBP studies the interactions between biological, chemical and physical processes and interactions with human systems and collaborates with other programmes to develop and impart the understanding necessary to respond to global change."

The new vision recognises that IGBP and indeed the three other international global change programmes are recognised by policymakers as leading the international Earth-system-science research community. The new vision also acknowledges the role of science in guiding society towards a sustainable path.

The vision has three key elements: the planet, the planet under pressure and transformation in an era of rapid global change.

It goes on to say: "In the next ten years, IGBP, working with our partners, will provide the knowledge, expertise and coordination to identify and assess risks posed to society and ecosystems by major changes in the Earth's biological, chemical and physical cycles and processes, and communicate this to society."

www.igbp.net

IGBP created a consultation process to strengthen its own vision.

Arctic
Consumption
Sustaining life URBANIZATION
NETWORK Great Acceleration Anthropocene
Megacities Energy Geoengineering Leadership
International coordination Deserts and drylands Water cycle
Food security Earth Air pollution World-class research
Carbon cycle Human health and wellbeing Ocean acidification
Economics FARMING Deforestation Planetary thresholds
Climate-change index INTERNATIONAL POLICY Ice
Population growth New knowledge towards solutions
Scientific evidence Ecosystems approach to fisheries management
Planetary stewardship Ice cores BIOGEOCHEMISTRY IPCC
Communication Ecosystem collapse Ozone
The planet is in a "no analogue state"
Nitrogen cycle COMPLEX SYSTEMS
Adaptation 10,000 scientists
Antarctic

IGBP is involved in a range of activities from global-change research to its synthesis and communication. All of these activities are encompassed in our updated vision.

PLANET UNDER PRESSURE OPEN SCIENCE CONFERENCE 2012

Scientific and political leaders are vying to see who can come up with the more powerful rhetoric to communicate global-change challenges. UK Chief Scientific Advisor John Beddington recently described the looming water, energy, food and climate crisis as the "perfect storm". In 2011, UN Secretary-General Ban Ki-moon told the World Economic Forum that the global economic model is akin to a "global suicide pact".

A fundamental priority for society is to find solutions. A priority for researchers is to communicate the challenges and the options to address these challenges. The 2012 Planet Under Pressure international conference is developing into an ambitious and influential undertaking. The open science conference, to take place in London, aims to attract 2500 researchers, policymakers, business leaders and journalists to discuss solutions to global sustainability and build lasting collaboration across communities. Special emphasis has been placed on the involvement of youth and participants from developing countries.

Bo Kjellén, the Chair of the 1992 Earth Summit Preparatory Committee (Working Group One), told IGBP, "This conference will be of great importance not only for Rio+20, but for the whole sequence of international cooperation that will be necessary to turn world affairs in a sustainable direction – with the next ten years a most crucial period."

Throughout 2010, IGBP has developed the conference with our co-sponsors – DIVERSITAS, IHDP, WCRP, the Earth System Science Partnership and the International Council for Science.

The secretariat is developing links to the 2012 United Nations Rio+20 conference. In particular, IGBP's Director of Communications Owen Gaffney and Executive Director Sybil Seitzinger have attended Rio+20 preparatory meetings and built links with the International Council for Science's policy team.

IGBP Deputy Director Wendy Broadgate is supporting the conference's scientific organising committee. The committee's Chief Scientific Advisor is Nobel Laureate Elinor Ostrom and the committee is chaired by Mark Stafford Smith, the Climate Adaptation Director of Australia's national science agency, CSIRO, and Lidia Brito, UNESCO's Director of Science Policy. The fundraising committee consists of IGBP Deputy Director João Morais, chair of the local organising committee John Ingram and Andrew Bennett, President of the Tropical Agriculture Association (UK).

www.planetunderpressure2012.net

The conference is developing into an ambitious and influential undertaking.

IGBP's Second Synthesis

In 2009 IGBP decided to synthesise available knowledge about several policy-relevant topics with a view to providing a snapshot of the state of the planet. This is a truly transdisciplinary activity, with engagement from scientists, industry and the policy community.

Outcomes of the second synthesis will include peer-reviewed papers, commentaries and summaries for policymakers. The outcomes are expected to feed into the Planet Under Pressure conference and international assessments.

The group participating in the topic on the needs of least developed countries held its first workshop in Maputo, Mozambique, in September 2010. Discussion revolved around natural disasters, ecosystem services and indigenous knowledge systems in the context of global environmental change.

Although several geoengineering schemes have been discussed with respect to their capacity to combat harmful climate change, their potential unintended consequences have received less attention. Against this backdrop, a diverse group met in La Jolla, California, for an IGBP synthesis workshop to explore the impacts of proposed geoengineering schemes on ecosystems.

The links between nitrogen and climate are complex, and are being investigated in one of the IGBP synthesis topics. Human perturbations of the nitrogen cycle cause adverse health and environmental effects but have a positive impact on Earth's climate (net cooling), suggests a report that emerged in October 2010 from this synthesis. The findings will be discussed further at a workshop to be held later this year involving the IPCC and the Task Force on Reactive Nitrogen.

The links between nitrogen and climate are complex.

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One of the topics of the second synthesis tackles how the human perturbation of the nitrogen cycle, for example, by the extensive use of fertilisers, is affecting climate.

OCEAN ACIDIFICATION INFORMATION TO INTERNATIONAL POLICYMAKERS

International policymakers see IGBP as a key source of knowledge on Earth's changing biogeochemical cycles. IGBP informs international policy through two main routes: international assessments, such as the Intergovernmental Panel on Climate Change, and scientific advisory bodies.

Ocean acidification is rising up the international political agenda. In May 2010, the advisory body for the UN Framework Convention on Climate Change, the Subsidiary Body for Scientific and Technological Advice (SBSTA), asked IGBP to present the latest findings on ocean acidification research.

IGBP Executive Director Sybil Seitzinger presented a summary of the latest findings in ocean acidification research arising from IGBP marine research projects and beyond at the SBSTA meeting in Bonn, Germany.

Seitzinger explained the effects of ocean acidification on climate and fisheries. The oceans absorb around 26 percent of anthropogenic carbon-dioxide emissions. But as the oceans become more acidic they will absorb less carbon dioxide.

Ocean acidification will also affect shell formation with a potential large impact on ocean food webs.

IGBP's marine projects, IMBER and SOLAS, are coordinating ocean acidification research internationally.

IGBP distributed the ocean acidification summary for policymakers, produced by IGBP and others*, to the meeting delegates.

**Ocean Acidification: A Summary for Policymakers* 2009, produced by IGBP, SCOR, IOC and IAEA as a result of the Second Symposium on the Ocean in a High-CO_2 World (2008). The summary has been translated into Spanish, French and Portuguese.

Ocean acidification is rising up the international political agenda.

IGBP provides the latest information to international policymakers about ocean acidification. The summary for policymakers (above) was produced by IGBP and its partners in late 2009 and distributed extensively in 2010.
www.ocean-acidification.net

INTEGRATED OBSERVING STRATEGY

"You can't manage what you can't measure," is part of the philosophy behind the Integrated Observing Strategy under development by the AIMES project.

The strategy, commissioned by IGBP, focuses on integrating observations of the physical, biogeochemical and human dimensions of global change. Existing observing networks are not designed to do this and instead focus on discrete tasks within individual domains or disciplines.

"A more integrated observing system approach is needed to detect and understand complex environmental system responses to change," according to the group developing the strategy. For example, an integrative understanding of water supply, demand and recycling requires natural observations that capture physical and biophysical aspects of hydrology. But it also needs to include information on water-resource demands, engineering and policy aspects.

An ongoing need is to integrate space-based observations with *in situ* observations: this is challenging because the temporal and spatial scales of space-based observations differ considerably from those of observations on the ground.

According to the group's preliminary assessment, there has been an underinvestment in measurements in the following areas: tropical regions, high altitudes, the remote ocean and areas intensively affected by human activity.

One observing network – FLUXNET, championed by the iLEAPS project – has had significant success in producing integrated analyses of biogeochemical processes across continents. Whilst challenging, FLUXNET could be expanded to incorporate observations on humans or biodiversity measurements.

You can't manage what you can't measure.

iLEAPS

IGBP has commissioned an Integrated Observing Strategy, which is being developed by the AIMES project. The group developing the strategy highlights the success of FLUXNET – a global network of observation towers – and advocates its expansion to incorporate observations on humans or biodiversity.

LEARNING FROM THE PAST

History is punctuated with famine, pestilence and war. Civilisations rise and fall. The links between these historic events and global change have fascinated researchers for decades. Not least as we look at our own global society and its impact on the planet.

The Integrated History and Future of People on Earth (IHOPE) project, sponsored by IGBP, AIMES, PAGES and IHDP, is attempting to unravel some of these links. In 2010, IHOPE published its science plan, which identifies three long-term goals.

First, map the Earth's integrated record of biophysical and human system changes over the past millennia.

Second, test human-environmental system models against the integrated history to better understand the socio-ecological dynamics of human history.

Third, project with more confidence and skill the options for the future of humanity and the Earth system.

The International Project Office, based at the Stockholm Resilience Centre, is implementing its science plan through a series of analyses of regional research activities. The regions include Africa, Australia, the Mediterranean (already one of the best-studied human histories), the Mayans, China and the US Southwest.

Over the next few years IHOPE will provide a mechanism to test a broad range of hypotheses about human-environment interactions based on these regional case studies.

www.stockholmresilience.org/ihope

The links between historic events and global change have fascinated researchers.

© iStockphoto.com/ Leon Rafael

IHOPE aims to understand the past to ensure a sustainable future for humanity.
Pictured above, a Mayan engraved stone (AD 591) showing a ball player.

THREATS TO GLOBAL HUMAN WATER SECURITY AND BIODIVERSITY

The water security of around five billion people – 80 percent of the human population – is threatened, according to research published in the journal *Nature*. Scientists associated with the Global Water System Project and DIVERSITAS have created a global database of rivers pinpointing risks to human water security and biodiversity. They took 23 parameters affecting river health including, for example, water diverted to cropland, livestock density, nitrogen enrichment, pesticide levels, sediment deposits, damming and invasive species. By combining these parameters, the scientists, led by Charles Vörösmarty and Peter McIntyre, produced a set of global maps showing areas at high risk.

Densely populated regions face the highest risk to their water security. "A strikingly small fraction of the world's rivers remain unaffected by humans," the authors report. Countries facing the highest joint threats to water supply and biodiversity are in the developing world: China, India, Peru, sub-Saharan Africa, parts of Central Europe and Central Asia. Rich nations – Europe, Australia and North America – have avoided threats to water security by expensive engineering projects: building dams and treatment plants, managing rivers and erecting barriers to allow crops on flood plains.

But these technical fixes have reduced biodiversity. With instant access to clean water, people in these countries have largely ignored the growing threats to biodiversity. Now decision-makers are caught in a dilemma. Societies in poorer countries face the highest risk to their water security. If they adopt the same solutions as rich nations it will be costly, further harm ecosystems they depend upon and fail to deal with the underlying cause. But another route is open: "integrated water resource management that expressly balances the needs of humans and nature".

Engineers, for instance, can rework dam operation rules to maintain economic benefits while simultaneously conveying adaptive environmental flows for biodiversity. The authors are not expecting a quick fix, arguing that if climate negotiations are any guide, "a generational timeframe may be necessary to stimulate sufficient political willpower to address the global river health challenge." Meanwhile, the majority of people on the planet and countless freshwater species remain living on the edge.

Vörösmarty *et al*. *Nature* 467: 555–561, doi:10.1038/nature09440.

www.riverthreat.net

A strikingly small fraction of the world's rivers remain unaffected by humans.

© iStockphoto.com/Jen Sharp

Rich nations have used technical fixes such as dams to minimise threats to water security. But such measures have reduced biodiversity. Pictured here is the Hoover Dam on the Colorado River.

CO_2 EMISSIONS ON THE REBOUND

In 2009, emissions of carbon dioxide from fossil fuels dipped by over one percent, according to scientists from IGBP's joint project, the Global Carbon Project. Writing in *Nature Geoscience*, the scientists attribute the fall to the global financial crisis that began in 2008. Because modern economic growth relies on burning fossil fuels, carbon dioxide emissions tend to track the gross domestic product (GDP) of nations.

A study published last year in the same journal predicted that as the global economy faltered, GDP would shrink and emissions would decrease by almost three percent. But just half of that expected decrease seems to have materialised. Although developed nations such as the US, UK and Germany did indeed emit lower quantities of carbon dioxide relative to 2008 levels, the financial crisis did little to slow down the growth in emissions in China and India: these nations emitted more carbon dioxide in 2009 relative to 2008.

As a result, the net reduction in emissions was less than anticipated. The world still burned enough fossil fuel and produced enough cement to ensure that the emissions in 2009 were the second highest in history. And as economies rebound, 2010 emissions are likely to be about three percent higher relative to last year.

Interestingly, a combination of new data and modelling indicates that carbon dioxide emissions due to land-use change during the past decade were lower than in the 1990s. Recent reports of decreasing rates of deforestation in some parts of the world, coupled with forest regeneration in Eurasia, lend credence to this conclusion, although uncertainties remain quite high.

Friedlingstein P *et al.* (2010) *Nature Geoscience*, 3: 811-812, doi: 10.1038/ngeo1022.

2010 emissions are likely to be about three percent higher relative to last year.

© iStockphoto.com/ Kajetan Stozek

An analysis by the Global Carbon Project shows that global emissions of carbon dioxide in 2009 were lower than those in 2008 as a result of the global financial crisis. But the fall in emissions was smaller than expected because the crisis did little to dent economic growth in India and China: these nations emitted more carbon dioxide in 2009 than they did in 2008.

SOUTH AMERICAN PALAEOCLIMATE

Reconstructions of past climate are important both for understanding how the climate-system works and for improving the accuracy of projections of future climate change. International research initiated by IGBP's PAGES project has led to the reconstruction of temperature and precipitation of southern South America for the past several hundred years.

The results, summarised by Neukom *et al.* (2010 a,b), allow comparison with the better-studied northern hemisphere. During some periods, the summer temperatures in southern South America and Europe, for example, seem to have fluctuated quite synchronously. This co-variation could be simply a chance phenomenon or arise from global controls such as changes in solar irradiation or large volcanic eruptions.

Other periods do not show a synchronicity for summer temperatures, and the winter temperatures generally do not seem to vary in consort. It is likely that the effects of the global forcing mechanisms were superimposed with and perturbed by strong regional to hemispheric-scale influences during these periods. Pinpointing the causes of these variations will require reconstructions from other regions and climate-model simulations.

Interestingly, in South America 20th-century warming was less pronounced in the context of the preceding centuries than in Europe, especially during the summer. Writing in the most recent issue of the *Global Change* magazine, Raphael Neukom and Jürg Luterbacher postulate that the lower rate of warming in the southern hemisphere – also evident in climate models – can be explained by the role played by the waters in this hemisphere.

The Southern Ocean has a large capacity to take up heat and store it in its waters, which leads to a smaller warming at the surface. The southern, water-dominated hemisphere thus reacts with a certain lag to global warming as compared with the northern, land-dominated hemisphere.

In contrast to the more muted warming, the scientists find that in recent decades precipitation has changed substantially in some areas of southern South America. In general, the data and analysis suggest that summers in many parts of southern South America have become progressively wetter, whereas winters have become drier.

Neukom R *et al.* (2010a) *Climate Dynamics*, doi: 10.1007/s00382-010-0793-3.

Neukom R *et al.* (2010b) *Geophysical Research Letters* 37: L14708, doi: 10-1029/2010GL043680.

In recent decades precipitation has changed substantially in some areas of southern South America.

© Mariano Morales

Polylepis tarapacana trees are highly sensitive to climate changes in the Andean Altiplano, and store information about such changes in their annual growth rings.

LAND SYSTEMS AND SUSTAINABILITY

In 2010, two research communities – the Global Land Project and the Urbanization and Global Environmental Change Project – came together for the first time for a major open science conference.

The aims of the Arizona conference, which attracted around 500 delegates, were to build a new community of researchers and to develop new thinking on global sustainability, particularly with regard to urbanisation and land-use change. From the Global Land Project's perspective the team wanted to continue to build the international community and advance the science.

The Global Land Project's Executive Officer, Tobias Langanke, said, "One thing we wanted to do was look at how to manage land systems to cope with global change and how to develop sustainable pathways for the future."

Keynote speaker Karen Seto, from Yale University, said in her talk on teleconnections between urban and rural systems that, "Depending on population densities and urban land expansion rate, under the UN medium fertility population growth scenario, by 2050, there will be between 400,000 km^2 and 1,429,000 km^2 of new urban land globally. Or roughly the size of Peru."

One relatively new aspect of the teleconnections between rural and urban systems according to Seto, is the phenomenon known as "land grabs" in Africa and elsewhere, for example, Southeast Asia. Countries such as China and big companies are leasing or buying large tracts of land in Africa to grow crops to export, with implications for African farmers and the African economy. In 2010, the Global Land Project produced a report on this topic.

Of similar concern, says Seto, is the new demand for rare earth metals. These metals, essential for many high-tech applications including green energy devices, could spark an "underground land grab". Indeed, China now produces 98 percent of the world's supply and is using this dominant position as a leverage point in negotiations.

www.glp2010.org

Of similar concern is the new demand for rare earth metals.

Tobias Langanke

The open science conference facilitated interaction between two communities: the Global Land Project and the Urbanization and Global Environmental Change Project.

AN EYE ON THE ARCTIC COAST

A recent report entitled "*State of the Arctic Coast 2010: Scientific Review and Outlook*" provides a comprehensive picture of the status and current and anticipated changes in the most sensitive Arctic coastal areas. The assessment leading up to the report was initiated after a 2007 workshop organised by the LOICZ project in conjunction with the International Permafrost Organisation (IPA) and the International Arctic Science Committee (IASC).

The assessment takes a socio-ecological approach that explores the implications of change for the interaction of humans with nature. The report is a first step towards a continuously updated coastal assessment and to identify key issues for scientific enquiry in an international Earth system research agenda. The document was prepared by an international writing team, including 15 lead authors and 27 contributing authors.

The report is organised in three parts: the first provides an assessment of the state of Arctic coastal systems under three broad disciplinary themes – physical systems, ecological systems and human dimensions; the second examines progress in integrative approaches to monitoring, understanding and managing change in Arctic coastal systems; the third identifies data gaps and research priorities over the coming decade.

Forbes DL, ed (2011) *State of the Arctic Coast 2010 – Scientific Review and Outlook*. International Arctic Science Committee, Land-Ocean Interactions in the Coastal Zone, Arctic Monitoring and Assessment Programme, International Permafrost Association. Helmholtz-Zentrum, Geesthacht, Germany, 178 pp.

http://arcticcoasts.org

The report is aimed to be a first step towards a continuously updated coastal assessment.

© iStockphoto.com/Dan Kite

The fragile Arctic coastal regions are the subject of a report published in 2011 by the LOICZ project and its partners.

UNTANGLING THE WEBS

Marine food webs refer to the complex relationships between predators, prey and their environment, which govern the movement of energy and matter through marine ecosystems. Global change can affect individual components of a web in unique ways: predicting the response of the entire web requires an integrated, end-to-end approach involving the full range of organisms in the ecosystem, from viruses to large fish.

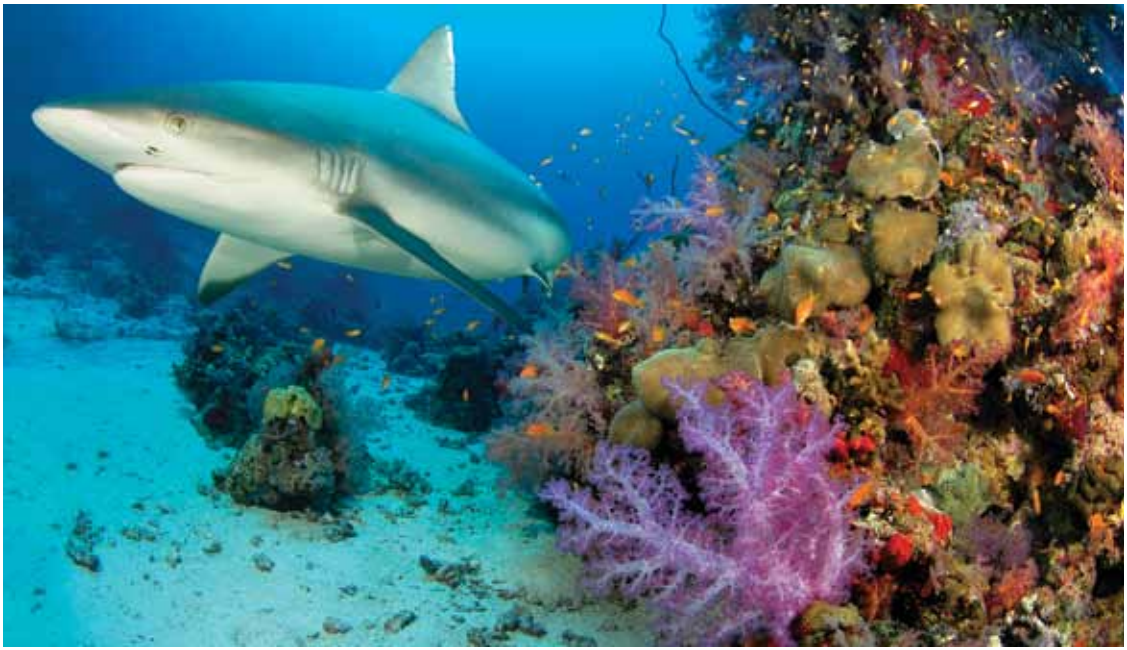
A recent review by the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) and the Global Ocean Ecosystem Dynamics projects provides a framework for understanding how global change can affect marine food webs. The proposed approach connects the physical and chemical changes in oceans to the interactions between the various organisms within a given web.

The review highlights eight thematic areas that need to be considered in integrated research of marine food webs. The areas include: biogeochemical cycles; stoichiometry and food quality; material and energy flows; biodiversity; food and feeding behaviour; distributions and movements; life histories and population dynamics; and adaptability. Furthermore, different threads link these areas.

The review points out that different research communities study food webs from different perspectives, and that there is a need for more integrative research – at the heart of the IMBER project – that cuts across traditional disciplinary boundaries. It also emphasises the need for more comprehensive models that allow studying webs across scales and components, and an approach that includes food webs from a range of marine environments.

Moloney C L *et al.* (2011) *Journal of Marine Systems* 84: 106-116.

There is a need for more integrative research.



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An end-to-end approach includes the full range of organisms in a marine ecosystem, from top predators such as sharks to micro-organisms such as plankton.

FOOD SECURITY AND GLOBAL CHANGE

Recent political events in the Middle East sparked in part by soaring food prices connected to droughts in Russia show clear links between food security, global environmental change and economic and political stability.

In 2010, the IGBP-IHDP-WCRP joint project focusing on food security, Global Environmental Change and Food Systems (GECAFS), published '*Food Security and Global Environmental Change*'. The aim of the book is to strategically inform future research on food security to help deliver global sustainability.

The book, edited by John Ingram, Polly Ericksen and Diana Liverman, navigates the complexity of the food systems that underpin food security. It summarises GECAFS' and others' analyses of the vulnerability and resilience of food systems and also discusses the value of undertaking such research at a regional level.

The authors note that global environmental change will "increase the potential risk of food-related violence"; and the growing private-sector interest in food systems, which they say "suggests new hybrid forms of food system governance are emerging".

The authors state "the twin goals of feeding nine billion people and lowering the environmental footprint of food systems are only weakly linked and at times conflicting in practice." They stress that a research approach is needed that "integrates a wide range of concepts and methods to serve improved policy formulation and resource management".

The book marks the successful conclusion of the GECAFS joint project. A lasting legacy of the GECAFS is that it has contributed to the view within the UN's Food and Agriculture Organization that a whole food-systems approach – one that integrates food production, packaging and other activities with food security outcomes such as access and availability – must be taken to effectively address food security, especially in the context of environmental change.

Food Security and Global Environmental Change, edited by Ingram J, Ericksen P and Liverman D. Earthscan. 384 pp. ISBN 9781849711289.

www.earthscan.co.uk/?tabid=102368.

New hybrid forms of food system governance are emerging.

The GECAFS project came to a close in 2010. The book draws on the project's research to present a synthesis of the current state of knowledge and thinking on the relationships between global environmental change and food security.

MAPPING DIMETHYL SULPHIDE VARIATIONS

Sulphur is essential for life, so it is no surprise the global sulphur cycle holds particular interest to global-change scientists.

One sulphur-containing molecule, dimethyl sulphide (DMS), has been under intense scrutiny for several decades. The molecule, released by phytoplankton on the ocean surface, gives the sea its distinct smell. Birds follow its scent towards rich hunting grounds. But, arguably more importantly, it is also thought to affect cloud formation and so weather, climate and Earth's radiation budget.

IGBP's Surface Ocean–Lower Atmosphere Study (SOLAS) has now produced state-of-the-art global maps showing monthly distribution of DMS flux between the ocean and the atmosphere.

The team estimates that 28.1Tg of sulphur in the form of DMS is transferred from the oceans into the atmosphere annually. This is 17 percent higher than previous estimates. The estimate is based on a threefold increase in data in the global surface ocean DMS database over the last decade.

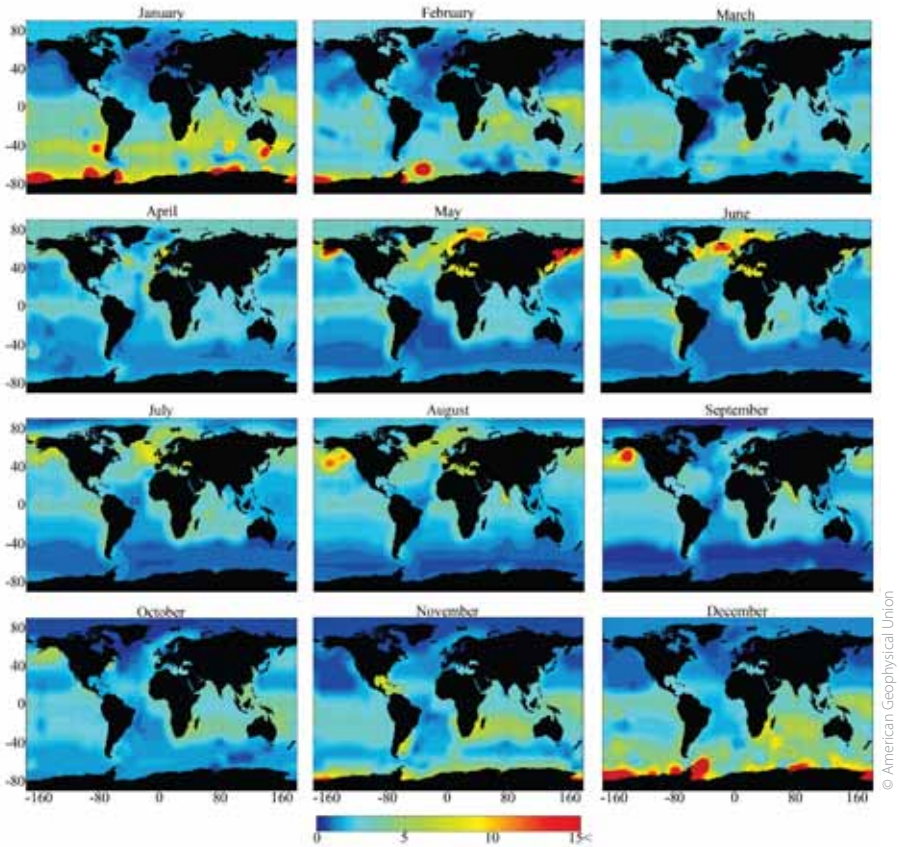
This new DMS climatology is a valuable tool for understanding atmospheric chemistry, climate and Earth-system processes. It provides details of regional and seasonal variations in DMS, which are critical for Earth-system models. It has revealed that DMS concentrations were previously over-estimated in polar regions and are actually higher than previously estimated in poorly sampled regions such as the southern Indian Ocean.

The report's authors say, "This work confirms the central role of DMS in the transport of sulphur from the biosphere into the atmosphere."

Emissions of DMS from the oceans are the main natural source of atmospheric sulphur. Once in the atmosphere, DMS oxidises resulting in particles that act as cloud condensation nuclei, which are necessary for cloud formation. The number of these atmospheric particles affects the radiation budget of the Earth, directly by scattering solar radiation and indirectly by influencing cloud microphysics and Earth's albedo – more clouds reflect more solar radiation back to space.

Lana A *et al.* (2011) *Global Biogeochemical Cycles* 25: GB1004, doi: 10.1029/2010GB003850.

Dimethyl sulphide has been under intense scrutiny for several decades.



© American Geophysical Union

Monthly climatology of DMS fluxes (*μmolS/m*^{2} d). Note that the scale is capped at 30 *μmolS/m*^{2} d to ensure readability of the plots, although only a few specific regions exceed this value.
Figure 3 from Lana A *et al.* (2011) *Global Biogeochemical Cycles* 25: GB1004, doi: 10.1029/2010GB003850.

FOREST AND GRASSLAND RESPONSE TO EUROPEAN HEAT WAVES

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

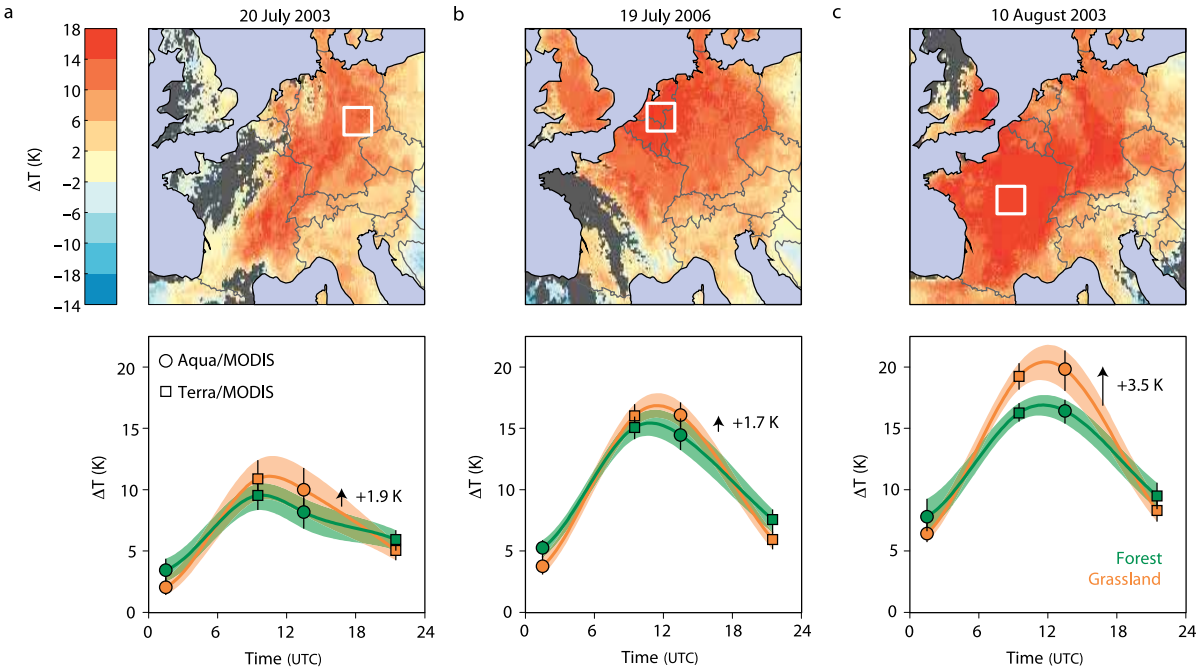
The team analysed measurements provided by a network of observation towers in Europe to understand the evolution of surface heating over forests and grasslands. The analyses show that the surface over grasslands is cooler than that over forests during the early stages of a heat wave. This is because of higher evaporation over grass. But eventually this causes soil-moisture depletion in the grasslands, and there is a shift in behaviour as the heat wave advances: the surface over grasslands begins heating up and might cause a shift in the regional climate to even higher temperatures.

Prolonged dry and warm conditions during the summer of 2003 in Europe meant that grassland became the main source of heating during the later stages of the heat wave. This likely explains the extreme temperatures measured in this region in August 2003.

The researchers contend that forests could serve to ameliorate the effects of prolonged and severe heat waves, and also contribute to preserving water by virtue of generally lower evapotranspiration.

Teuling A J *et al.* (2010) *Nature Geoscience* 3: 722-727.

Forests could ameliorate the effects of prolonged heat waves.



Forests and grasslands respond in fundamentally different ways to extended heat waves. Figure 3, reprinted with permission from Macmillan Publishers Ltd: *Nature Geoscience,* Teuling A J *et al.* , v.3, 722-727 (2010).

TRACKING ARCTIC POLLUTANTS

Asian anthropogenic emissions are a major source of carbon-monoxide pollution in the Arctic, according to a recent study by researchers affiliated with IGBP's IGAC project. Black carbon, however, is sourced dominantly from northern Eurasia, another related study found. The Arctic environment is a particularly sensitive one, and these types of measurements could help in devising and assessing future emissions-reduction strategies.

Carbon monoxide is a pollutant, whereas black carbon, in addition to being a pollutant, also affects climate. The research teams worked under the auspices of POLARCAT, an international initiative that used land-based platforms, aircraft, ships and satellites to make measurements. Combining the measurements with modelling, the teams determined the sources of important Arctic pollutants.

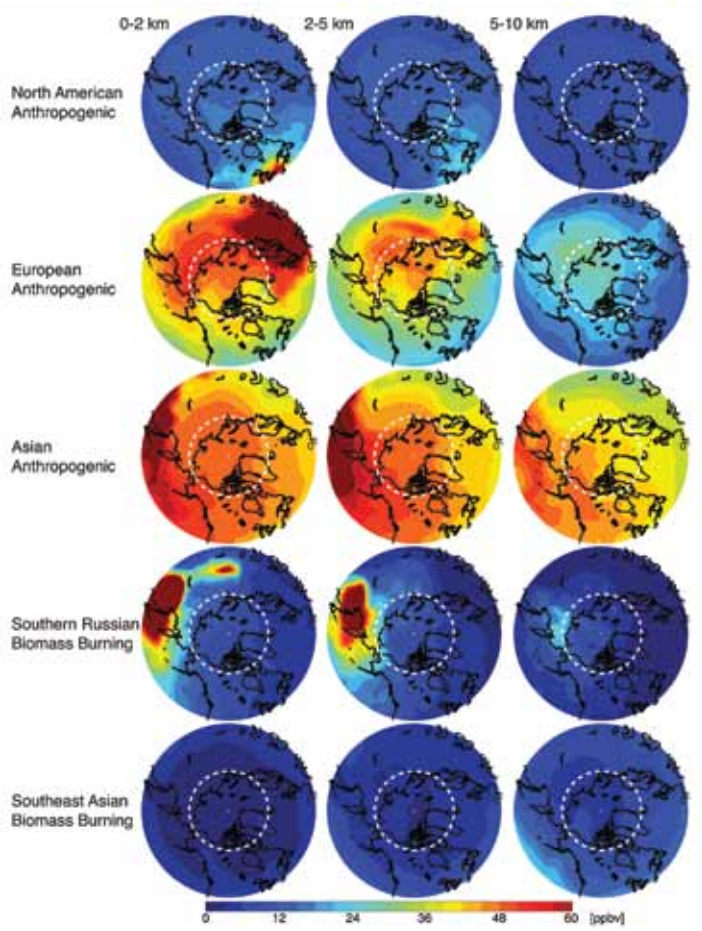
Although European sources are important contributors to the near-surface carbon monoxide in the Arctic, Asian emissions resulting from human activities are by far the dominant contributors to other levels of pollution in the atmosphere. Strong El Niño conditions, when winds are favourable, tend to favour transport from Asia.

Black carbon does not stay in the atmosphere for long because it can be removed by rain and snow. This is one of the reasons why nearby northern Eurasia is the primary contributor of this material to the Arctic.

Fischer J A *et al.* (2010) *Atmospheric Chemistry and Physics* 10: 977–996.

Hirdman D *et al.* (2010) *Atmospheric Chemistry and Physics* 10: 669–693.

Asian emissions are by far the dominant contributors.



An analysis of carbon-monoxide pollution in the Arctic implicates Asian emissions linked to human activity. As the figure shows, European emissions are important only close to the surface. From Fischer J A *et al.* (2010) *Atmospheric Chemistry and Physics* 10: 977–996. Reprinted under the Creative Commons Attribution 3.0 licence.

On the Fast Track

IGBP's fast-track initiatives address innovative and cross-cutting issues, and explore gaps in current understanding. In 2010, three ongoing initiatives tackled nitrogen, nutrients that limit upper-ocean oceanic productivity, and coastal megacities.

Several elements, for example, phosphorus, iron and silicon, serve to limit the biological productivity of the shallow oceans and thereby influence the exchange of carbon dioxide between the sea surface and the atmosphere. Recent studies have sought to understand how exactly such nutrients influence productivity, and what future changes could be expected. The fast-track initiative on upper-ocean nutrient limitation, co-sponsored by SCOR, held a workshop in Southampton, UK, in late 2010 to synthesise the results of recent work. The synthesis will form the basis of a review to be published this year.

The nitrogen visualisation tool, presented during the 4th International Nitrogen Conference, provides a way of investigating the inter-linkages between the different nitrogen-related problems. Although the tool looked at nitrogen from a global perspective, issues related to nitrogen tend to be region-specific. The fast-track initiative on regionalisation of this tool now offers a way of visualising the regional intricacies of nitrogen. A Flash version of the regionalised tool, including the new data collected over the past year or so, will become available for broader testing in July/August of this year.

Megacities are large urban agglomerations with ten million or more inhabitants. Many megacities are located at the coast, and the juxtaposition of land and ocean leads to pressures. The fast-track initiative on megacities in the coastal zone, co-sponsored by SCOR, focuses on the physical and biogeochemical interactions between the atmosphere, the land and the ocean in and around coastal megacities. This was also the theme of a workshop that the initiative held in Norwich, UK, in April 2010. The workshop identified the most important environmental issues associated with megacities and explored the best way to minimise their impacts. Understanding the interaction between megacities and the coastal regions they fringe should help devise mitigation strategies for air and water pollution.

The workshop explored the best way to minimise the impact of megacities.

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Megacities in the coastal zone lead to substantial impacts on fragile ecosystems. An ongoing IGBP-SCOR fast-track initiative is exploring the best ways to minimise their impacts.

COMMUNICATIONS

Overwhelming evidence dictates that society must make giant leaps towards global sustainability if it is to avoid crossing dangerous thresholds in the Earth system. Good communication is essential if this message is to reach the right people at the right time.

But during 2010, climate research came under the full glare of a hostile, cynical international media. The research "community" found it difficult to tackle attacks in the media effectively. The Intergovernmental Panel on Climate Change came in for the harshest criticism. It is now putting in place a strategy to improve external communications. The media furore highlights the need for all research programmes in this highly charged area to devote enough attention to external communications.

IGBP issued a statement in support of IPCC in May 2010; the statement emphasises that "the IPCC process for assessing climate change, its causes, its impacts and responses, is reliable and unbiased." In June 2010, IGBP's Director of Communications Owen Gaffney spoke on this topic at the Deutsche Welle Global Media Forum's climate communications conference in Bonn. And Science Editor Ninad Bondre contributed to the debate with an article on the origins of scepticism and options for addressing it.

Gaffney also published a commentary on the BBC website outlining the extent of global change and the need for societal transformation to avoid crossing Earth-system thresholds ("Humanity needs to take a giant leap"). In December last year, IGBP Executive Director Sybil Seitzinger published an opinion piece in *Nature*, arguing that international policymakers must take a comprehensive and long-term view of global sustainability. She also spoke at a major World Bank conference in Stockholm.

During the year, IGBP arranged a series of meetings with former senior UN negotiators to discuss how to participate effectively in the UN process, particularly regarding the UN Rio+20 Summit in 2012. Bo Kjellén, Chairman of Working Group One for the 1992 Rio Earth Summit and Sweden's chief negotiator, commented: "The 2012 Planet Under Pressure conference will be of great importance not only for Rio+20, but for the whole sequence of international cooperation that will be necessary to turn world affairs in a sustainable direction – with the next ten years a most crucial period."

In August, UN Secretary-General Ban Ki-moon announced a high-level Global Sustainability Panel. Since the announcement, IGBP has initiated discussions with Ban Ki-moon's chief climate advisor and director of the panel, Janos Pasztor. These close links are ensuring the panel has direct access to IGBP research.

In autumn, IGBP began development of a new website as well as streamlining and improving its database of over 10,000 researchers and stakeholders of global-change research. Our community receives two issues a year of the highly regarded *Global Change* magazine. The magazine featured interviews with Janos Pasztor and Nobel Laureate Elinor Ostrom, and covered the most significant findings in global-change research.

IGBP holds successful annual meetings of the international project offices to help foster interdisciplinary thinking and good practices.

The communcations team has initiated discussions with Ban Ki-moon's chief climate advisor.

Two issues of *Global Change* were published last year, and we also updated the IGBP brochure.

PARTNERSHIPS

Earth System Science Partnership

The International Council for Science (ICSU) sponsors four global environmental change programmes: IGBP, DIVERSITAS, the International Human Dimensions Programme on Global Environmental Change and the World Climate Research Programme. During the past decade, the programmes have worked together via their Earth System Science Partnership. Collaboration has increased substantially of late in view of ICSU's vision for more integrated science. An important example is the joint organisation of the 2012 Planet Under Pressure conference.

Joint projects on global sustainability

- Climate Change, Agriculture and Food Security (CCAFS)
- Global Carbon Project (GCP)
- Global Environmental Change and Human Health (GECHH)
- Global Water System Project (GWSP)

Regional research

- Monsoon Asia Integrated Regional Study (MAIRS)
- African Monsoon Multidisciplinary Analysis (AMMA)

Capacity building in developing countries

- Global Change System for Analysis, Research and Training (START)

International assessment panels

IGBP works closely with the Intergovernmental Panel on Climate Change (IPCC). ICSU's review of IGBP stated, "the success and recognition of IPCC and the Millennium Ecosystem Assessment both owe a huge amount to the work of IGBP."

IGBP joins scoping meetings, contributes to the outline, nominates authors and is part of the expert review. Over 70 individuals from the IGBP community have been appointed as coordinating lead authors, lead authors or review editors.

Monitoring, measuring and Earth observation

IGBP connects remote sensing with modelling and *in situ* measurements. IGBP's large network can help define the research requirements from remote-sensing, contributing to the design and operation of remote sensing equipment.

All major space agencies contribute to IGBP research and work closely with the IGBP research community. NASA, the European Space Agency (ESA) and the Group on Earth Observations (GEO) participate in IGBP's annual scientific committee meetings. IGBP also participates in the Integrated Global Observing Strategy (IGOS) and the Committee on Earth Observation Satellites (CEOS).

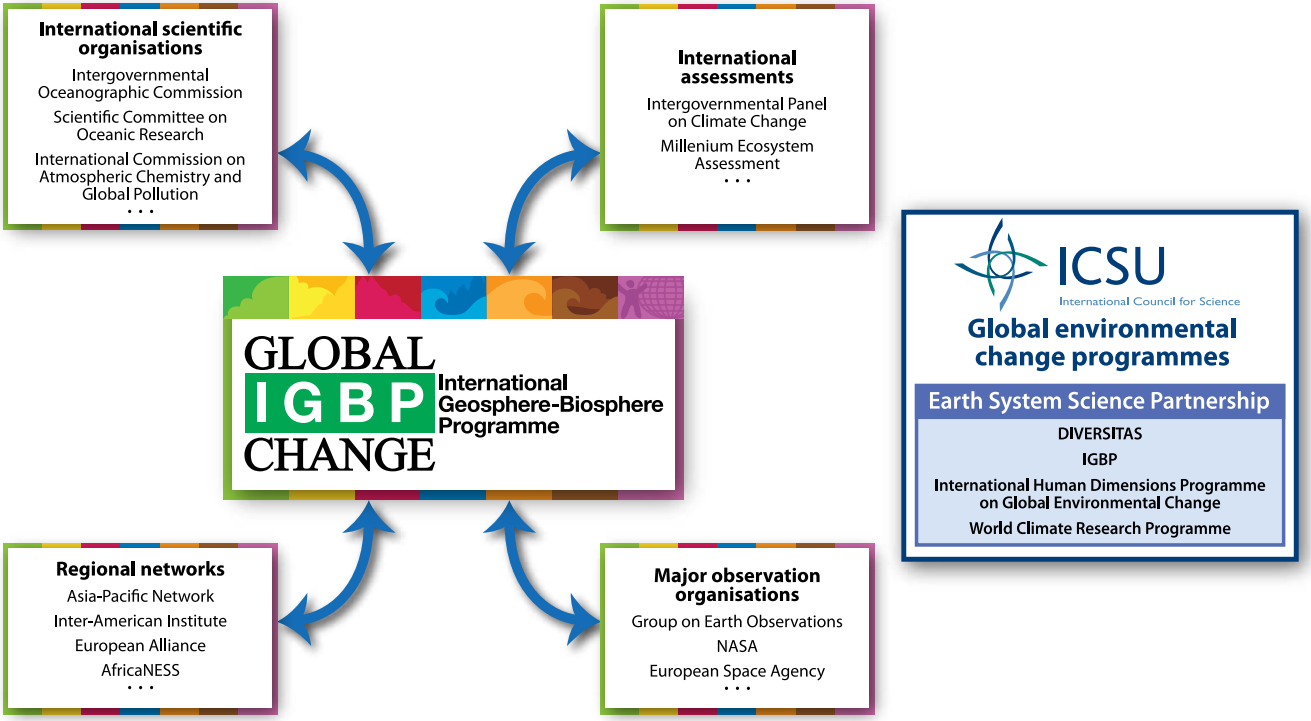
Regional collaboration

- Asia Pacific Network for Global Change Research (APN)
- Inter-American Institute for Global Change Research (IAI)
- The European Alliance of Global Change Committees
- AfricanNESS, the African Network for Earth System Science
- IGBP endorses the African Monsoon Multidisciplinary Analysis (AMMA)

IGBP project co-sponsors

- International Human Dimensions Programme on Global Environmental Change: GLP, LOICZ, IHOPE.
- Intergovernmental Oceanographic Commission (IOC) of UNESCO: GLOBEC
- ICSU's International Commission on Atmospheric Chemistry and Global Pollution (ICACGP): SOLAS and IGAC.
- ICSU's Scientific Committee on Oceanic Research (SCOR): GLOBEC, IMBER, SOLAS.
- World Climate Research Programme: SOLAS.

IGBP collaborates closely with SCOR on many issues in marine science, for example, core projects (see above) and fast-track initiatives (upper-ocean nutrients and megacities in the coastal zone). IGBP also works closely with SCOR and the Intergovernmental Oceanographic Commission (IOC) on the symposium series on ocean acidification entitled The Ocean in a High-CO_2 World. Planning is under way for the next symposium to be held in Monterey, USA, in September 2012.



IGBP works closely with the United Nations through the UN's assessment processes, other international scientific organisations, major observation organisations and regional networks. ICSU's four international global-change research programmes jointly sponsor several projects, including those coordinated by the Earth System Science Partnership.

National Committees and the Brazil Regional Office

IGBP has a **regional office** in Brazil and **70 national committees** across Africa, the Americas, Asia-Pacific, Europe and the Middle East. Last year, the IGBP national committees organised workshops, published research articles and engaged core projects.

The regional office through the support of the Brazilian National Institute for Space Research (INPE) prints and mails the *Global Change* magazine to more than 2,500 universities and research institutes in developing countries. It also translates policy briefings on oceans and global environmental change developed by IGBP, and ensures their wide distribution.

In 2010, the regional office helped support the participation of 18 developing-country researchers in the first workshop of the IGBP second synthesis topic on the needs of the least developed countries, held in Maputo, Mozambique, in September.

Following up on the November 2009 workshop on impacts, adaptation and vulnerability, the regional office and the Earth System Science Center at INPE led the writing of a report and a scientific paper: Impacts, adaptation and vulnerability to global environmental change: challenges and pathways for an action-oriented research agenda for middle- and low-income countries. *Current Opinion in Environmental Sustainability* 2: 364-374 (2010).

Zev Levin, previous chair of **Israel's national committee**, was part of a team of researchers that studied ice nucleation caused by ash spewed from the Icelandic volcano that caused travel chaos in Europe in 2010. The effectiveness of volcanic ash particles as ice nuclei is not clear, and previous work had led to contradictory results. Levin's group found that ash particles are indeed effective as nuclei for ice formation. In other words, a large-scale natural cloud seeding event might have taken place. This work has been submitted for publication.

Members of the **Irish national committee** continue to be involved actively in research undertaken by IGBP's core projects, in particular LOICZ, SOLAS and IGAC. National activities conducted under the auspices of these projects include coastal climate adaptation and marine aerosol production. A SOLAS-sponsored COST Action (735) workshop was hosted by the National University of Ireland (Galway) in 2010. A resulting meeting report was published in the *Bulletin of the American Meteorological Society*.

By virtue of its large scientific community and a vigorous research programme, **India** is an important component of the IGBP network. Shreyas Managave and colleagues were able to identify a clear seasonal cycle for intra-annual variations in the oxygen isotopic composition of annual growth rings of three teak trees from central India. The isotopic variations were found to be related to changes in relative humidity. Breaks in monsoon conditions, usually associated with droughts, could hence be identified. Such sampling could be used to reconstruct the northeast monsoon rainfall over southern India. Past break-monsoon conditions detectable by high resolution intra-annual $\delta^{18}O$ analysis of teak rings. *Geophysical Research Letters* 37: L05702, doi:10.1029/2009GL041172 (2010).

The **German national committee** has been promoting interdisciplinary and integrative research approaches in global change science for many years. To promote scientific research on the opportunities and risks of climate engineering (geoengineering) and continue the interdisciplinary dialogue initiated in 2009, the committee held a round table discussion in March 2010. The meeting helped to identify knowledge gaps and develop urgent research questions from the perspective of natural and social scientists. Scientists from a wide range of disciplines, including law, marine biogeochemistry and chemistry participated in the discussions, in addition to representatives of several Germany agencies.

Germany hosts several project offices of the global environmental change programmes (IHDP, LOICZ, ESG, GWSP and SOLAS). In 2010, the presidents of DFG (the German Research Foundation), ICSU and ISSC signed a Memorandum of Understanding with a view to promoting a closer institutional cooperation between the natural and social sciences at an international level.

In November 2010, **the Portuguese and Spanish national committees** jointly organised the 2nd Iberian IGBP seminar in Lisbon. The seminar, entitled "Global Change in the Iberian Peninsula: An Integrated Approach", was chaired by Nelson Lourenço

and Aida Rios, and reflected the commitment of both committees to the promotion and dissemination of scientific studies about global change in the Iberian peninsula. The seminar aimed to explore the role of human activities in global change, the environmental outcomes of this change and how social systems respond to it. It was attended by more than 70 researchers who presented around 40 oral presentations and posters. Keynote speakers included Carlos Nobre (Chair of the IGBP Scientific Committee), Wolfram Mauser (University of Munich), Mohammed-Saïd Karrouk (Chair of IGBP's Moroccan National Committee), Carole Crumley (University of North Carolina and Research Director of IHOPE) and Fátima Abrantes (PAGES scientific steering committee). More information about the workshop can be found here: www.igbp-portugal.org.

The **Romanian national committee** on global environmental change hosted the 4th Meeting of the European Alliance of Global Change Research Committees in September 2010. The meeting was attended by over 20 representatives of the European Alliance national committees, members and potential members. A scientific excursion with focus on environmental issues in the Carpathian Mountains was organised during the second part of the meeting. The excursion followed a profile through the main topographic features of Romania, highlighting environmental changes associated with urbanisation and land degradation.

In October 2010, a new board of the **European Alliance*** was elected during a meeting held in Bucharest. The new chair is Nelson Lourenço from the Portuguese IGBP national committee. John Ingram (United Kingdom), Dan Wilhelmsson (Sweden) and Wolfgang Lucht (Germany) were chosen as vice-chairs. This new board will continue the work done by Wolfram Mauser, who has successfully guided the European Alliance through its formation period. The European Alliance will host a national committees' day at the 2012 Planet Under Pressure conference. This will be an opportunity to discuss how to bridge to the broad community of stakeholders in the context of a development agenda, and the value of regional networks of national committees for delivering global sustainability research.

In 2010, the **US National Research Council** released six major reports on different aspects of climate change. The reports point to a strong body of scientific evidence showing that climate change is occurring, is caused largely by human activities, and poses significant risks for a broad range of human and natural systems. Limiting the magnitude of future climate change will require a major departure from business as usual in how the world uses and produces energy. In the meantime, plans for adaptation should consider a range of possible future climate conditions and associated impacts, some well outside the realm of past experience. Comprehensive, robust and credible information systems are needed to plan and evaluate effective responses to climate change.

Advancing the Science of Climate Change
http://www.nap.edu/catalog.php?record_id=12782

Adapting to the Impacts of Climate Change
http://www.nap.edu/catalog.php?record_id=12783

Limiting the Magnitude of Future Climate Change
http://www.nap.edu/catalog.php?record_id=12785

Informing an Effective Response to Climate Change
http://www.nap.edu/catalog.php?record_id=12784

Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia
http://www.nap.edu/catalog.php?record_id=12877

Verifying Greenhouse Gas Emissions: Methods to Support International Climate Agreements
http://www.nap.edu/catalog.php?record_id=12883

* The European Alliance is an association of members of the national committees of IGBP, IHDP, WCRP and DIVERSITAS.

National Committees Listed by Region

Africa

Benin
Botswana
Cameroon
Comoros
Congo, Democratic Republic of
Egypt
Ghana
Ivory Coast
Kenya
Morocco
Mozambique
Sierra Leone
South Africa
Togo
Tunisia
Zambia
Zimbabwe

Americas

Argentina
Bolivia
Brazil
Colombia
Cuba
Jamaica
Peru
United States*
Venezuela

Asia-Pacific and the Middle East

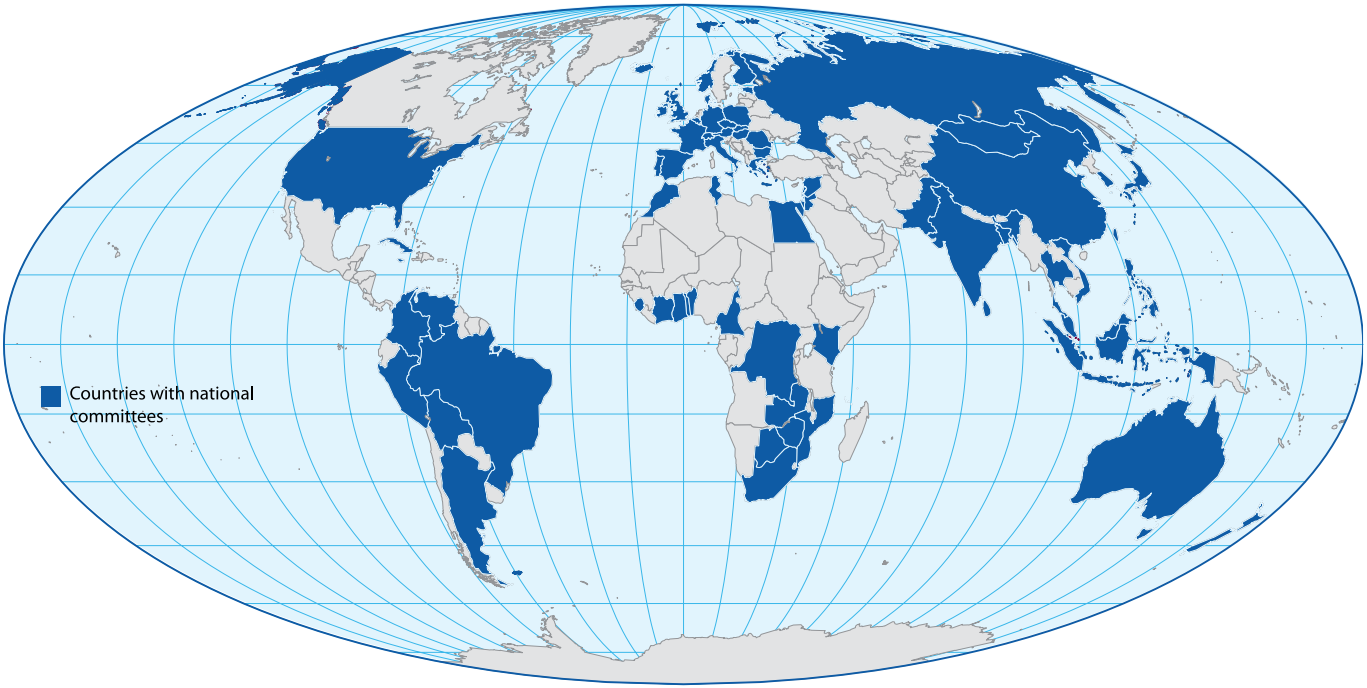
Bangladesh
China: Beijing
China: Taipei
India
Indonesia
Israel
Japan
Jordan
Korea, Republic of
Lebanon
Malaysia
Mongolia
Pakistan
Philippines
Singapore
Sri Lanka
Syrian Arab Republic
Thailand
Vietnam
Australia
New Zealand

Europe

Austria
Belgium
Bulgaria
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Norway
Poland
Portugal
Romania
Russian Federation
Slovakia
Spain
Switzerland
United Kingdom

*Through the US National Academies

National Committees Worldwide



IGBP has 70 national committees around the globe.

IGBP Scientific Committee (Jan 2010)

ICSU-appointed members

Carlos Nobre (Chair)
National Institute of Space Research
BRAZIL

Chen-Tung Arthur Chen (Vice-chair)
National Sun Yat-sen University
TAIWAN

Opha Pauline Dube (Vice-chair)
University of Botswana
BOTSWANA

Olga Solomina (Vice-chair)
Russian Academy of Sciences
RUSSIAN FEDERATION

Robert A Duce (Treasurer)*
Texas A & M University
UNITED STATES

Jan Willem Erisman
Energy Research Centre of The Netherlands
NETHERLANDS

Raymond S Bradley
University of Massachusetts
UNITED STATES

Mercedes Bustamante
University of Brazilia
BRAZIL

Henry Jacoby
Massachusetts Institute of Technology, Cambridge
UNITED STATES

Christiane Lancelot
Université Libre de Bruxelles
BELGIUM

Taroh Matsuno*
Yokohama Institute for Earth Sciences
JAPAN

Jean Palutikof
Griffith University
AUSTRALIA

Dahe Qin
China Meteorological Administration
CHINA

Lynn Russell*
Scripps Institution of Oceanography
University of California San Diego
UNITED STATES

Dan Yakir*
The Weizmann Institute of Science
ISRAEL

Project chairs and co-chairs

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Old Dominion University
UNITED STATES

Pavel Kabat (Co-chair iLEAPS)*
Wageningen University
NETHERLANDS

Markku Kulmala (Co-chair iLEAPS)
University of Helsinki
FINLAND

Paul Monks (Co-chair IGAC)
University of Leicester
UNITED KINGDOM

Alice Newton (Chair LOICZ)
University of Algarve, Faro
PORTUGAL

Bette Otto-Bliesner (Co-chair PAGES)
Climate and Global Dynamics Division,
National Centre for Atmospheric Research
UNITED STATES

Colin Prentice (Co-chair AIMES)*
Macquarie University
AUSTRALIA

Anette Reenberg (Chair GLP)
University of Copenhagen
DENMARK

David S Schimel (Co-chair AIMES)
NEON Inc.
UNITED STATES

Doug Wallace (Chair SOLAS)
Kiel University
GERMANY

Heinz Wanner (Co-chair PAGES)*
University of Bern
SWITZERLAND

Tong Zhu (Co-chair IGAC)
Peking University
CHINA

International partner chairs

Antonio J Busalacchi (WCRP)
University of Maryland
UNITED STATES

Harold Mooney (DIVERSITAS)
Stanford University
UNITED STATES

Oran R Young (IHDP)*
University of California
UNITED STATES

Rik Leemans (ESSP)
Wageningen University
NETHERLANDS

*** Rotated off the Scientific Committee at the end of 2010**

IGBP Project Offices

Core projects

Analysis, Integration and Modelling of the Earth System (AIMES)
Executive Officer: Kathy Hibbard
International Project Office:
Pacific Northwest National Laboratory, Richland, USA

Global Ocean Ecosystem Dynamics (GLOBEC)*
Executive Officer: Manuel Barange
International Project Office:
Plymouth Marine Laboratory, UK

Global Land Project (GLP)
Executive Officer: Tobias Langanke
International Project Office:
University of Copenhagen, Denmark

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)
Executive Officer: Lisa Maddison
International Project Office:
Institut Universitaire Européen de la Mer, Brest, France

International Global Atmospheric Chemistry (IGAC)
Executive Officer: Megan Melamed
International Project Office:
University of Washington, Seattle, USA

Integrated Land Ecosystem-Atmosphere Process Study (iLEAPS)
Executive Officer: Anni Reissell
International Project Office:
University of Helsinki, Finland

Land-Ocean Interactions in the Coastal Zone (LOICZ)
Executive Officer: Hartwig Kremer
International Project Office:
Institute for Coastal Research, Geesthacht, Germany

Past Global Changes (PAGES)
Executive Officer: Thorsten Kiefer
International Project Office:
Bern, Switzerland

Surface Ocean – Lower Atmosphere Study (SOLAS)
Executive Officer: Emilie Breviere
International Project Office:
Liebniz Institute for Marine Research, University of Kiel, Germany

Joint projects

Global Carbon Project (GCP)
Executive Directors: Josep (Pep) Canadell, Shobhakar Dhakal
International Project Offices:
CSIRO Marine and Atmospheric Research, Canberra, Australia;

National Institute for Environmental Studies, Tsukuba, Japan

Global Environmental Change and Food Systems (GECAFS)**
Executive Officer: John Ingram
International Project Office:
Oxford University, UK

Global Environmental Change and Human Health (GECHH)
Project Officer: Lucilla Spini
International Project Office:
United Nations University Institute for Water, Environment and Health, Hamilton, Canada

Global Water System Project (GWSP)
Executive Officer: Janos Bogardi
International Project Office:
Bonn, Germany

*** Until June 2010**
**** Until March 2011**

National Committee Chairs/Contacts

Africa

BENIN
Sikirou Kola Adam
National University of Benin

BOTSWANA
Opha Pauline Dube
University of Botswana

CAMEROON
Maurice Tsalefac
University of Yaoundé

COMOROS
Ainouddine Sidi
National Centre for Scientific Research

CONGO, DEMOCRATIC REPUBLIC OF
François Kapuku Buipi
University of Kinshasa

EGYPT
Mohamed Saber
National Research Centre

GHANA
Yaw Opoku-Ankomah
Water Research Institute

IVORY COAST
Abdourahamane Konaré
University of Cocody

KENYA
Joseph O Malo
Kenya National Academy of Sciences

MOROCCO
Mohammed Saïd Karrouk
Hassan II University

MOZAMBIQUE
Patricio Sande
Scientific Research Association of Mozambique

SIERRE LEONE
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National Botanical Institute

TOGO
Ayechoro Koffi Akibode
University of Lome

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M'hamed Brini
Tunisian Institute for Agronomy

ZAMBIA
H N W Chabwela
University of Zambia

ZIMBABWE
Susan Muzite
Research Council of Zimbabwe

Americas

ARGENTINA
Mario N Nunez
Center for Atmospheric and Ocean Research (CIMA)

BOLIVIA
Jaime Argollo Bautista
Major de San Andrés University

BRAZIL
Eduardo Moacyr Krieger
Brazilian Academy of Sciences

COLOMBIA
Germán Poveda
University of Colombia

CUBA
Rene Pablo Capote Lopez
National Biodiversity Center

JAMAICA
Chadwick Anderson
Scientific Research Council

PERU
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Universidad Nacional Agraria La Molina

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Lelys Bravo de Guenni
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Asia-Pacific and the Middle East

AUSTRALIA
Roger Gifford
Australian Commonwealth Scientific and Research Organisation

BANGLADESH
M Shamsher Ali
Bangladesh Academy of Sciences

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A selection of the top 10-15 scientific publications from core projects and fast-track initiatives published in 2010, or in some cases early 2011.

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Fast-track initiatives

Plant Functional Classifications

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FINANCIAL

IGBP activities are predominantly funded by contributions from countries around the world. The IGBP national contribution scale is based on the United Nations Scale of Assessments (in percent).* The IGBP scale is adjusted so that the total from all contributors will cover our central budget.

The national contributions support the operation of the IGBP Secretariat, the meetings of the Scientific Committee of IGBP and the Scientific Steering Committees of IGBP projects, fast-track initiatives and syntheses, IGBP contributions to the Earth System Science Partnership and other partner organisations, and communication and outreach activities.

National contributions 2010

National contributions received arranged by level of contribution

1	United States of America	15	Belgium	29	Hungary
2	Sweden	16	Spain	30	Indonesia
3	Germany	17	China-Beijing	31	Malaysia
4	France	18	Austria	32	Egypt
5	Japan	19	Denmark	33	Thailand
6	United Kingdom	20	Korea	34	Pakistan
7	Italy	21	Finland	35	Botswana
8	Russia	22	South Africa	36	Cameroon
9	Brazil	23	Czech Republic	37	Congo
10	Norway	24	Israel	38	Iceland
11	Netherlands	25	New Zealand	39	Kenya
12	Australia	26	Poland	40	Romania
13	Switzerland	27	Ireland	41	Zimbabwe
14	China-Taipei	28	Portugal	42	Colombia

National contributions received for previous years

Russia 2009
(outstanding part of 2009 contribution)

* Some countries pay well above this scale.

FINANCIAL STATEMENT

Income and expenditure for year ending December 2010

INCOME*	EURO
National contribution	1,265,299
Brazil (in kind support)	8,248
Other network income	48,891
Reallocated funds from previous year	174,701
Pension debt from 2009	-14,896
Carry-over network funds from previous year	325,331
TOTAL INCOME	**1,807,573**

EXPENDITURES	EURO
Core Science Projects	314,032
IGBP Synthesis & Fast-Track Initiatives	126,230
Planet Under Pressure conference 2012	64,879
Communications and Publications	235,108
Partner Activities	147,964
Scientific Committee and Officers	141,868
Funding and Budget	82,246
National Committees and Adhering Bodies	20,439
Administration	69,321
Professional Development	15,084
TOTAL EXPENDITURES	**1,217,170**
Reallocated funds for next year	140,541
Carry-over network funds **	**449,862**

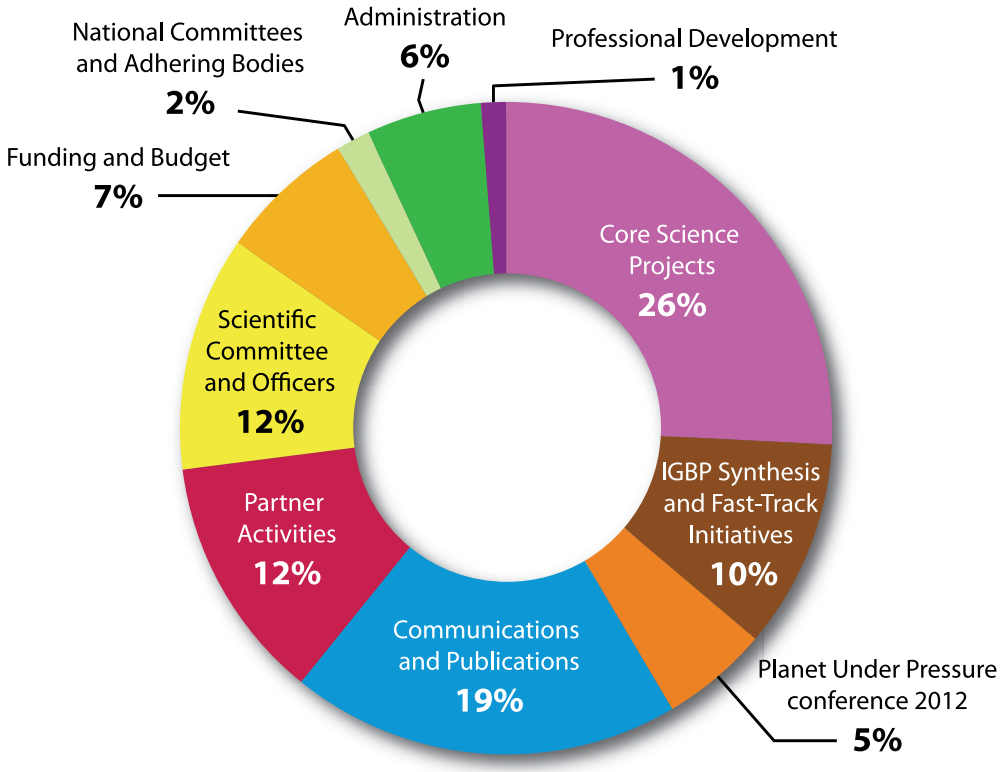
* Exclusive of administered grant from European Space Agency (ESA) for supporting IGBP travel and workshops relevant to ESA.

** Carry-over funds to support operating expenses during the first half of the year.

Carry-over increase from 2009 primarily due to payment of previous year's unpaid national contributions

Please note: IGBP has a reserve fund at the Royal Swedish Academy of Sciences of SEK 1.5 million.

PROPORTIONAL EXPENDITURE 2010



Percentage of budget used for core activities.

FUNDING FOR INTERNATIONAL CORE PROJECT OFFICES

Project	Country/Organisation	USD	EURO
AIMES	US NSF International Programs (GEO)	242,212	167,853
	IGBP 2010 + carry-over from 2009	45,004	31,188
	AIMES Total Income	**287,216**	**199,041**
GLOBEC (Jan-March 2010)	IOC–UNESCO	2,725	1,888
	US NSF–SCOR	64,500	44,699
	Plymouth Marine Laboratory (PML; in kind)	58,500	40,541
	UK Natural Environment Research Council	69,750	48,337
	IGBP	19,841	13,750
	Other	3,000	2,079
	GLOBEC Total Income	**215,591**	**149,405**
GLP	University of Copenhagen	278,641	193,098
	IHDP	20,000	13,860
	IGBP 2010 + carry-over from 2009	28,670	19,868
	GLP Total Income	**327,310**	**226,826**
IGAC	US NASA	89,753	62,199
	NOAA	90,179	62,494
	US NSF	88,765	61,514
	The Academy of Sciences located in Taipei, China	3,608	2,500
	IGBP 2010 + carry-over from 2009	54,304	37,633
	IGAC Total Income	**326,609**	**226,340**
iLEAPS	University of Helsinki, Faculty of Sciences + Finnish Meteorological Institute	259,740	180,000
	IGBP 2010	39,683	27,500
	iLEAPS Total Income	**299,423**	**207,500**

Project	Country/Organisation	USD	EURO
IMBER	US NSF–SCOR	50,000	34,650
	SCOR carry-over from previous year	61,082	42,330
	University of Western Brittany / IUEM	15,873	11,000
	CNRS/IRD/Brittany region, Ifremer	200,102	138,670
	IGBP: IMBER/GLOBEC Transition	11,544	8,000
	IGBP 2010	19,841	13,750
	IMBER Total Income	**358,442**	**248,400**
LOICZ	Institute for Coastal Research	620,491	430,000
	IGBP 2010	19,841	13,750
	LOICZ Total Income	**640,332**	**443,750**
PAGES	Swiss NSF (2009/2010)	326,347	226,158
	US NSF (2009/2010)	313,410	217,193
	IGBP 2010	39,683	27,500
	PAGES Total Income	**679,440**	**470,852**
SOLAS	UK Natural Environment Research Council (1 /4 2010–31/3 2011)	40,746	28,237
	BMBF (Germany; 1 Feb 2010–31 Jan 2011)	144,349	100,034
	IFM-GEOMAR	90,909	63,000
	US NSF–SCOR	25,000	17,325
	IGBP 2010	19,841	13,750
	SOLAS Total Income	**320,846**	**222,346**

ACRONYMS

AfricanNESS	African Network for Earth System Science
AIMES	Analysis, Integration and Modelling of the Earth System
AMMA	African Monsoon Multidisciplinary Analysis
APN	Asia-Pacific Network for Global Change Research
CCAFS	Climate Change, Agriculture and Food Security
CEOS	Committee on Earth Observation Satellites
CNRS	Centre National pour la Recherche Scientifique
COST	European Cooperation in the Field of Scientific and Technical Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIVERSITAS	An international programme of biodiversity science
ESA	European Space Agency
ESF	European Science Foundation
ESSP	Earth System Science Partnership
EU	European Union
FAO	Food and Agriculture Organization
FTI	Fast Track Initiative
GCP	Global Carbon Project
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GEO	Group on Earth Observations
GLOBEC	Global Ocean Ecosystem Dynamics
GLP	Global Land Project
GWSP	Global Water System Project
IAEA	International Atomic Energy Agency
IAI	Inter-American Institute for Global Change Research
IASC	International Arctic Science Committee
ICACGP	International Commission on Atmospheric Chemistry and Global Pollution
ICED	Integrating Climate and Ecosystem Dynamics
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy

IHDP	International Human Dimensions Programme on Global Environmental Change
IHOPE	Integrated History and Future of People on Earth
iLEAPS	Integrated Land Ecosystem–Atmospheric Processes Study
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research
INI	International Nitrogen Initiative
INPE	Brazilian National Institute for Space Research
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IPA	International Permafrost Organisation
IPCC	Intergovernmental Panel on Climate Change
IPO	International project office
LOICZ	Land–Ocean Interactions in the Coastal Zone
LUCC	Land Use and Cover Change
MA	Millennium Ecosystem Assessment
MAIRS	Monsoon Asia Integrated Regional Study
NASA	National Aeronautics and Space Administration
NCAR	National Centre for Atmospheric Research
NEESPI	Northern Eurasia Earth Science Partnership Initiative
NERC	Natural Environment Research Council
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NSF	National Science Foundation
PAGES	Past Global Changes
POLARCAT	Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate Chemistry, Aerosols and Transport
SBSTA (UNFCCC)	Subsidiary Body for Scientific and Technological Advice
SCOR	Scientific Committee on Oceanic Research
SOLAS	Surface Ocean–Lower Atmosphere Study
START	Global Change System for Analysis, Research and Training
UNESCO	UN Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
WCRP	World Climate Research Programme

International Geosphere-Biosphere Programme