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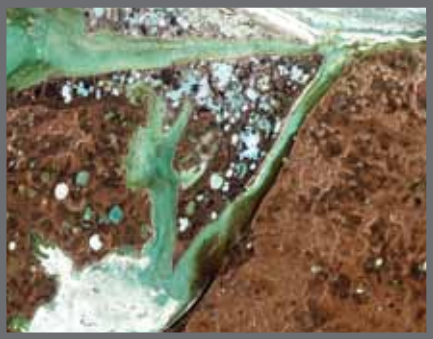
International Geosphere-Biosphere Programme



ANNUAL REPORT 2011

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 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 endorse projects such as the International Nitrogen Initiative.

Core projects*

- Analysis, Integration and Modelling of the Earth System (AIMES)
- Global Land Project (GLP)
- 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)
- Climate Change, Agriculture and Food Security (CCAFS)

***** see page 32 for co-sponsors

****** with the other global-change programmes constituting the Earth System Science Partnership

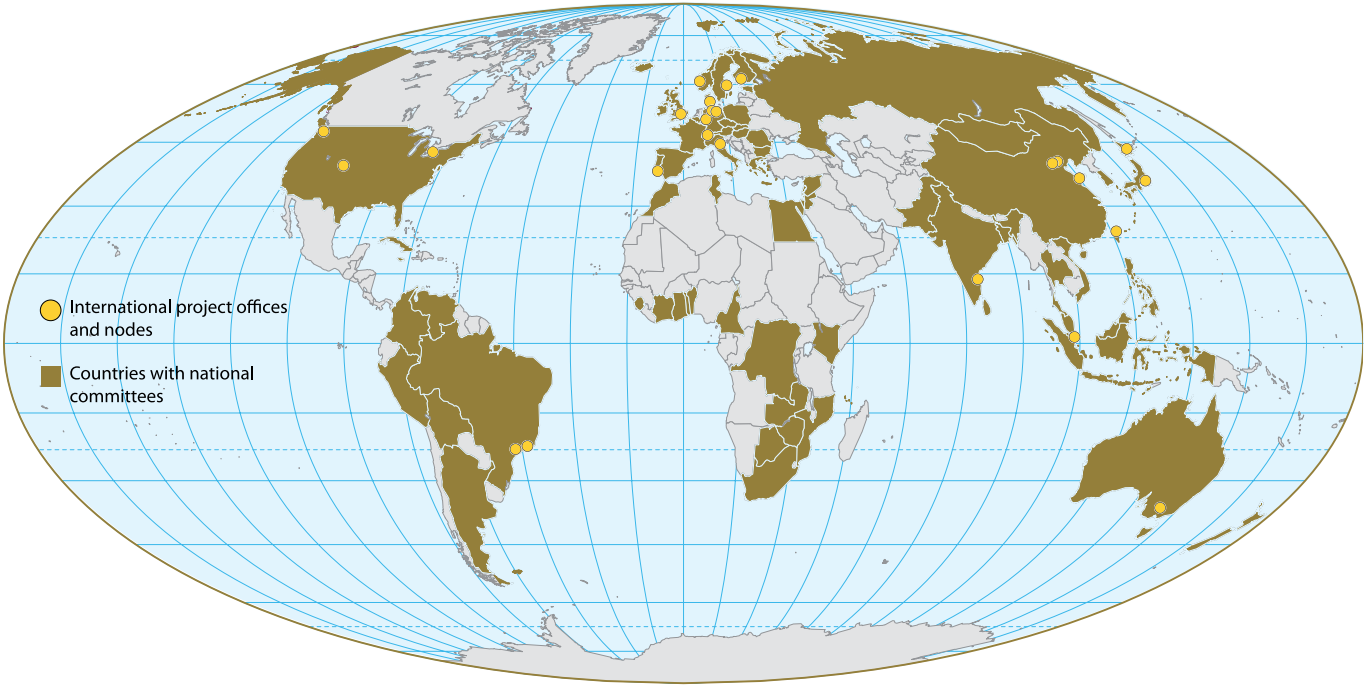
Major endorsed projects

- 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. In collaboration with the Scientific Committee on Oceanic Research (SCOR)
- Regionalisation of the nitrogen visualisation tool
- Megacities and the coastal zone: air-sea interactions. In collaboration with SCOR

Our second synthesis comprises several policy-relevant topics that seek to provide a snapshot of the current understanding and identify gaps in knowledge. See page 24 for more.



IGBP's global network includes 25 international project offices, including their nodal offices, and 71 national committees.

THE YEAR IN REVIEW

Last year our core and joint projects as well as scientific- and national-committee members continued to facilitate and produce exciting research findings, some of which you can read about in various sections of this report. The research reflects traditional IGBP strengths and includes, for example, past changes in ice-sheet dynamics and sea level, ecosystem response to ocean acidification, and the climate effects of land-cover change. But new directions and innovative collaborations are also hinted at, as exemplified by the work on payment mechanisms for ecosystem services, which involved experts in economics, business, urban planning and ecology.

The IGBP secretariat led the preparations for the highly successful Planet Under Pressure conference, which dominated our activities during the past year. New partnerships were built by engaging the business and policy communities in key aspects of the conference, and diversity was emphasised. This ambitious event required unprecedented cooperation with our partners and a range of stakeholders, something the secretariat staff managed efficiently and successfully.

Via policy briefs and other products and processes, for example the planetary stewardship workshop at the Royal Swedish Academy of Sciences, we worked throughout the past year to ensure that the science and other outputs from the Planet Under Pressure conference have an impact on Rio+20. Indeed, UN Secretary-General Ban Ki-moon addressed the conference: "I welcome the State of the Planet declaration issued today. Its timing, two months before the UN Conference on Sustainable Development, could not be better."

IGBP's recent evolution has emphasised policy-relevant and solutions-oriented research, transdisciplinarity and effective communication. The global-change research landscape is now being encouraged to change in a similar fashion. A new ten-year initiative promoted by the International Council for Science (ICSU), funding agencies and several international organisations, entitled Future Earth: Research for Global Sustainability, is in the works.

The new initiative will build on the existing global-change research programmes and their projects to coordinate and focus international scientific research on global sustainability. We believe IGBP, with its truly international reach and over two decades of accumulated experience in research, networking and communication, should play a central role in facilitating a smooth transition to the new initiative over the next few years. We have provided timely inputs to the visioning process undertaken by ICSU. We are keeping our community informed of the developments and we are conveying our community's concerns and suggestions.

Our synthesis and integration activity, too, made good progress and several workshops relating to this activity were held with the involvement of a wide range of stakeholders. We acknowledge the generous funding provided for the synthesis workshops by several agencies, including the US NSF, UK NERC, APN and Taiwan Environmental Protection Administration.

In mid-2011, IGBP began a strategic management planning process with an emphasis on sustainability that encompasses both its operations and its international reach throughout the scientific community. Aspects of this exercise influenced the sustainability strategies put in place at Planet Under Pressure and will continue to be explored in the coming year.

Finally, we take this opportunity to thank Carlos Nobre who stepped down at the end of 2011 after six years as chair of the IGBP scientific committee. Carlos made valuable contributions to IGBP including raising the profile of developing-country research and researchers in IGBP, and setting up the Brazil Regional Office.

IGBP Chair James Syvitski and Executive Director Sybil Seitzinger, May 2012.

Generous support from 42 nations ensures the continued success of IGBP. We particularly thank the Royal Swedish Academy of Sciences, which has hosted IGBP's secretariat for 25 years, and the many nations hosting IGBP's international project offices and regional offices: Brazil, China, Denmark*, Finland, France**, Germany, India, Japan, Singapore, Norway, Switzerland, Taiwan, the UK and the US.

* Until January 2012
** Until May 2012

IGBP's recent evolution has emphasised policy-relevant and solutions-oriented research.

Executive Director Sybil Seitzinger

Chair James Syvitski

CARBON AND CLIMATE

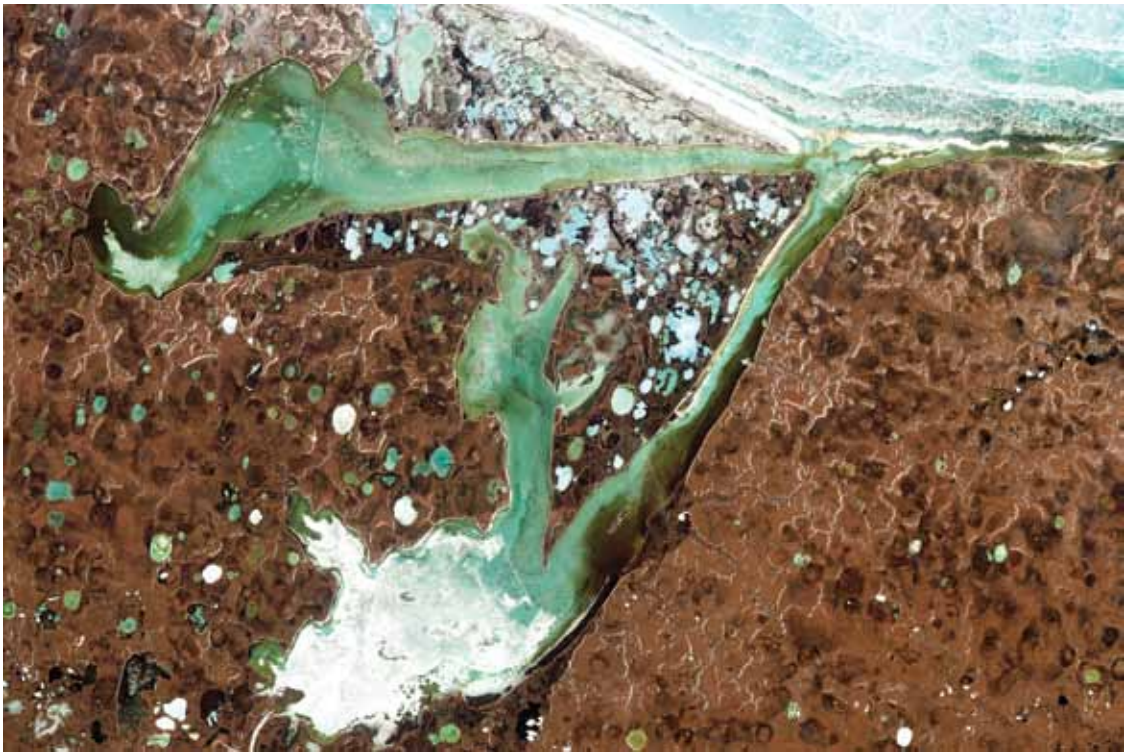
To understand the dynamic link between the terrestrial and marine carbon cycles, and to better integrate them into Earth-system models, we need new continued exploration of four key themes: organic carbon decomposition; nutrient cycles and carbon-dioxide (CO_2) emissions; sources and sinks of methane; and improved budgets for a "boundless" carbon cycle. With this in mind, researchers with diverse expertise from ten countries gathered in Brussels in October 2011 to participate in a workshop on the carbon cycle and the climate system, co-sponsored by the AIMES project.

There is a need for a strategy to model the boundless carbon cycle at spatial and temporal scales compatible with existing Earth-system models, according to Professor P Regnier of the Université Libre de Bruxelles who introduced the aims and scope of the workshop. The possibility of massive release of methane in a warming climate is currently receiving considerable attention. Professor Regnier emphasised the need for relating analysis to the observed recent trends in atmospheric methane concentrations and to identify possible thresholds in the methane cycle.

The effect of climate change on tropical forests was the theme of a presentation by AIMES Chair Professor Peter Cox of the University of Exeter. According to Cox, a key uncertainty – and one that we need to constrain – is the response of the vast Amazon forest. Models suggest a linear relationship between tropical carbon loss and interannual variability in atmospheric CO_2, which may be used to constrain the risk of tropical forest dieback.

This "emergent" model-data constraint suggests a relatively low risk of dieback due to CO_2-induced climate change. However, the analysis also points to a loss of about 50 billion tonnes of carbon per degree centigrade of warming in the tropics if this warming arises from non-CO_2 factors such as increases in methane or reductions in aerosol pollution.

A key uncertainty is the response of the vast Amazon forest.



NASA Earth Observatory/Jesse Allen and Robert Simmon.
Based on Landsat data provided by the US Geological Survey.

Thermokarst lakes (formed by thawing permafrost) in the region surrounding the Omulyakhskaya and Khromskaya Bays along the northern Siberian coast. Such landscapes are receiving close attention given their potential to release carbon dioxide and methane as the climate warms.

EVALUATING PAYMENT MECHANISMS FOR ECOSYSTEM SERVICES

Over the past 50 years, 60 percent of all land-based ecosystem services have declined as a direct result of the conversion of land to the production of foods, fuels and fibres. "This should come as no surprise," say experts following a workshop organised by the Global Land Project. The scientists met to analyse the pitfalls of using markets to induce people to take account of the environmental costs of their behaviour. Some payment mechanisms to support ecosystem services can be environmentally harmful, warned the researchers in a subsequent article published in the journal *Science*.

Society pays for the products of agriculture, aquaculture and forestry, and has developed well-functioning markets for these products. However, markets for important ecosystem services such as watershed protection, habitat provision, pest and disease regulation, climate regulation and storm buffering are nearly non-existent. But bad payment mechanisms can be worse than no payment mechanisms, the study's authors warn, pointing to the lessons learned from four decades of agricultural subsidies. Subsidies encourage the overuse of fertilisers and pesticides. Fertilisers, for example, are a main reason for the growing number of "dead zones" in the world's oceans.

The authors note too that while ecosystem services that are produced on private lands can benefit from carefully designed payment schemes, many ecosystem services are produced on public lands or seas, or on land and sea areas beyond national jurisdiction. For such services, different measures of the importance of ecosystem services are needed, they say. These measures should track changes in the value of publicly owned environmental assets in the same way that society currently tracks changes in the value of buildings, financial stocks or infrastructure.

The scientists' report is timely given the growing enthusiasm for the use of Payments for Ecosystem Services (PES) schemes that allow governments and non-governmental organisations to pay for environmental public goods. For example, the United Nations' Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries or REDD scheme. The scheme pays countries to not cut down their forests, which in turn puts the breaks on loss of biodiversity, in addition to curbing carbon emissions.

Kinzig A P *et al* (2011) *Science* 334 (6056): 603-604, doi: 10.1126/science.1210297.

Bad payment mechanisms can be worse than no payment mechanisms.

© iStockphoto.com/ Kung Wu

An analysis of payment mechanisms for ecosystem services points to lessons learned from four decades of agricultural subsidies. Subsidies can encourage the overuse of fertilisers and pesticides, which are associated with environmental problems. The photograph shows rice terraces in Longsheng, Guangxi province, China.

FROM PREDATORS TO PRECIPITATION

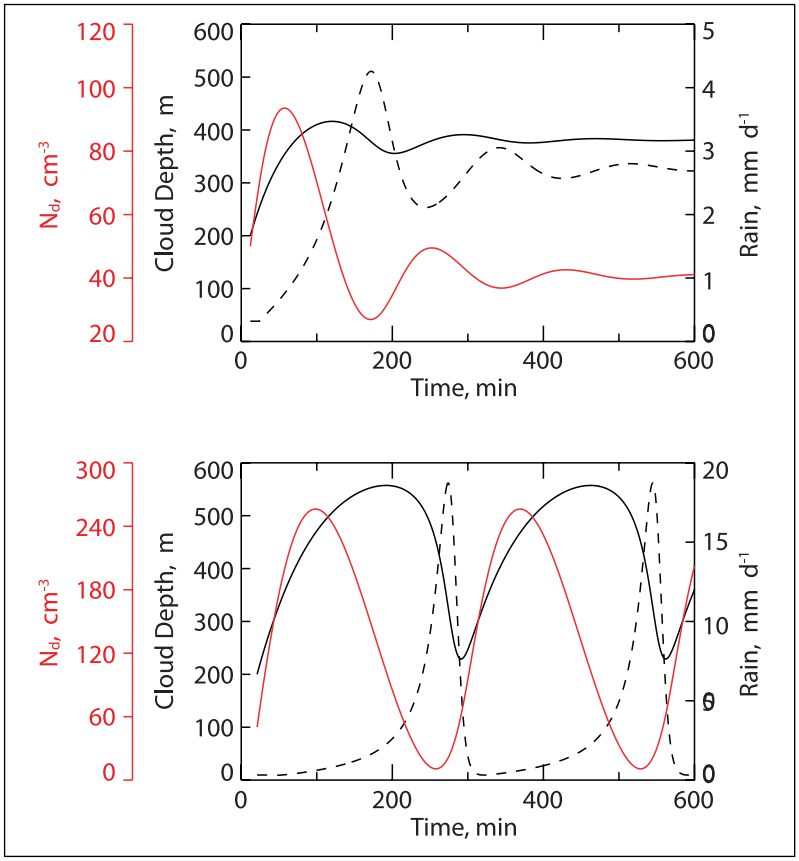
The relationship of rain to clouds is similar to that between a tiger and deer, according to researchers associated with the IGAC project. This interesting conclusion emerges from a study of the many physical processes that interact in the cloud system. In more technical language, complex aerosol-cloud-precipitation systems display predator-prey behaviour, with rain acting as the predator, clouds as the prey and aerosols as a mediator.

Understanding shallow clouds is important because of their role in modulating Earth's climate; they reflect incoming shortwave radiation and tend to cool the climate system. The formation of clouds and their capacity to produce rainfall is related to aerosols – extremely small particles or liquid droplets – but the processes and feedbacks remain poorly understood. The researchers suggest that viewing the components of this system as distinct populations and applying the relevant equations from population dynamics can help shed light on this issue. In particular, the influence that one component of the system has on another and the feedbacks involved are amenable to this sort of conceptualisation.

The two primary populations considered are clouds and rain, with aerosols as a mediating third population. As rainfall (predator) occurs, it depletes (preys on) the water content of clouds (prey) until it cannot rain any more. It is only when the cloud thickens again that it can rain again. Aerosols serve to sustain the clouds by providing condensation nuclei, and they also help preserve clouds by suppressing rainfall.

Koren I and Feingold G (2011) *Proceedings of the National Academy of Sciences* 108: 12227-12232, doi: 10.1073/pnas.1101777108.

Complex aerosol-cloud-precipitation systems display predator-prey behaviour.



Simulations suggest that when the rain rate is low (upper panel), the system has fewer oscillations and reaches steady state fairly rapidly. When the rain rate is moderate (lower panel), oscillations increase and it takes longer to reach a steady state. In both cases, the oscillations are suggestive of a predator-prey relationship. The figure is a combination of figures 6A and 7A from Koren I and Feingold G (2011) *Proceedings of the National Academy of Sciences* 108: 12227-12232, doi: 10.1073/pnas.1101777108.

SNOW AND RAIN

Whether land-cover change in a high-CO_2 world will warm or cool a region depends on how snow and rainfall will vary in that region, according to a recent study involving researchers from IGBP's iLEAPS project. Land-cover change affects temperature in several ways, for example by changing the reflectivity of a landscape or altering evapotranspiration. Deforestation tends to cool mid- to high-latitude regions and warm tropical regions. But will this also be the case in an even warmer future world when regional climate change is to be expected?

Andy Pitman and colleagues used a climate model to investigate the impacts of land-cover change under high-CO_2 conditions. They focused on three different regions of the world. They found that the changes in temperature in these regions resulting from land-cover change are strongly dependent on the changes in snow cover or rainfall. For example, the Asian region – which warmed in response to increasing cropland under relatively low atmospheric CO_2 concentrations – cooled instead under high- CO_2 conditions because of increases in rainfall linked with elevated carbon dioxide.

The authors recommend that models seeking to gauge the impact of future changes in land cover in a particular region accurately simulate changes in snow and/or rainfall in that region. This may be beyond the capacity of existing climate models.

Pitman A *et al.* (2012) *Nature Climate Change* 1: 472-475.

Land-cover change affects temperature in several ways.

© iStockphoto.com/ Adrian Assalve

Simulations using a climate model suggest that variations in temperature induced by future land-cover change in a region depend strongly on the changes in precipitation that will result from increased atmospheric CO_2.

ECOSYSTEM RESPONSE TO OCEAN ACIDIFICATION

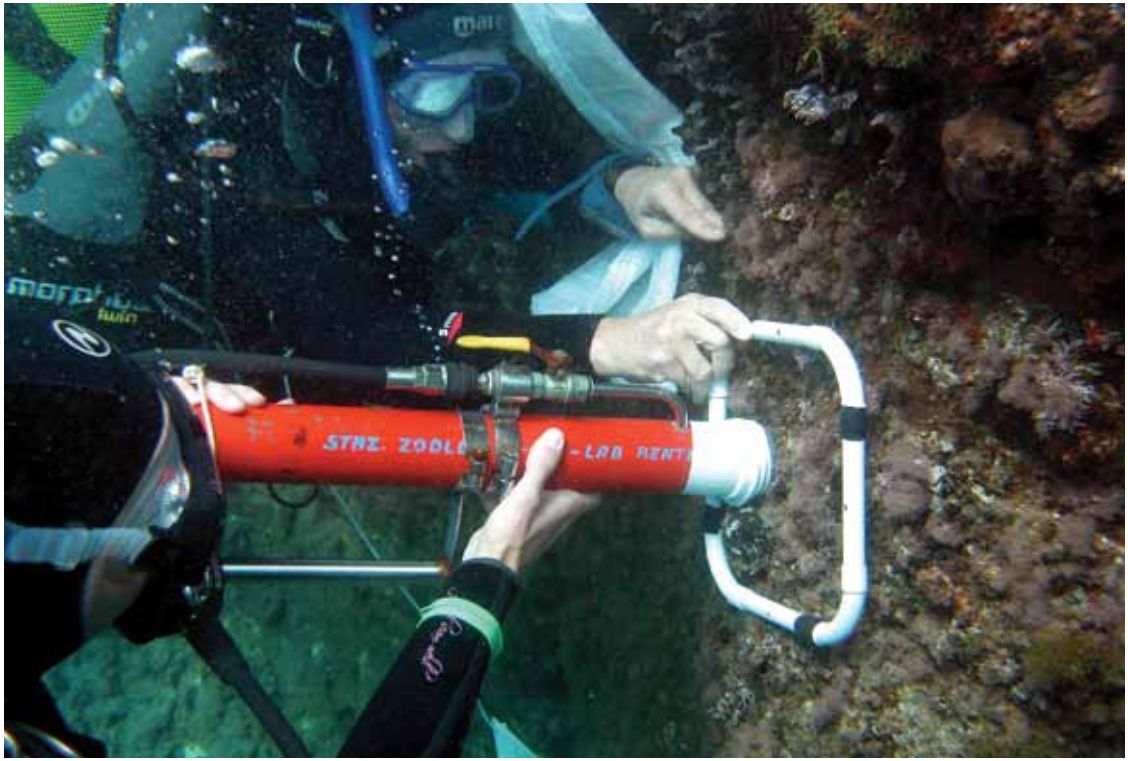
Recent years have witnessed increasing interest in documenting and understanding the response of marine life to ocean acidification. Because diverse responses have been documented at the level of individual species, it is challenging to predict how marine ecosystems will change with ocean acidification. Researchers associated with the IMBER project sought to answer this question by looking at benthic invertebrate communities around natural carbon-dioxide vents in the Mediterranean Sea. Their results point to lower biodiversity and reduced ecosystem function under conditions of extremely low pH.

Carbon-dioxide vents provide a natural laboratory for studying the effects of varying degrees of ocean acidification: pH is lowest near the vents and increases away from them. The researchers collected benthic invertebrates from the community surrounding the vents, and documented various aspects including the taxa and their abundances in the different pH zones. They found that taxonomic richness (including important calcifying species) was reduced in the zones with lowest pH, although some organisms like crustaceans did increase in abundance. The aggregate invertebrate biomass – an important ecosystem indicator – also decreased in the zones with lowest pH.

The conditions in the lowest pH zones are more extreme than are expected globally during the coming century. But conditions could be more extreme at the small scale, the researchers point out, underscoring the relevance of the results. Under conditions of somewhat higher pH around the vents – analogous to those expected in the near future – the results suggest no significant change in taxonomic richness although laboratory studies have found a noticeable impact. This could indicate higher tolerance under natural conditions as well as the possibility of adaptation, although additional work is needed to fully evaluate this.

Kroeker K J *et al* (2011) *Proceedings of the National Academy of Sciences* 108 (35): 14515-14520, doi: 10.1073/pnas.1107789108.

It is challenging to predict how marine ecosystems will change with ocean acidification.



Bruno Iacono - Archive SZN

Ecologists Kristy Kroeker and Lucia Porzio collecting the small mobile invertebrate community along the pH gradient created by the vents. The authors used an "airlift," a modified underwater vacuum, to collect the invertebrates before collecting the remaining sessile invertebrates and algae.

COASTAL SYSTEMS AND GLOBAL CHANGE

In late 2011, the LOICZ project organised its open science conference in Yantai, China, focusing on coastal systems, global change and sustainability. The conference brought together over 350 people working on land–ocean issues to showcase the width and scope of current research, to inspire new research and to inform policy. The key themes discussed at the conference included Arctic coasts, urbanisation, river-mouth systems and small island states. A well-targeted training programme for early career scientists – the Young LOICZ Forum – offered young people the opportunity to learn about drivers and pressures on coastal systems and to better define their future professional role in coastal management.

The session on islands at risk was introduced by John Hay from the University of the South Pacific, Rarotonga, Cook Islands. He highlighted the special situation of the small island with respect to local (for example, overfishing) as well as global (for example, sea-level rise) threats. A combination of factors renders such island states vulnerable: for example, high population densities in hazard-prone areas coupled with low capacity to respond to exigencies.

Hay provided a historic overview of vulnerability assessments in the Pacific region, which suggests that a predominantly top-down approach in the 1980s has now transitioned to an approach with a strong bottom-up emphasis. Discussing recent developments, he mentioned that climate-change adaptation and disaster risk management are now integrated with development and humanitarian processes. "Vulnerability and related assessments in the Pacific are now better aligned with the realities of the circumstances of small islands," Hay said.

The conference brought together over 350 individuals working on land–ocean issues.

© iStockphoto.com/ Lucyna Koch

The coastal systems and sustainability conference discussed the risk to islands from local and global change, including sea-level rise. The photo shows Malé, the capital city of the Maldives, an archipelago in the Indian Ocean.

ICE-SHEET DYNAMICS AND SEA-LEVEL SWINGS

Understanding the current and future response of sea level to a changing climate and warming world is critical in evaluating mitigation and adaptation strategies. Sea-level studies from different periods in the past can provide constraints on the sensitivity of sea level to different climate conditions. With this in mind, ten papers in a special issue on Sea Level and Ice Sheet Evolution and several other papers help enhance our understanding of how ice-sheet instability influences the rates of sea-level change. The papers emerged from research supported by IGBP's PAGES project.

New records from Israel, Tasmania, Alaska and Greenland for the last centuries to millennia demonstrate that sea level was sensitive to the relatively moderate climate changes that occurred during that time, such as the Medieval Climate Anomaly (c. 950-1300 AD) and the Little Ice Age (c. 1450-1850 AD). At the local and regional scale, though, transient (for example, elastic and gravitational) effects modulated sea level significantly. During the last interglacial (c. 125,000-114,000 years ago) – at a time when climate was a few degrees warmer and overall sea level several metres higher than today – new coral data from the Bahamas indicate that rates of sea-level rise were significantly faster than during the late Holocene (the past three millennia). This suggests that the ice sheets were less stable in conditions slightly warmer than today.

Even higher rates of sea-level rise occurred during the Bølling (c. 14,500 years ago), a warm period in the Northern Hemisphere that occurred halfway through the transition from the last glacial to the Holocene. The rapid rise was enabled by the presence of large ice sheets in both polar regions at the time. Two independent analyses find that the northern ice sheet was not the only source of melt water during that enigmatic jump in sea level, but that the Antarctic ice sheet also contributed significantly.

Another substantial sea-level rise during the early Holocene resulted from the draining into the Atlantic Ocean of a large ice-margin lake in eastern North America. New sedimentological data from the Mississippi delta indicate that the eventual drainage into the North Atlantic was synchronous with a hemisphere-wide cool spell around 8,200 years ago: the drainage probably impeded the overturning circulation and heat transport in the Atlantic Ocean.

Gehrels R *et al.* (2011) *Eos* 92 (35) 289-296.

Shennan I, Milne G and Bradley S (2011) *Journal of Quaternary Science*. doi: 10.1002/jqs.1532

Thompson W G *et al.* (2011) *Nature Geoscience* 4 (10): 684-687.

Siddall M and Milne G, eds (2012) Sea Level and Ice Sheet Evolution: A PALSEA Special Edition. *Earth and Planetary Science Letters* 315/316: 1-102.

Ice sheets were less stable in conditions slightly warmer than today.

© iStockphoto.com/Michel de Nijs

High rates of sea-level rise occurred during the Bølling (c. 14,500 years ago) warm period in the Northern Hemisphere. Research suggests the rapid rise was enabled by the presence of large ice sheets in both polar regions at the time. The photograph shows a calving glacier on the Spitsbergen archipelago near the North Pole.

CARBON BUDGET FOR THE NORDIC SEAS

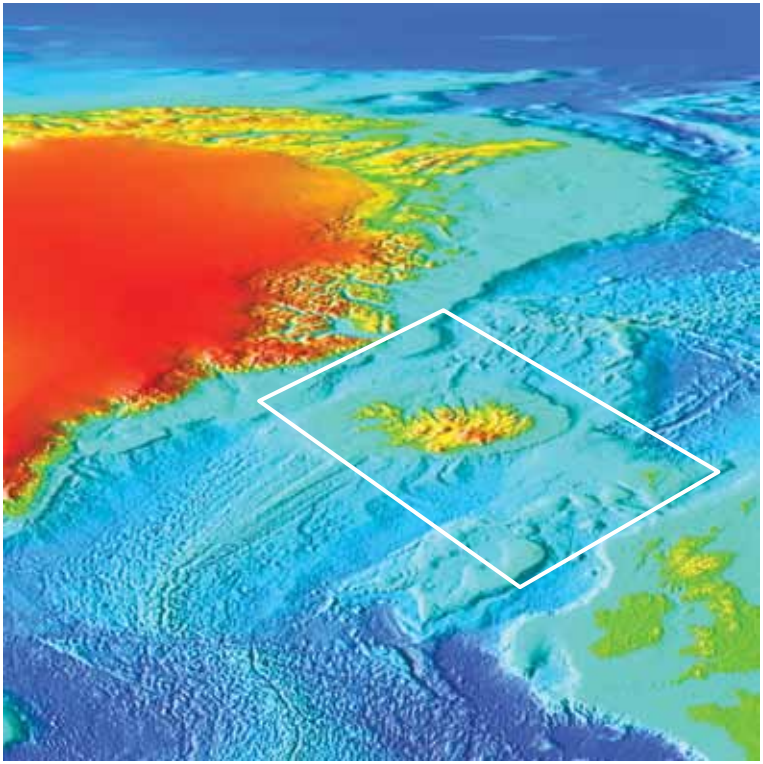
The Nordic Seas is the ocean area connecting the North Atlantic with the Arctic Ocean. It is here that carbon from surface waters is transported to deeper waters, a process that helps sustain the global ocean carbon sink. Researchers associated with IGBP's SOLAS project recently calculated the carbon budget for these seas, which allows an estimate of the carbon absorbed, stored and exported from the region.

The study found that there is no difference between the atmospheric carbon-dioxide uptake in pre-industrial times and the early 2000s. The dominant exchange of carbon in the Nordic Seas region takes place across the Greenland–Scotland Ridge. Horizontal transport of carbon in the region is almost two orders of magnitude larger than the uptake from the atmosphere. Anthropogenic carbon is carried into the Nordic Seas by waters of the Atlantic Ocean, some of which might cycle back to the deep Atlantic. The southern outflow of about 0.09 gigatons of anthropogenic carbon via dense waters contributes to its sequestering in the North Atlantic ocean. This is almost 4 percent of the annual global ocean uptake of anthropogenic carbon.

Several uncertainties remain, however: these arise, among other things, from the concentrations of carbon and the volumes of water flowing in and out of the seas. An important outstanding question is how the budget will change in response to a changing climate. The carbon-dioxide uptake capacity of the Arctic Ocean, for example, is expected to increase as its ice cover decreases. By virtue of being largely ice free, the Nordic Seas will likely not be affected to the same extent.

Jeansson E *et al.* (2011) *Global Biogeochemical Cycles* 25: GB4010, doi: 10.1029/2010GB00396.

The dominant exchange of carbon in the Nordic Seas region takes place across the Greenland–Scotland Ridge.



National Oceanic and Atmospheric Administration, U.S. Department of Commerce, http://www.ngdc.noaa.gov/.

The Greenland–Scotland Ridge (area enclosed by the white box) modulates the flow of cold, dense water from the Nordic Seas to the North Atlantic Ocean.

ABSORPTION OF FOSSIL-FUEL EMISSIONS BY FORESTS

Two workshops designed to contribute to the Global Carbon Project concluded with a major paper in the American journal *Science* in 2011. The paper, entitled "A Large and Persistent Carbon Sink in the World's Forests", announced that the world's established forests remove 2.4 billion tonnes of carbon per year from the atmosphere – equivalent to one third of current annual fossil-fuel emissions.

This is the first time volumes of the greenhouse gas absorbed from the atmosphere by tropical, temperate and boreal forests have been so accurately quantified. This is a timely breakthrough with which we can now clearly demonstrate how forests and changes in landscape such as wildfire or forest regrowth affect the removal or release of atmospheric carbon dioxide, according to Dr Pep Canadell, the Executive Director of the project and a co-author of the paper. This research tells us that forests play a much larger role as carbon sinks as a result of tree growth and forest expansion.

The international research team combined data from forest inventories, models and satellites to construct a profile of forests as major regulators of atmospheric CO_2. In addition to the large carbon sink, scientists now know that deforestation is responsible for emitting 2.9 billion tonnes of carbon per year – an exchange that had not been quantified in the past because of a lack of data. For comparison, total emissions from fossil fuels are currently above eight billion tonnes of carbon per year.

It seems emissions from deforestation are much larger than previously thought, suggesting that the potential benefits of avoiding deforestation, through the United Nations-backed Reduced Emissions from Deforestation and Degradation (REDD) scheme, are much larger than previously appreciated. The REDD scheme aims to formulate a financial value for the carbon stored in forests.

Canadell said a surprising finding was the large capacity of tropical forest regrowth to remove atmospheric CO_2. Regrowth takes place following the end of logging and slash-and-burn land clearing projects. The researchers estimate that tropical forest regrowth is removing an average of 1.6 billion tonnes of carbon per year. Unfortunately, he said, some countries have not looked on forest regrowth as a component of REDD.

Yude P *et al. Science* 333: 988-993.

It seems emissions from deforestation are much larger than previously thought.

© iStockphoto.com/Greg Ward

An international research team combined data from forest inventories, models and satellites to construct a profile of forests as major regulators of atmospheric CO_2. The photograph shows young pine trees growing in a New Zealand pine forest.

SECOND SYNTHESIS UPDATE

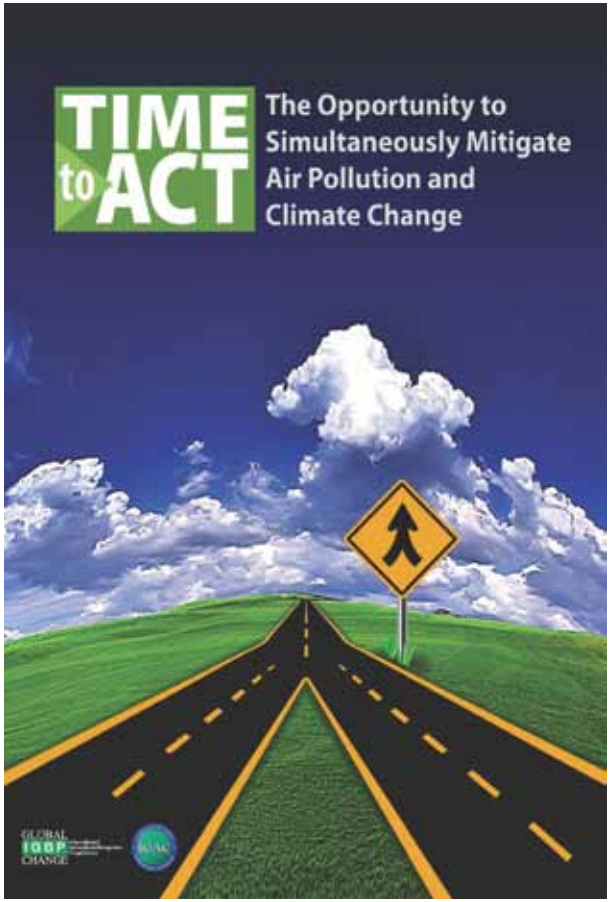
IGBP's second synthesis, initiated in 2009, aims to assess the state of knowledge regarding a number of policy-relevant topics. Several workshops relating to the synthesis were held during the past year, in addition to sessions at the Planet Under Pressure conference in London. In addition to IGBP seed funding, external funding was successfully sought from diverse sources including the US NSF, UK NERC, APN and the Taiwanese Environmental Protection Administration.

The group participating in the nitrogen and climate topic led a workshop in Amsterdam last year organised by the Task Force on Reactive Nitrogen and co-sponsored by the IPCC. The focus was on the interactions of reactive nitrogen with climate change and opportunities for integrated management strategies. The workshop report discusses the drivers, impacts and vulnerabilities, and mitigation and adaptation possibilities.

Two workshops associated with the air pollution and climate topic (in Arona, Italy and Taipei, Taiwan) led to the development of a statement on air pollution and climate released at the London conference. The statement mentions that achieving win-win benefits for climate and human health will need, among other things, an interdisciplinary approach that cuts across traditional science-policy barriers and accounts for the evolution of regional and global economic and developmental drivers.

The megacities in the coastal zone topic also benefited from two workshops last year in London and in Yantai (China). This generated two reports, each of which is a collection of papers/chapters that highlight the vulnerability of coastal cities and the risks they face as well as the opportunities for mitigation and adaptation.

An interdisciplinary approach that cuts across traditional science-policy barriers is needed.



This statement on air pollution and climate was one of the products of synthesis workshops held in 2011. The statement can be downloaded from http://www.igacproject.org/AirPolClim.

PLANET UNDER PRESSURE CONFERENCE

The Planet Under Pressure conference, 26-29 March 2012, was undoubtedly a huge success and a highlight of the year. But most of the planning for the conference took place in 2011.

The conference met many of its objectives. It attracted over 3000 scientists, decision-makers, business representatives, journalists and others, well above the expected 2500. Over 400 articles have been published worldwide in the mainstream media in 20 languages and the conference still reverberates in the media, online discussions and policy circles. Planet Under Pressure finished with the publication of the first State of the Planet Declaration.

The declaration highlighted the urgent need to focus on solutions to global challenges. One solution is to bring natural and social scientists even closer together. In this respect, Planet Under Pressure may mark a turning point in international Earth-system research. Indeed, the conference marked the beginning of a refocus of the international research community, led by the four ICSU-sponsored global-change programmes and their partnership, towards a programme of research focusing on sustainability. It has thus helped promote the new Future Earth initiative.

The conference's proximity to the UN's Rio+20 Summit has given the scientific community a strong voice in this process, particularly through nine policy briefs and suite of white papers commissioned specially for the conference, and the media attention the conference gained.

Beyond policy links, the conference's communications strategy was ambitious and experimental. During the conference the "Bridges to the Future" participatory sessions proved popular and aided the formation of new collaborations between science, business and policy communities. Through engagement with science and technology centres worldwide we arranged 150 events reaching 12,000 people, from Columbia to the US, from the Philippines to Egypt. The film *Welcome to the Anthropocene*, commissioned for the conference, has been viewed by over 700,000 people, and conference updates reached one million people via Twitter.

One solution is to bring natural and social scientists even closer together.

From plenary talks to panel discussions and from traditional sessions to unconventional World Cafés, the Planet Under Pressure conference provided numerous opportunities for a lively exchange of ideas. Photos courtesy Philip Wade and Kim Davis.

A FAST-TRACK LEGACY

IGBP's fast-track initiatives (FTI) began in 2003 and were designed to provide a mechanism to explore crosscutting questions that need rapid answers. Each running for three years, they have been some of IGBP's most successful scientific activities. What is common to all is the high quality of the final products, many appearing in the high-profile journals *Science* and *Nature*.

The earliest proposals included the global nitrogen cycle, the role of fire in the Earth system and the global iron cycle. The most recent FTIs deal with upper-ocean nutrient limitation, regionalisation of the nitrogen visualisation tool and air–sea interactions in coastal megacities. Several FTIs have been undertaken in partnership with the Scientific Committee on Oceanic Research.

Like good wines, some FTIs take time to mature. In March 2012, a paper entitled "The Geological Record of Ocean Acidification" was published in *Science* to wide interest and even an editorial in the *New York Times*. The paper came from a workshop led by IGBP's Past Global Changes project (PAGES). But the PAGES Executive Officer Thorsten Kiefer explains that the start of the process can be traced back to an FTI – Ocean Acidification Over Time – that began in 2005 and was completed in 2008. A more immediate product of that activity was a paper in *Nature Geoscience* in 2009.

Other notable FTIs include the Planet in 2050 (which was a theme that featured prominently at Planet Under Pressure) and Plant Functional Types. The latter has blossomed into the TRY database with 3 million trait records for about 69,000 plant species and with 204 participants from 142 scientific institutes worldwide.

Proposals for FTIs were initiated at IGBP's annual Scientific Committee meetings. Typically, IGBP provided funding for an international workshop. No new FTIs have been started during the past two years; the focus has shifted to tackling broader science-policy issues under the auspices of the second synthesis.

What is common to all is the high quality of the final products.

A word cloud depicting the range of important, crosscutting scientific topics addressed by fast-track initiatives over the years.

COMMUNICATIONS

By far the most significant project during the past year was developing the communications strategy for the Planet Under Pressure conference and preparing for this mammoth undertaking, largely coordinated by the IGBP secretariat.

The conference was the largest and most ambitious initiative attempted by the four global-change programmes and their partnership. It attracted over 3000 participants, including world-leading experts on climate, global change, global sustainability, development, policy, economics and many other disciplines.

UN Secretary-General Ban Ki-moon addressed the conference through recorded video. The conference helped inform Ban Ki-moon's Global Sustainability Panel report and became a major landmark on the road to Rio+20. Articles appeared in the *New York Times*, *Financial Times*, BBC, *International Herald Tribune,* Deutsche Welle and many more. Over 450 original articles in the wider media have appeared as far afield as Lebanon, China, India and Guatemala.

Live web streaming of the plenary sessions allowed us to more than double our audience. The *Daily Planet* live broadcast news show continues to draw an audience along with the plenary recordings offered on demand. The conference piloted non-traditional participatory sessions including several World Cafés, a Pro-Action Café and an Unconference focusing on developing a deeper dialogue with policymakers and business executives.

And we developed an extensive internet presence and social media strategy. The conference website had 260,000 site visits and 29,313 visitors. All questions in plenary came via the internet and text messaging. Our reach was over one million people through Twitter, with almost 2000 Likes on Facebook reaching 12,500 people weekly. Our blog site had over 10,000 readers from 80 countries and the Debategraph was viewed by an additional 10,000 people.

Over 150 science and technology centres from the Americas and Asia to Australia and New Zealand, Africa and Europe held events related to the conference and tuned in via web streaming, adding 12,000 viewers and a media campaign reaching 250,000. The conference concluded with the pre-launch of the Future Earth initiative and the publication of the first State of the Planet Declaration.

The conference took up the bulk of our time in 2011 and early 2012, but we also managed to carry out our regular tasks. Two issues of the *Global Change* magazine were published, with feature articles ranging from the potential role of climate in the collapse of the Roman Empire to the Anthropocene – Earth's newest epoch. Our new website and database were launched last year and we continue to improve on them. We also continued to sponsor the prestigious Stockholm Seminar series at the Royal Swedish Academy of Sciences.

In addition, we helped organise the Planetary Stewardship workshop in Stockholm in June last year, and coordinated and delivered nine policy briefs and white papers for Planet Under Pressure and Rio+20. The communications team helped update IGBP's Great Acceleration graphs, engaged ICSU's Future Earth initiative in communications issues and developed links with researchers and institutes within Sweden via the Swedish Secretariat for Environmental Earth System Sciences.

Owen Gaffney chaired a session on communication and capacity-building at the UN's Subsidiary Body for Scientific and Technological Advice. Ninad Bondre served as a guest editor of a special newsletter issue of the Past Global Changes project; the issue looks at a host of global-change topics from past and present perspectives.

We helped organise the Planetary Stewardship workshop in Stockholm.

We coordinated the production of nine policy briefs aimed at Rio+20 and the State of the Planet declaration arising from the Planet Under Pressure conference. We also published two issues of the *Global Change* magazine.

PARTNERSHIPS

Global environmental change programmes

The International Council for Science (ICSU) sponsors four global environmental change programmes: IGBP, DIVERSITAS, the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP). The programmes collaborate on several fronts; an important and highly successful effort was the joint organisation of the 2012 Planet Under Pressure conference. They co-sponsor each other's core projects and jointly sponsor projects under the umbrella of the Earth System Science Partnership (ESSP).

IGBP project co-sponsors

- International Human Dimensions Programme on Global Environmental Change: GLP and LOICZ.
- International Commission on Atmospheric Chemistry and Global Pollution (ICACGP): SOLAS and IGAC.
- Scientific Committee on Oceanic Research (SCOR): IMBER and SOLAS.
- World Climate Research Programme: SOLAS.

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, collaboration and capacity building in developing countries

- Monsoon Asia Integrated Regional Study (MAIRS)
- African Monsoon Multidisciplinary Analysis (AMMA)
- The Swedish Secretariat for Environmental Earth System Sciences (SSEESS)
- Asia-Pacific Network for Global Change Research (APN)
- Inter-American Institute for Global Change Research (IAI)
- The European Alliance of Global Change Committees
- Global Change System for Analysis, Research and Training (START)

Inputs to international assessments and advisory bodies

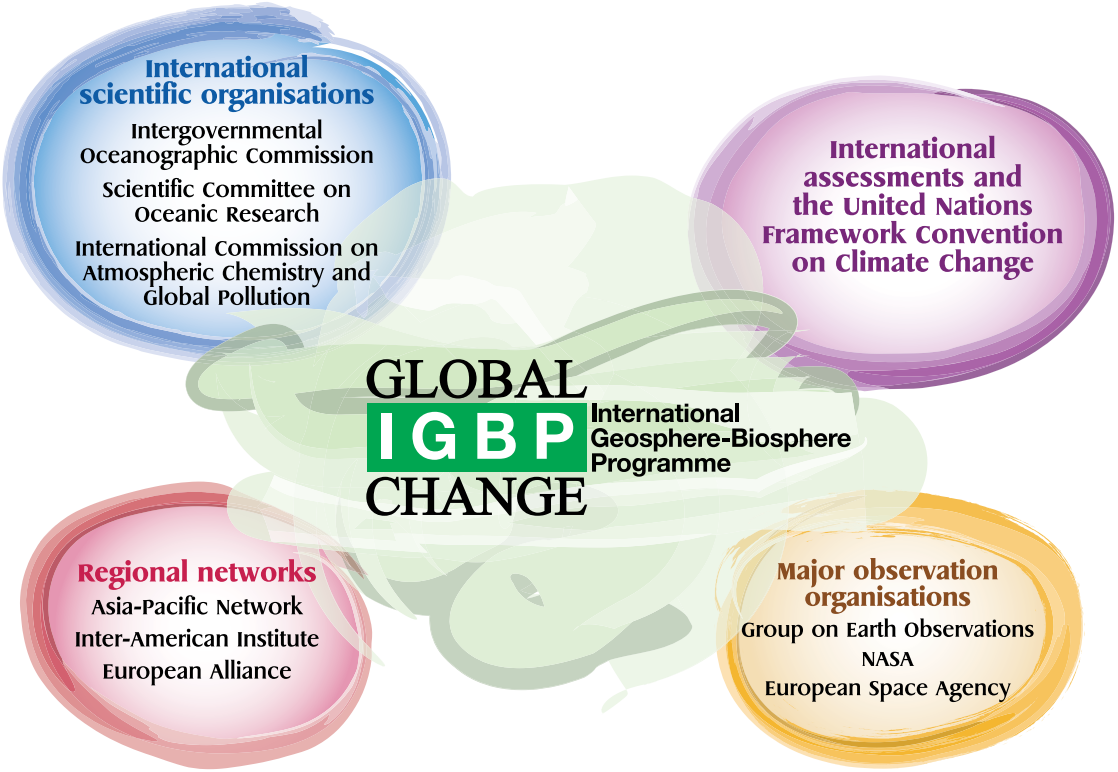
IGBP contributes in several ways to the work of the Intergovernmental Panel on Climate Change (IPCC). IGBP joins scoping meetings, contributes to the outline of the assessment report, and is part of the expert review. Well over 70 individuals from the IGBP community have been appointed as coordinating lead authors, lead authors or review editors of the forthcoming fifth assessment report. Several IGBP researchers are drafting authors of the recently published IPCC special report on extreme events and disasters.

IGBP, along with the other global-change programmes, is also invited by the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA) to provide updates on the latest policy-relevant science. Last year SBSTA requested even more extensive interaction and asked that a workshop be held in conjunction with the 2011 meeting. Accordingly, IGBP participated in a workshop in Bonn, 2-3 June 2011, and presented results on climate change. IGBP Communications Director Owen Gaffney chaired a panel discussion on "Communicating climate change science". Professor Mary Scholes of the University of Witwatersrand participated on behalf of IGBP in a side event during the 17th Conference of the Parties (COP17) in Durban, South Africa, in December 2011. The side event was entitled "Updates from climate change science – special focus: Africa".

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. A couple of years ago IGBP initiated the development of an integrated observation strategy, which has been led by the AIMES project.

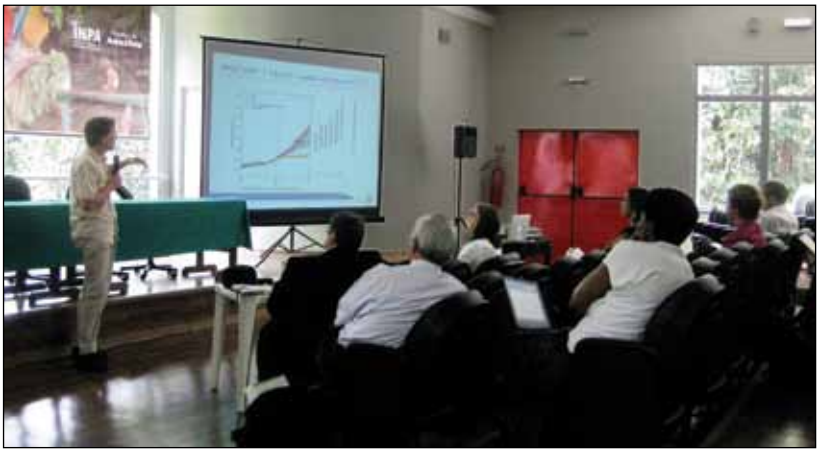
All major space agencies contribute to IGBP research and work closely with the IGBP research community. NASA, the European Space Agency (ESA) and the Group on Earth Observations (GEO) participate in IGBP's annual scientific committee meetings. IGBP also participates in the Integrated Global Observing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



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 is represented by **71 national committees** (some of which are global-change committees that also represent partner programmes) across Africa, the Americas, Asia-Pacific, Europe and the Middle East. These committees coordinate regional and national activities including activities such as scientific workshops and symposia. National committee members are often leaders in their field and make significant contributions to scientific progress.



Mark Stafford Smith presenting at the IGBP Officers' Meeting in Manaus, Brazil. Photo by Wendy Broadgate.

In October 2011, the Brazil regional office hosted IGBP's 24th Officers' Meeting in Manaus. This was followed by a one-day symposium entitled "Global Environmental Change: Regional Perspectives and Advances" at the National Institute for Amazonia Research in collaboration with the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). The 30 scholars and students that attended this symposium had the opportunity to engage with the international community and present research on topics such as coastal zones, the nitrogen cycle, carbon emissions and complex socio-ecological systems. They also discussed the implications of this research on regional policy making.

The Brazilian regional office helped raise 150,000 USD for the Planet Under Pressure conference, facilitating the participation of 45 Brazilian scientists and students (including 13 PhD students). It also promoted the conference via several print and other media outlets.

The committee from **Botswana** was involved in several environmental research projects and information exchange with various groups within and outside the country. Last year witnessed the completion of the EU-funded DESIRE project, a multi-country and multi-stakeholder initiative that seeks local solutions to problems posed by desertification. The Botswana component was led by national committee member Raban Chanda. The findings point to a high level of awareness about the causes of desertification and its effects. Land users identified a number of solutions but placed the greatest emphasis on game ranching and biogas production; this, however, will require substantial external assistance to implement. The committee was also actively engaged in informing policy, both at the international level (via UNFCCC and IPCC processes) and at the national level (for example, the Botswana Millennium Development Report).

In 2011/2012, the **German National Committee** on Global Change Research continued the discussions on climate engineering and prepared in cooperation with other German committees a joint statement targeted at the German Research Foundation. The committee also published recommendations on national funding options in the field of ecosystem services and ecological, social and economic needs.

On an international level and in the context of Future Earth, the committee – together with ESSP, ICSU and others – organised an international workshop on integrated global-change research to discuss current examples of integrated research and to identify key components of efforts to take forward the successful co-design and co-production of knowledge. These discussions were continued at the Planet Under Pressure conference in London.

Chuluun Togtokh, vice-chair of IGBP's **Mongolian Global Change National Committee**, has pointed out in an article published in *Nature* that the United Nations' Human Development Index fails to take into account sustainability. To rectify this omission he has recalculated the 2011 index to take account of per capita carbon emissions from each nation. The results are striking: for example, Australia slides from 2nd place to 26th, the United States drops from 4th to 28th, and Canada falls from 6th to 24th. In contrast, Sweden jumps up from 10th to 2nd place. Togtokh names his new metric the Human Sustainable Development Index.

According to the national committee from **Singapore,** global- and climate-change research have seen an exponential increase in recent years due to generous funding support from the National Research Foundation of Singapore and other government agencies. Local universities, such as the National University of Singapore, are actively engaged in global and climate-change research through university level research centres focused on multidisciplinary research. One focus of research is the downscaling of global climate and ocean models for the South East Asian domain coupled to local scale atmospheric and hydrological models. Another focus is peatlands, which as carbon sinks and sources of fresh water have potential repercussions on the global climate and water resources. At the Nanyang Technological University, climate change research is centred on the Earth Observatory of Singapore where atmospheric modelling studies on the effects of El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole on temperature, wind and rainfall in South East Asia are ongoing. Local universities and research institutions collaborate closely with their international counterparts. Local government agencies also work closely with the research programmes so that there is practical application and realisation of research efforts.

Aware of the challenges posed by climate change to **Vietnam**, members of this country's national committee have been involved in several projects on mitigation and adaptation to climate change as well as international workshops on global-change issues in Vietnam and countries of the Mekong Lower Basin. They have also collaborated with many international organisations on research and training programmes.

Recently, committee members participated in a workshop organised by the Vietnam Business Council for Sustainable Development (VBCSD), entitled "Business and Climate Change". This partnership between the scientific community and businesses will explore the development of a low-carbon economy in Vietnam during the coming years.

During the past year, the **Polish national committee** was involved in a range of activities related to global and climate change. These include: the recognition of the major factors influencing biodiversity; the impact of climate change on marginal glaciers; and the impact of climate and human activities on the functioning of Baltic Sea ecosystems. The committee participated actively in the meetings of the European Alliance*. Members attended several international and national research conferences on themes including Polish contributions to the International Polar Year and polar regions. Results of studies are regularly presented at conferences and published in *Papers on Global Change* – the annual journal published by the Polish National Committee on Global Change. Since 2010, the journal is accessible online (http://versita.com/pgc/).

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

National Committees and Regional Alliances

IGBP has a regional office in Brazil and 71 national committees across Africa, the Americas, the Asia-Pacific and the Middle East, and Europe. The IGBP Secretariat profiles the research and activities of committees and their members in several ways. For example, the communications team assists in publishing scientific results or opinions in high-profile journals and the *Global Change* magazine. The Secretariat also helped to organise a National Committees Day in London following the Planet Under Pressure conference. It is currently involved in communicating feedback from national committees to the Future Earth transition team.

IGBP 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

*Through the US National Academies

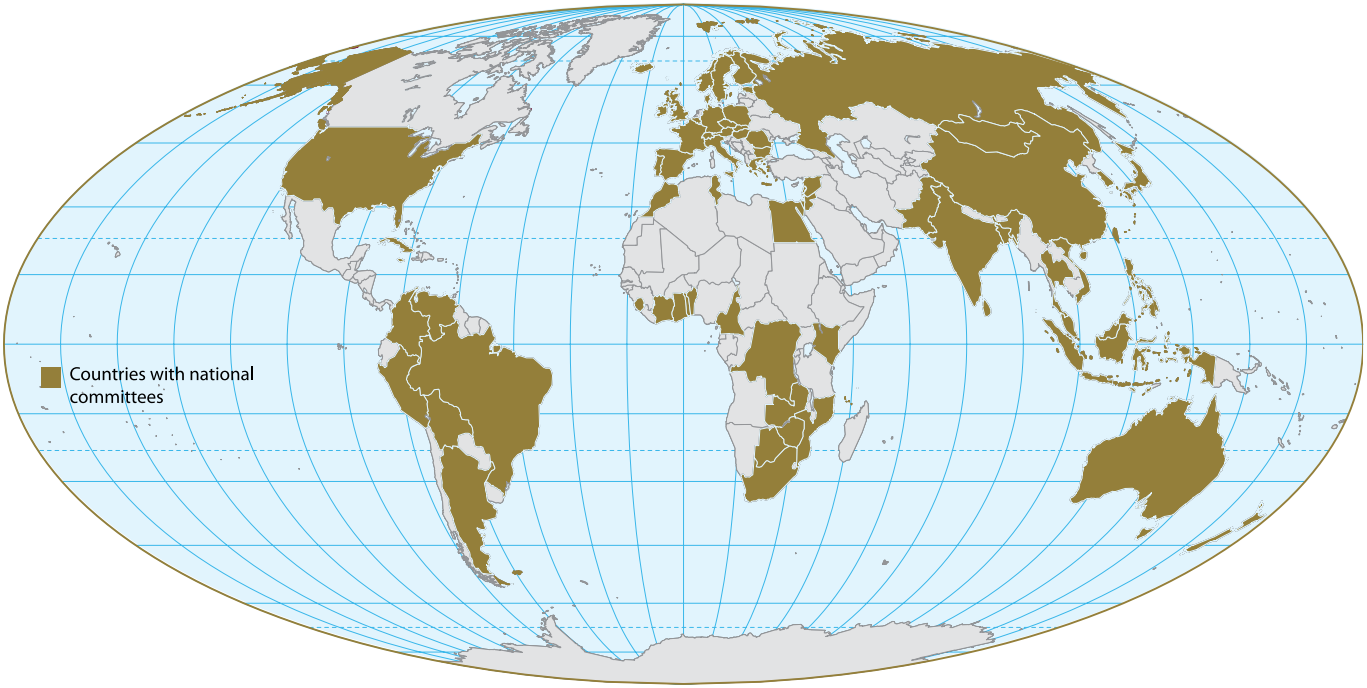
Asia-Pacific and the Middle East

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

Europe

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

National Committees



IGBP has 71 national committees around the globe.

IGBP Scientific Committee (2011)

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

Jan Willem Erisman (Treasurer)
Louis Bolk Institute
NETHERLANDS

Raymond S Bradley
University of Massachusetts
UNITED STATES

Eduardo S Brondizio
Indiana University
UNITED STATES

Mercedes Bustamante
University of Brazilia
BRAZIL

Henry Jacoby *
Massachusetts Institute of Technology, Cambridge
UNITED STATES

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Université Libre de Bruxelles
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UNITED STATES

Jean Palutikof
Griffith University
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CHINA

S K Satheesh
Indian Institute of Science
INDIA

Mitsuo Uematsu
The University of Tokyo
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James P M Syvitski (Chair Elect)
University of Colorado
UNITED STATES

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University of Exeter
UK

Hubertus Fischer (Co-chair PAGES)
University of Bern
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Alex Guenther (Co-chair iLEAPS)
National Center for Atmospheric Research
UNITED STATES

Eileen E Hofmann (Chair IMBER)
Old Dominion University
UNITED STATES

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

Paul Monks (Co-chair IGAC)
University of Leicester
UK

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

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

Anette Reenberg (Chair GLP) *
University of Copenhagen
DENMARK

Eric Saltzman (Chair SOLAS) (from mid-2011)
University of California at Irvine
UNITED STATES

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

Doug Wallace (Chair SOLAS) **
Kiel University
GERMANY

Tong Zhu (Co-chair IGAC)
Peking University
CHINA

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Antonio J Busalacchi (WCRP)
University of Maryland
UNITED STATES

Harold Mooney (DIVERSITAS)
Stanford University
UNITED STATES

Partha Dasgupta (IHDP)
University of Cambridge
UK

Rik Leemans (ESSP)
Wageningen University
NETHERLANDS

* Rotated off the Scientific Committee at the end of 2011

** Rotated off the Scientific Committee in mid-2011

IGBP Project Offices

Core projects

Analysis, Integration and Modelling of the Earth System (AIMES)

Acting Executive Officer: Greg Guibert

International Project Office:
National Center for Atmospheric Research, Boulder, Colorado, USA

Global Land Project (GLP)

Executive Officer: Giovana Espindola

International Project Office:
National Institute for Space Research (INPE), São Paulo, Brazil
Nodes:
Beijing, China; Sapporo, Japan

Executive Officer: Tobias Langanke
(until end of 2011)

International Project Office:
University of Copenhagen, Denmark

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Executive Officer: Bernard Avril

International Project Office:
Institute of Marine Research, Bergen, Norway

Executive Officer: Lisa Maddison
(until May 2012)

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
Nodes:
Taipei, Taiwan; Bologna, Italy

Integrated Land Ecosystem–Atmosphere Processes Study (iLEAPS)

Executive Officer: Tanja Suni

Executive Officer: Anni Reissell
(until November 2011)

International Project Office:
University of Helsinki, Helsinki, Finland

Land–Ocean Interactions in the Coastal Zone (LOICZ)

Executive Officer: Hartwig Kremer

International Project Office:
Institute for Coastal Research, Helmholtz-Zentrum Geesthacht, Germany
Nodes:
Yantai, China; Chennai, India; Faro, Portugal; Singapore

Past Global Changes (PAGES)

Executive Officer: Thorsten Kiefer

International Project Office:
Bern, Switzerland

Surface Ocean–Lower Atmosphere Study (SOLAS)

Executive Officer: Emilie Breviere

Acting Executive Officer:
Susanna Pakkasmaa (during mid-2011–May 2012)

Acting Executive Officer:
Ellie Farahani (during early to mid-2011)

International Project Office:
Liebniz Institute for Marine Research, University of Kiel, Germany
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Plymouth, UK

Joint Projects

Global Carbon Project (GCP)

Executive Directors: Josep (Pep) Canadell; Shobhakar Dhakal

International Project Offices:
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National Institute for Environmental Studies, Tsukuba, Japan

Global Environmental Change and Human Health (GECHH)

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Global Water System Project (GWSP)

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PUBLICATIONS

A selection of the top 10-15 scientific publications from core projects and fast-track initiatives published in 2011, or in some cases early 2012.

IGBP

Stafford Smith M, Gaffney O, Brito L, Ostrom E and Seitzinger S (2012) Interconnected risks and solutions for a planet under pressure – overview and introduction. *Current Opinion in Environmental Sustainability* 4 (1): 3–6, doi: 10.1016/j.cosust.2012.01.011

Planet Under Pressure policy briefs for the 2012 UN Conference on Sustainable Development, Rio+20

The International Project Office of the Global Water System Project: Affeltranger B, Bogardi J, Cosgrove W, Dudgeon D, Forkutsa I, Jain S, Lawford R, Leentvaar J, Llamas R, Marx S, Meyn A, Pahl-Wostl C, Renaud F, Riedke E, Sebesvari Z, Simonovic S, Syvitski J, Szöllösi-Nagy A, Trenberth K, Vielhauer K, Voigt H, Vörösmarty C and Yang H (2011) Water security for a planet under pressure.

Ingram J, Aggarwal P, Ericksen P, Gregory P, Horn-Phathanothai L, Misselhorn A and Wiebe K (2011) Food security for a planet under pressure.

DIVERSITAS: Díaz S, Reyers B, Bergendorff T, Brussaard L, Cooper D, Cramer W, Duraiappah A, Elmqvist T, Faith D P, Fonseca G, Hammond T, Jackson L E, Krug C, Larigauderie A, Leadley P W, Le Prestre P, Lonsdale M, Lovejoy T E, Mace G M, Matsuda H, Mooney H A, Prieur-Richard A-H, Pulleman M, Rosa E A, Scholes R J, Spehn E, Turner II B L, Williams M J and Yahara T (2011) Biodiversity and ecosystems for a planet under pressure.

The Earth System Governance Project: Biermann F *et al.* (2011) Transforming governance and institutions for a planet under pressure.

IGBP: Gaffney O, Bondre N, Seitzinger S, Stafford Smith M, Biermann F, Leemans R, Ingram J, Bogardi J, Larigauderie A, Glaser G, Diaz S, Kovats S, Broadgate W, Morais J and Steffen W (2011) Interconnected risks and solutions for a planet under pressure.

The International Human Dimensions Programme on Global Environmental Change: Duraiappah A K, Scherkenbach C, Munoz P, Bai X, Fragkias M, Gutscher H and Neskakis L (2012) Human well-being for a planet under pressure.

The International Human Dimensions Programme on Global Environmental Change: Duraiappah A, Neskakis L, Munoz P, Fuetenebro P, Köpsel V, Darkey E, Smith L (2012) A green economy for a planet under pressure.

van Vuuren D P, Nakicenovic N, Riahi K, Brew-Hammond A, Kammen D M, Modi V, Nilsson M and Smith K R (2012) An energy vision for a planet under pressure.

The Global Environmental Change and Human Health project: Kovats S, Butler C, Corvalán C, Morse A, McMichael T, Rosenberg M, Confalonieri U, Haines A, Poveda G, Aguirre A, Oswald-Spring Ú, Cesario M and Lindgren (2012). Global health for a planet under pressure.

Analysis, Integration and Modelling of the Earth System

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Lenton T M (2011) Beyond 2°C: redefining dangerous climate change for physical systems. *Wiley Interdisciplinary Reviews: Climate Change* 2 (3): 451-461.

Lenton T M (2011) 2°C or not 2°C? That is the climate question. *Nature* 473: 7.

Steffen W, Persson Å, Deutsch L, Zalasiewicz J, Williams M, Richardson K, Crumley C, Crutzen P, Folke C, Gordon L *et al.* (2011) The Anthropocene: from global change to planetary stewardship. *AMBIO* 0044-7447, doi: 10.1007/s13280-011-0185-x.

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Fast-track initiatives and synthesis

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FINANCIAL

IGBP activities are predominantly funded by contributions from over 40 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 core 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 2011

National contributions received arranged by level of contribution

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

National contributions received for previous years

Greece 2010
India 2010

* Some countries pay well above this scale.

FINANCIAL STATEMENT

Income and expenditure for the year ending December 2011

INCOME	EURO
National contribution	1,250,515
In kind support Scientific Committee and Officers' meeting*	124,206
Other network income	8,318
Synthesis grants**	98,703
Interest on bank account	26,758
Reallocated from previous year	140,541
Carry-over network funds from previous year	449,862
TOTAL INCOME	**1,807,573**

EXPENDITURES	EURO
Core Science Projects	296,499
IGBP Synthesis & Fast-Track Initiatives	157,862
Planet Under Pressure 2012 (excl. external grants)	144,332
Communications and Publications	254,917
Partner Activities	113,334
ICSU Transition Team/Visioning	28,574
Scientific Committee and Officers	303,152
Funding and Budget	85,948
National Committees and Adhering Bodies	11,935
Secretariat Administration	197,762
Professional Development	6,793
TOTAL EXPENDITURE* **	**1,601,108**
Reallocated funds for next year	144,998
Carry-over network funds ** **	**352,797**

* USA: EURO 90,636

Brazil: EURO 33,570

** Taiwan support for Megacities workshop in Yantai, China: EURO 23,970 (received to date)

Taiwan support for Air Pollution and Climate workshop in Taiwan: EURO 48,000

APN grant for synthesis on the Needs of Least Developed Countries: EURO 26,733 (received to date)

*** In addition to the income presented above, IGBP received additional grants for workshops, Planet Under Pressure conference and European Space Agency activities (total EURO 846,262)

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

Note: IGBP has a reserve fund at the Royal Swedish Academy of SEK 1.5 million that is not included in the financial report.

ADMINISTERED GRANTS 2011

(not included in the financial statement 2011)

ACTIVITY/FUNDER	EURO	Original amount received
Planet Under Pressure conference		
APN	76,100	USD 100,000 transferred directly to the conference
ICSU	30,000	
US NSF	333,071	USD 448,351
The Research Council of Norway	60,000	
The Swedish International Development Cooperation Agency	158,009	SEK 1,456,000
The Indian Institute of Science, Bangalore	5,780	GBP 4,975
The Ministry of Earth Sciences, India	9,980	
European Space Agency (ESA)	160,000	
Planetary Stewardship workshop (funded by Swedish agencies)		
FORMAS	10,423	SEK 100,000
Vinnova	10,449	SEK 100,000
Forskningsrådet	10,449	SEK 100,000
TOTAL EURO	**864,262**	

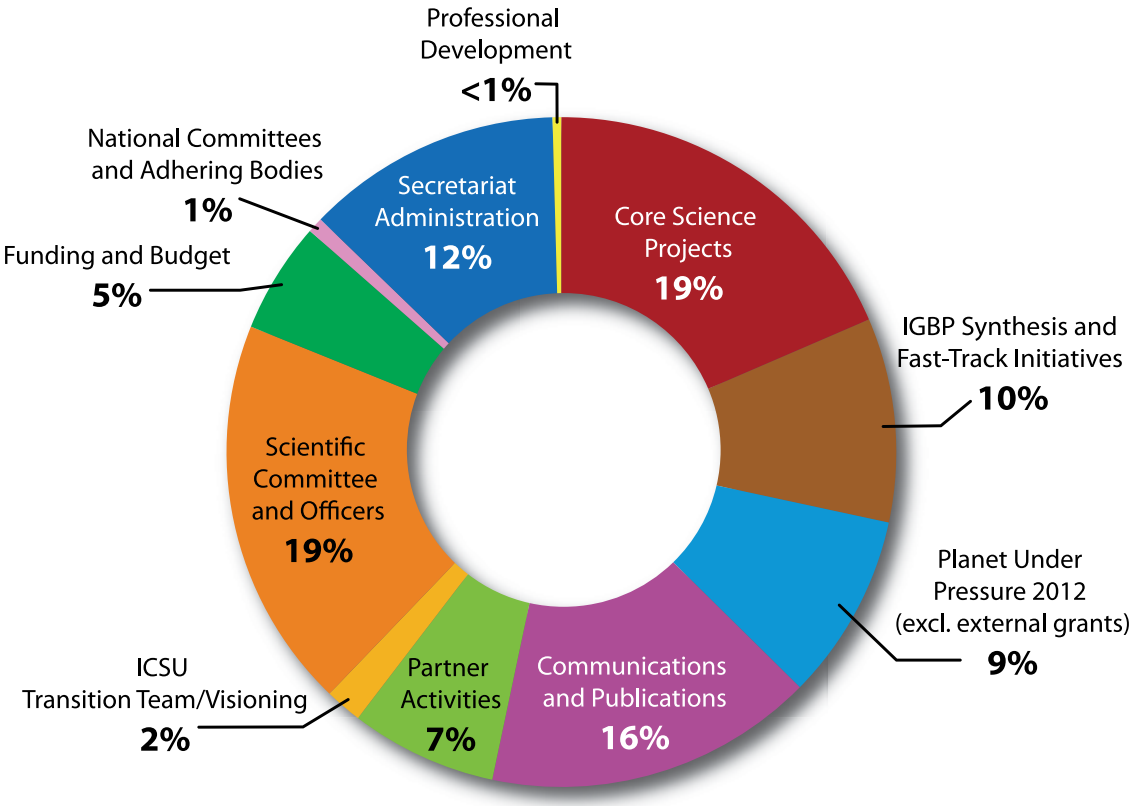
Note: In 2012 we have received additional funding for the Planet Under Pressure conference as follows:

ICSU: EURO 15,000

Germany DFG: EURO 10,000

PROPORTIONAL EXPENDITURE 2011

(Excluding administered grants)



Percentage of budget used for core activities.

2011 FUNDING FOR INTERNATIONAL CORE PROJECT OFFICES

Project	Country/Organisation	USD	EURO
AIMES	IGBP 2011 + carry-over from 2010	36,137	27,500
	AIMES Total Income	**36,137**	**27,500**
GLP	University of Copenhagen (1 435 000 DKK)	252,863	192,429
	IHDP	20,000	15,220
	IGBP 2011	18,068	13,750
	GLP Total Income	**290,932**	**221,399**
IGAC	US NASA*	96,199	73,207
	NOAA*	96,428	73,382
	US NSF*	96,446	73,395
	European ACCENT**	23,653	18,000
	The Academy of Sciences*** located in Taipei, China	3,000	2,283
	IGBP 2011 + carry-over from 2010	39,036	29,706
	IGAC Total Income	**354,762**	**269,974**
iLEAPS	University of Helsinki, Faculty of Sciences	236,531	180,000
	Finnish Meteorological Institute	19,711	15,000
	IGBP 2011	36,137	27,500
	Grant for LULCC synthesis workshop	5,388	4,100
	iLEAPS Total Income	**292,378**	**226,600**

Project	Country/Organisation	USD	EURO
IMBER	US NSF–SCOR	50,000	38,050
	SCOR carry-over from previous year	46,130	35,105
	University of Western Brittany / IUEM	9,935	7,561
	CNRS/IRD/Brittany region, Ifremer	141,365	107,579
	IGBP 2011	18,068	13,750
	IMBER Total Income	**265,498**	**202,044**
LOICZ	Institute for Coastal Research	565,046	430,000
	IHDP	17,411	13,250
	IGBP 2011	18,068	13,750
	LOICZ Total Income	**600,526**	**457,000**
PAGES	Swiss NSF (1 August 2010–31 July 2011)	357,966	272,412
	US NSF**** (1 August 2010–31 July 2011)	313,410	238,505
	IGBP 2011	36,137	27,500
	PAGES Total Income	**707,513**	**538,417**
SOLAS	UK Natural Environment Research Council (1 April 2011–31 March 2012)	22,070	16,795
	BMBF 1 Feb 2010–31 Jan 2011)	112,904	85,920
	IFM-GEOMAR		100,528
	US NSF–SCOR	25,000	19,025
	IGBP 2011	18,068	13,750
	SOLAS Total Income	**178,042**	**236,018**

* Contributions from NASA, NOAA and NSF are for 1 July 2011 through 30 June 2012, not the calendar year 2011.

** Support from ACCENT is from 1 November 2011 through 31 October 2012

*** The Academy of Sciences contribution is an approximation; they cover the cost of newsletter printing/mailing, which is ~ 3,000 USD

**** Income US NSF includes supplements for the Open Science Meeting/ Young Scientists' Meeting

ACRONYMS

ACCENT	Action on Climate Change through Engagement, Networks and Tools
AIMES	Analysis, Integration and Modelling of the Earth System
AMMA	African Monsoon Multidisciplinary Analysis
APN	Asia-Pacific Network for Global Change Research
BMBF	Federal Ministry of Education and Research (Germany)
CCAFS	Climate Change, Agriculture and Food Security
CEOS	Committee on Earth Observation Satellites
CIMA	Center for Atmospheric and Ocean Research (Argentina)
CNRS	Centre National pour la Recherche Scientifique
COP17	17th Conference of the Parties
CSIC	Spanish National Research Council
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIVERSITAS	An international programme of biodiversity science
ENSO	El Niño-Southern Oscillation
ESA	European Space Agency
ESSP	Earth System Science Partnership
EU	European Union
FORMAS	The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FTI	Fast-Track Initiative
GCP	Global Carbon Project
GECHH	Global Environmental Change and Human Health
GEO	Group on Earth Observations
GLP	Global Land Project
GWSP	Global Water System Project
IAI	Inter-American Institute for Global Change Research
ICACGP	International Commission on Atmospheric Chemistry and Global Pollution
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IFM-GEOMAR	Leibniz Institute of Marine Sciences
IRD	L'Institut de recherche pour le développement

IHDP	International Human Dimensions Programme on Global Environmental Change
iLEAPS	Integrated Land Ecosystem–Atmosphere 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)
IPCC	Intergovernmental Panel on Climate Change
IUEM	The European Institute for Marine Studies
LBA	Large-Scale Biosphere-Atmosphere Experiment in Amazonia
LOICZ	Land–Ocean Interactions in the Coastal Zone
MAIRS	Monsoon Asia Integrated Regional Study
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NEESPI	Northern Eurasia Earth Science Partnership Initiative
NERC	Natural Environment Research Council
NIVA	Norwegian Institute for Water Research
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
PAGES	Past Global Changes
PES	Payments for Ecosystem Services
REDD	Reduced Emissions from Deforestation and Degradation
SBSTA (UNFCCC)	Subsidiary Body for Scientific and Technological Advice
SCOR	Scientific Committee on Oceanic Research
SSEESS	Swedish Secretariat for Environmental Earth System Sciences
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
VBCSD	Vietnam Business Council for Sustainable Development
WCRP	World Climate Research Programme

International Geosphere-Biosphere Programme