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Annual Report 2012

GLOBAL CHANGE IGBP International Geosphere-Biosphere Programme

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The Royal Swedish Academy of Sciences
Box 50005
SE-104 05, Stockholm
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Tel: +46 8 16 64 48
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Editors: Owen Gaffney, Ninad Bondre

Graphic Designer: Hilarie Cutler

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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

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)

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.

Joint projects and studies**

- Global Carbon Project (GCP)
- 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)

Major endorsed projects

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

* see page 44 for co-sponsors

** as part of the Earth System Science Partnership which formally ended December 2012. Joint projects continue under the global environmental change programmes.

IGBP's global network of 26 international project offices, including their nodal offices, and 51 national committees.

THE YEAR IN REVIEW

Ever since it was founded IGBP has contributed to the conceptualisation of the Earth as a system and to its deeper understanding. In recent years our projects have sought to address policy-relevant research while continuing to explore fundamental Earth-system processes.

Last year was no different: high-profile publications from our core and joint projects assessed the climate effects of black carbon, reconstructed millennial-scale regional temperature variability, presented the global carbon budget for 2011 and re-evaluated marine dinitrogen fixation. Via their open science conferences and summer schools, our core projects continued to identify new research directions and build the next generation of researchers. Our national committees explored various global-change problems and processes at the regional scale. Find out more about these accomplishments in the report's following sections.

We produced a strategy for an overarching synthesis, which is to be undertaken during the coming two and and a half years. This activity will integrate natural- and social-science perspectives on the Anthropocene, take stock of the programme's scientific legacy and point to the emerging frontiers in global-change research. The synthesis will entail workshops that bring together the IGBP and broader global-change research communities.

In September last year we helped to organise the Third Symposium on the Ocean in a High-CO_2 World, which was held in Monterey, California. We worked with our projects to make their new findings accessible to the public via our *Global Change* magazine, website, social media and press releases.

Throughout last year IGBP continued to support the International Council for Science (ICSU) and its alliance* partners in developing the Future Earth initiative. We held several consultations with our core projects to facilitate their transition to Future Earth and nominated individuals from the IGBP community for Future Earth's regional workshops. We have nominated several high-profile researchers – including current IGBP Scientific Committee members – for Future Earth's Scientific Committee.

As part of the transition to Future Earth, the Earth System Science Partnership (ESSP) formally dissolved at the end of last year; however, the four global-environmental-change programmes continue to collaborate and co-sponsor the ESSP joint projects. IGBP will merge with Future Earth at the end of 2015.

Until then, we will continue to support our community's effort to produce high-quality research and address some of the most pressing challenges of global change and sustainable development.

IGBP Chair James Syvitski and Executive Director Sybil Seitzinger, June 2013.

*The alliance of partners consists of ICSU, the Belmont Forum (a high level group of major research funders), the UN Educational, Scientific and Cultural Organization (UNESCO), the UN Environment Programme (UNEP), the UN University (UNU) and the World Meteorological Organization (WMO) as an observer.

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 26 years, and the many nations hosting IGBP's international project offices and the regional office: Australia, Brazil, Finland, France *, Germany, Norway, Switzerland and US.

* Until May 2012

IGBP has contributed to the conceptualisation of the Earth as a system.

Executive Director Sybil Seitzinger

Chair James Syvitski

CONTRIBUTIONS TO CLIMATE RESEARCH

During the past few years the Analysis, Integration and Modelling of the Earth System (AIMES) project has contributed to climate research in several significant ways.

For example, the project responded to a call from the Intergovernmental Panel on Climate Change (IPCC) to help develop a new approach to greenhouse-gas emissions pathways to the end of the century. The process brought together a diverse range of research communities – an essential step in the move towards fully integrated Earth-system models. The four Representative Concentration Pathways (RCPs) resulting from this work indicate the change in radiative forcing of the lower atmosphere as a result of rising greenhouse gases. An important advance over previous scenarios is the inclusion of the effects of mitigation in some of the RCPs. The pathways provide a range of options for the world's governments and other institutions and will be one of the key advances in the forthcoming Intergovernmental Panel on Climate Change's Fifth Assessment Report.

The project has contributed to our understanding of the links between the carbon cycle and climate. Research published early this year in *Nature* suggests that tropical land will release 53 ± 17 gigatonnes of carbon per kelvin in response to climate change. This value is much lower than the projections of some models (over 150 gigatonnes of carbon per kelvin) and implies that there is a relatively low risk of Amazon forest dieback due to carbon-dioxide-induced global warming.

Strengthening observations has been an important concern of the project. It has developed a strategy aimed at integrating observations of the physical, biogeochemical and human dimensions of global change.

The project is currently in a phase of restructuring its scientific committee and international project office to respond to the challenges of the new Future Earth initiative.

Cox P M *et al.* (2013) *Nature* 341-344, doi: 10.1038/nature11882.

Moss R H *et al.* (2010) *Nature* 463: 747-756.

Scenarios provide a range of options for the world's governments and other institutions.

Félix Pharand-Deschênes/ Globaia

The AIMES project has developed and is continuing to refine a strategy aimed at integrating observations of the physical, biogeochemical and human dimensions of global change.

A CHANGING LANDSCAPE OF SLASH AND BURN

The fringes of tropical forests have long been the sites of slash and burn, or swidden, cultivation. This style of cultivation is undergoing substantial transformation around the world, according to researchers associated with the Global Land Project.

In a rapidly globalising world, swidden cultivation is responding to various pressures – economic, political and environmental. Exploring the nature of this response and its consequences for farming communities and ecosystems is important to manage land-use and land-cover change in the tropics. Against this backdrop, the researchers undertook a meta-analysis that synthesised the findings of several case studies in peer-reviewed publications, books and doctoral dissertations. This exercise provided an idea of the changes in the extent of swidden cultivation as well as the drivers of the changes.

Whereas over half of the studies reported a decrease in the extent of swidden cultivation, about a third reported an increase and just over a tenth documented no change. The observations could be attributed to a combination of drivers including access to markets and various policies. For example, the relatively rapid reduction in the extent of swidden in Southeast Asia appears to result from government policies aimed at curbing the practice and incentivising agricultural intensification. In contrast, the increase in swidden extent in Central Africa is likely caused by limited access to markets and by farmers' decisions to preserve multifunctional landscapes in order to reduce risk.

The shift from swidden to more permanent and intensive agriculture has often been viewed as a strategy to improve the sustainability of agriculture on the fringes of tropical forests. But the researchers note that this shift may reduce a region's capacity to sequester carbon in the long term. Also, although intensification tends to be accompanied by immediate economic benefits, it can also lead to increased inequality and conflicts. Future research should both improve the quantification of land-use and land-cover changes at the frontiers of tropical forests and delve into the impacts of such changes on local communities.

van Vliet N *et al.* (2012) *Global Environmental Change* 22: 418-429.

In a rapidly globalising world, swidden cultivation is responding to various pressures.

© iStockphoto.com/ MsLightBox

Despite the global trend towards land-use intensification, in many areas swidden will remain part of rural landscapes, according to a new synthesis report, *Trends, drivers and impacts of changes in swidden cultivation in tropical forest-agriculture frontiers: A global assessment.*

BLACK CARBON REPORT

Black carbon is the second largest man-made contributor to global warming and its influence on climate has been greatly underestimated, according to the first quantitative and comprehensive analysis of this issue, coordinated by IGBP's International Global Atmospheric Chemistry (IGAC) project.

The study, published in the *Journal of Geophysical Research: Atmospheres,* states that the direct influence of black carbon, or soot, on warming the climate could be about twice previous estimates. Accounting for all of the ways it can affect climate, black carbon is believed to have a warming effect of about 1.1 Watts per square metre (W/m^2), approximately two thirds of the effect of the largest man-made contributor to global warming, carbon dioxide.

Co-lead author David Fahey from the US National Oceanic and Atmospheric Administration (NOAA) said, "This study confirms and goes beyond other research that suggested black carbon has a strong warming effect on climate, just ahead of methane."

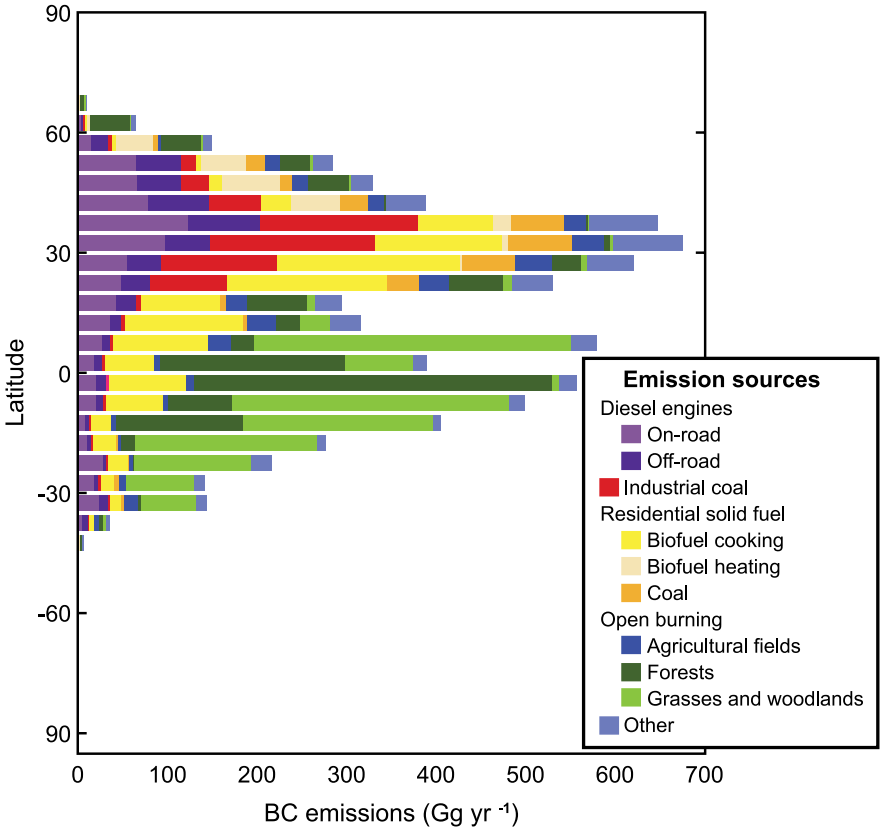
The results indicate that there may be a greater potential to curb warming by reducing black carbon emissions than previously thought. "Policymakers, like the Climate and Clean Air Coalition, are talking about ways to slow global warming by reducing black carbon emissions. This study shows that this is a viable option for some black carbon sources and since black carbon is short lived, the impacts would be noticed immediately," says co-lead author Tami Bond from the University of Illinois at Urbana-Champaign.

The black carbon report, published January 2013, was the culmination of a hectic year for IGAC. In September, the project held a major international conference, Atmospheric Chemistry in the Anthropocene, in Beijing. During the conference IGAC and the World Meteorological Organization published another significant report, *Impacts of Megacities on Air Pollution and Climate.* A policy brief based on this report was launched at the Planet Under Pressure conference.

Bond T *et al.* (2013) *Journal of Geophysical Research: Atmospheres*, doi: 10.1002/jgrd.50171.

Zhu T *et al.* (2012) WMO/IGAC *Impact of Megacities on Air Pollution and Climate.* WMO/IGAC, ISBN 978-0-9882867-0-2, 309 pp.

Black carbon is the second largest man-made contributor to global warming.



Black carbon emissions in the year 2000 by latitude and source.
A new assessment looked at black carbon emissions from a variety of sources. The figure shows that emissions from different sources dominate at different latitudes. For example, biomass burning dominates the tropics in the Southern Hemisphere whereas emissions from diesel engines, industrial coal and biofuels dominate in the Northern Hemisphere.
Figure redrawn from Bond T *et al.* (2013).

HOT DAYS LINKED TO SOIL-MOISTURE DEFICITS

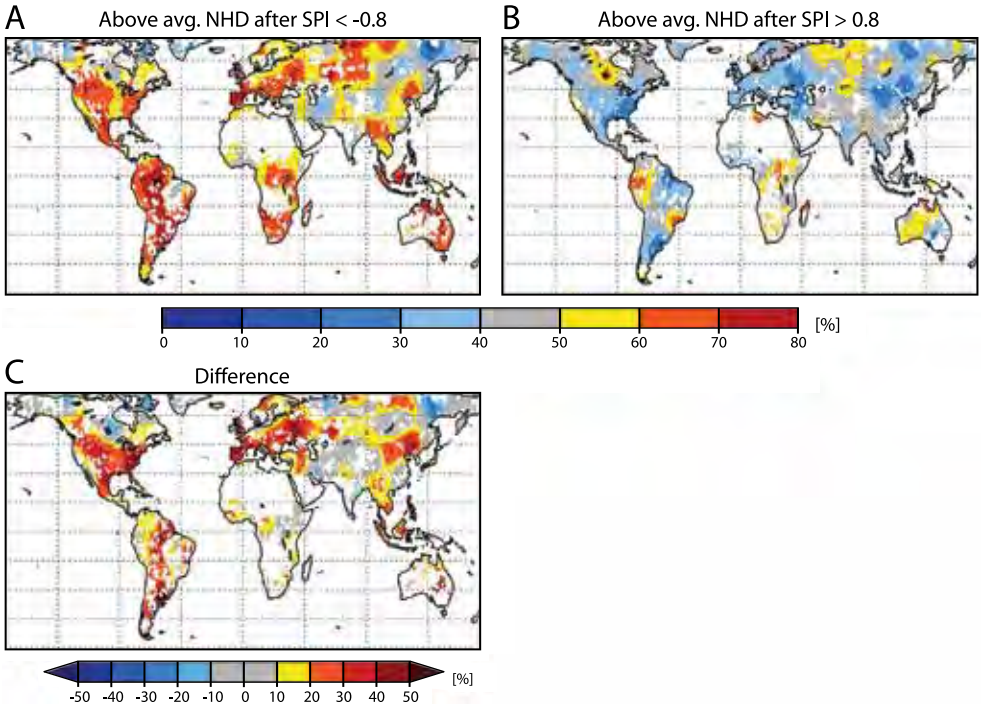
The hottest days in a region are likely to be preceded by deficits in soil moisture, according to researchers associated with the Integrated Land Ecosystem–Atmosphere Processes Study. Although this relationship was previously demonstrated for some individual regions, this study – reported in the *Proceedings of the National Academy of Sciences* – finds that it holds at the global scale. The study extends the observations of strong soil moisture–atmosphere coupling to several regions not identified in previous studies.

Last year an IPCC special report suggested that heat waves are likely to increase in the 21st century as a result of climate change. There is thus growing interest in predicting such events, for this would allow measures to be put in place to deal with the effects. The researchers looked at data over the past several decades to evaluate whether soil-moisture deficits could be used to predict the hot extremes that followed a few weeks later. To do so, they sought to establish a statistical relationship between the soil-moisture deficits (using the deviation of observed precipitation from the long-term mean as a proxy) and the number of hot days in a year.

The results suggest that for a large fraction of the globe (including most parts of North and South America, Europe and Australia) hot extremes are more likely to be preceded by dry periods than wet periods. Monitoring soil moisture in these regions could thus substantially improve the predictions of hot days and allow the development of early warning and adaptation measures.

Mueller B and Seneviratne S (2012) *Proceedings of the National Academy of Sciences* 109: 12398-12403, doi: 10.1073/pnas.1204330109.

Monitoring soil moisture in these regions could thus substantially improve the predictions of hot days.



Hot day occurrence probability after dry (A) versus wet (B) conditions. Panel C depicts the difference between the two. Values are given in percentage of years with above-average number of hot days (NHD) from total number of low and high SPI (Standardized Precipitation Index) years, respectively. Values based on a composite of less than four years are not shown (white areas). The SPI is a measure of the soil-moisture deficit. Figure 4 from Mueller B and Seneviratne S (2012) *Proceedings of the National Academy of Sciences* 109: 12398-12403, doi: 10.1073/pnas.1204330109.

ADDING THE HUMAN DIMENSION TO MARINE RESEARCH

How are socio-economic challenges incorporated into international marine research? IGBP's Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project has set up a "Human dimensions working group" to address this issue.

Co-chaired by social scientist Moenieba Isaacs and natural scientist Alida Bundy, the working group aims to create an integrated and interactive natural-social science marine research community within IMBER. An early result of this initiative is a special issue of the journal *Current Opinion in Environmental Sustainability* focusing on interactions between natural and human processes in marine systems. Researchers drew attention to some less recognised problems in the marine system, for example, the changing ratios of elements such as carbon, nitrogen and phosphorus, and their chemical states (organic, inorganic, dissolved and particulate). Humans rarely add nutrients to systems in "natural ratios" and management efforts tend to focus on controlling single nutrients. This can result in changes to the structure and functioning of marine food webs.

The special issue covers governance of fisheries and points to the need for a "broader notion of institutions that can deal with the social, cultural and historical aspects of fisheries, including meanings and values, trust and norms". The authors argue that knowledge from diverse sources must be integrated into the decision frameworks and governance structures for fisheries.

The issue also includes contributions exploring the "ingredients for successful and sustainable interactions between people and sea", and tackling the thorny issue of ethics, in particular one paper argues for "the adoption of an ethical approach to fisheries, defined within the concept of justice to include the fair distribution of benefits and harms" to ecosystems as well as human societies.

In addition to the special issue, in January 2013, IMBER organised its third IMBIZO – a term for "a gathering" borrowed from Zulu – in Goa, India. This IMBIZO focused on the future of marine biogeochemistry, ecosystems and societies. It brought together about 120 researchers from 29 countries.

Perry R I, Bundy A and Hofmann E, eds (2012) Aquatic and marine systems. *Current Opinion in Environmental Sustainability* 4 (3): 253-374.

IMBER organised its third IMBIZO – a term for "a gathering" borrowed from Zulu – in Goa, India.

© iStockphoto.com/ Jordi Ramisa

Fish market in Ziguinchor, Senegal. The IMBER project has set up a human dimensions working group to integrate socio-economic challenges into marine research internationally.

COASTAL MEGACITIES UNDER THE SCANNER

A diverse group of experts brought together by the Land–Ocean Interactions in the Coastal Zone project says that "Global trends in urban development and environmental change are permanently altering the ways in which coastal megacities interact with the environment." We need "policy and research agendas that are innovative and forward-thinking", the group adds.

This message is one of several in the executive summary of a global review of coastal megacities, soon to be published in book form by Earthscan. The review resulted from an IGBP synthesis workshop in China, which brought to bear the expertise of researchers and policymakers on megacities in the coastal zone. It draws on perspectives from both the physical and social sciences.

Megacities – cities with populations exceeding 10 million – are often located on coasts. Also concentrated along coasts are agglomerations of urban areas that collectively house millions if not tens of millions of people. Megacities exert considerable pressure on coastal ecosystems: for example, extraction of groundwater leads to subsidence and expansion often comes at the expense of wetlands and mangroves. But coastal megacities are also vulnerable to environmental pressures such as sea-level rise. An understanding of the two-way interactions between megacities and coasts is thus critical to managing coastal change and increasing resilience.

The review points out that risk reduction in coastal megacities is complex, not just because of uncertainties in the projected environmental changes but also because it requires collaboration among a variety of stakeholders. These include international corporations that own land, donors of climate adaptation efforts and citizens. The increasing interconnectedness between urban centres constitutes a new source of risk, according to the group. But this also provides potential opportunities adapting to the changes in a collaborative and complementary manner.

Risk reduction in coastal megacities is complex.

© iStockphoto.com/Pawel Gaul

Megacities and large urban agglomerations on the coast are important stressors on the coastal environment. But they are also susceptible to environmental change such as sea-level rise. The IGBP synthesis on megacities in the coastal zone addressed the problems unique to such urban areas by drawing on perspectives of both natural and social scientists.

OCEAN ACIDIFICATION: PRESENT BEATS PAST

The oceans may be acidifying faster today than at any time in the last 300 million years, according to research published in the journal *Science* last year. The results are based on a workshop organised by the Past Global Changes project. The workshop had its roots in an IGBP Fast-Track Initiative.

In a review of hundreds of paleoceanographic studies, the researchers found evidence for only one interval in the last 300 million years with similar changes to the ocean as today: the Paleocene-Eocene Thermal Maximum, or PETM. About 56 million years ago, a mysterious surge of carbon into the atmosphere warmed the planet and turned the oceans corrosive. The measure of ocean acidity – its pH – may have fallen as much as 0.45 units.

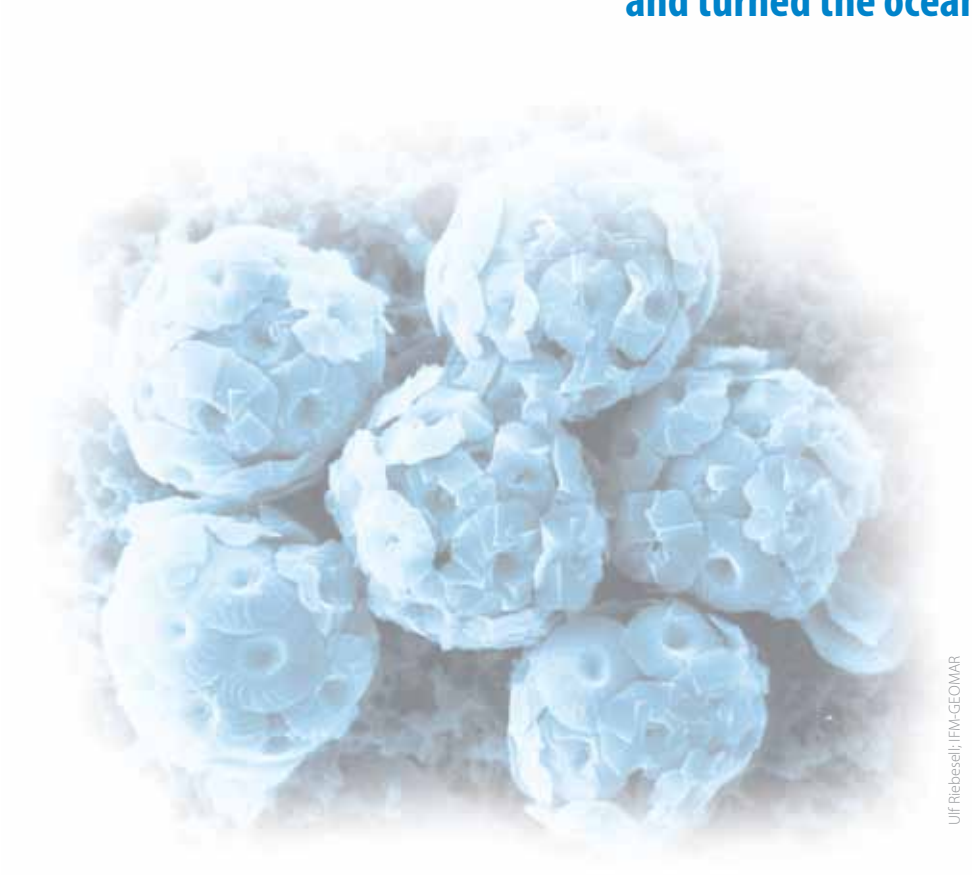
"The ocean acidification we're seeing today is unprecedented," said Candace Major, Program Officer in the National Science Foundation's (NSF) Division of Ocean Sciences, which funded the research. "Even when viewed through the lens of the past 300 million years."

In the last hundred years, rising carbon dioxide from human activities has lowered ocean pH by 0.1 units, but at an acidification rate at least ten times faster than 56 million years ago, says Bärbel Hönisch, the study's lead author. The IPCC predicts that pH will fall another 0.2 units by 2100, raising the possibility that we may soon see ocean changes similar to those observed during the PETM.

This work was one of the highlights from the PAGES project in 2012. The project also spent 2012 preparing for a major open science conference held in Goa, India in February 2013 entitled The Past: A Compass for Future Earth.

Hönisch B *et al.* (2012) *Science* 335: 1058-1063, doi: 10.1126/science.1208277.

A mysterious surge of carbon into the atmosphere warmed the planet and turned the oceans corrosive.



Ulf Riebesell; IFM-GEOMAR

The mean pH of the surface ocean today is 8.1, a decrease in hydrogen ion concentration of around 30% from the pre-industrial value. Ocean acidification in combination with warming and the loss of oceanic oxygen present significant challenges to marine organisms and ecosystems.

MARINE DINITROGEN FIXATION

Biological dinitrogen (N_2) fixation rates in the oceans may be almost twice the previous estimate, according to researchers associated with the Surface Ocean–Lower Atmosphere Study. This result, published in *Nature* last year, was based on the application of a new method to samples from the Atlantic Ocean.

Carbon is abundant in most parts of the ocean but biological productivity is limited by availability of nutrients such as nitrogen, phosphorus and iron. The dissolved N_2 in oceans is fixed and made bioavailable by marine microorganisms called diazotrophs. Although geological data suggest a balanced marine nitrogen inventory over the past three millennia, measurements have indicated that the loss of nitrogen exceeds fixation by approximately 200 Tg (teragrams) N yr^{-1}.

One reason for this contradictory information could be that the established method for measuring N_2 fixation underestimates the actual value considerably. A laboratory study had supported this possibility last year, but confirmation in open-ocean settings was lacking. To address this, the researchers compared rates of N_2 fixation in the Atlantic using both the established method and a new method. The established method relies on the introduction of the tracer $^{15}N_2$ in bubble form, the new method introduces the tracer as a dissolved gas.

The results confirmed that the established method greatly underestimated the fixation rates. Moreover, the magnitude of the underestimation varied regionally and could be related to the composition of the diazotrophic community.

If the findings of this study can be extrapolated to other ocean basins, the global marine N_2-fixation rate derived from direct measurements may increase from 103 ± 8 Tg N yr^{-1} to 177 ± 8 Tg N yr^{-1}.

Großkopf T *et al.* (2012) *Nature* 488: 361-364, doi: 10.1038/nature11338.

The results confirmed that the established method greatly underestimated the fixation rates.

T. Baustian; GEOMAR

Incubation chamber on RV *Polartstern*. Water samples collected from the Atlantic Ocean were prepared in this chamber for later measurements.

GLOBAL CARBON BUDGET

The Global Carbon Project's (GCP) annual analysis showed carbon dioxide emissions rose 3% in 2011.

From 2000 to 2011, emissions have grown at an average of 3.1% per year. Carbon dioxide emissions continue to track the high end of a range of emission pathways. The gap between current emission trends and the emission pathway required to keep the global-average temperature increase below 2°C is expanding.

"The continued economic troubles in the developed world have led to reduced emissions, but this is more than compensated by strong emissions growth in fast-growing economies such as China," said lead author Glen Peters of CICERO, a climate research institute in Norway. The study shows that global carbon emissions in 2011 were 54% above 1990 levels.

Developed countries have largely stabilised their emissions, and most of the growth occurs in emerging economies. Per capita emissions of the developed nations, however, remain far higher than those of most developing nations. Chinese emissions grew 10% in 2011, or over 800 million tonnes of carbon dioxide – as much as Germany emits in one year.

"I am worried that the risks of dangerous climate change are too high on our current emissions trajectory," said co-author Corinne Le Quéré, Director of the Tyndall Centre for Climate Change Research and Professor at the University of East Anglia.

"We must reverse the trends in emissions before 2020."

The research was based on the release of an extensive new dataset published simultaneously in *Nature Climate Change* and *Earth System Science Data Discussions*. The Global Carbon Project is an IGBP joint project with the other global environmental change programmes.

Peters G, *et al.* (2012) *Nature Climate Change* 3, 4-6 doi: 10.1038/nclimate1783

Le Quéré C *et al.* (2012) *Earth System Science Data Discussions* doi: 10.5194/essdd-5-1107-2012.

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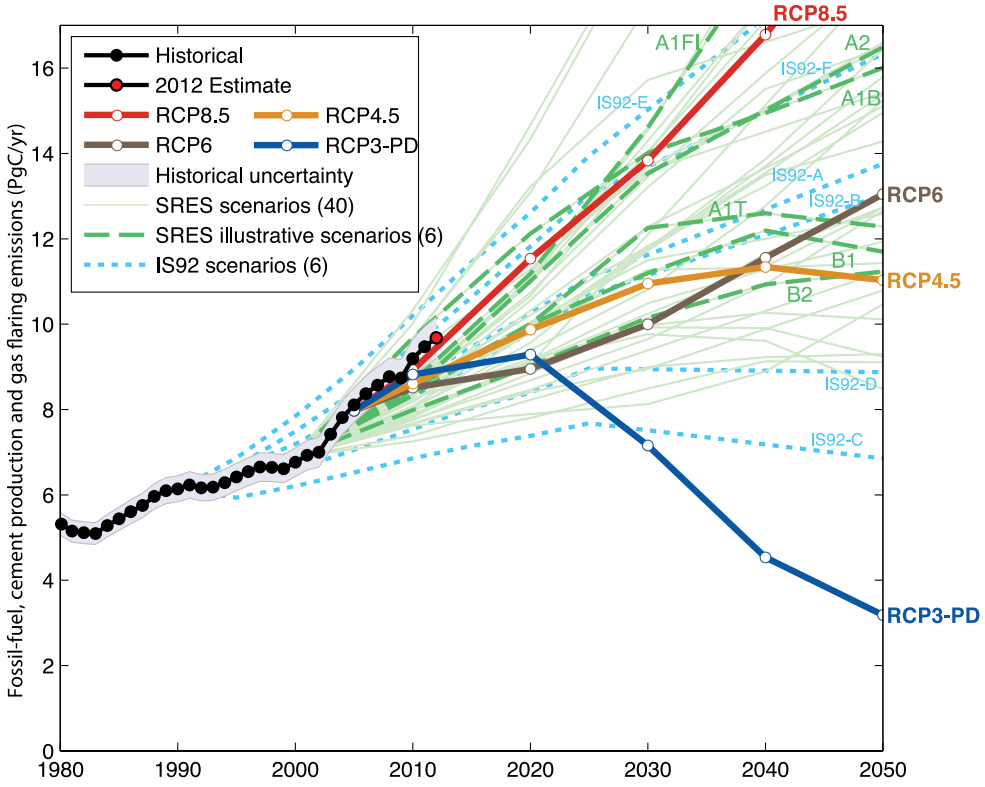


Estimated CO_2 emissions over the past three decades compared with various emissions pathways. Actual emissions (black dotted line) are now above the highest emissions pathway (RCP8.5) from the recently developed Representative Concentration Pathways used in the forthcoming Intergovernmental Panel on Climate Change's *Fifth Assessment Report*.

NITROGEN MANAGEMENT IN THE EARTH SYSTEM

A report from the IGBP-sponsored International Nitrogen Initiative, *Our Nutrient World*, highlighted the global scale of how humans are altering the natural flows of nitrogen, phosphorus and other nutrients. While these alterations have had huge benefits for world food and energy production, it has caused a web of water and air pollution that is damaging human health, causing toxic algal blooms, killing fish, threatening sensitive ecosystems and contributing to climate change.

The study was carried out by nearly 50 experts from 14 countries. The scientists suggest that a 20% improvement in nutrient-use efficiency by 2020 would reduce the annual use of nitrogen fertiliser by 20 million tonnes. They call this global aspirational goal "20:20 for 2020". Their analysis shows how this could provide a net saving worth around 170 (46 to 400) billion US dollars per year. This figure includes implementation costs and financial benefits from reduced nitrogen use and improvements to the environment and human health.

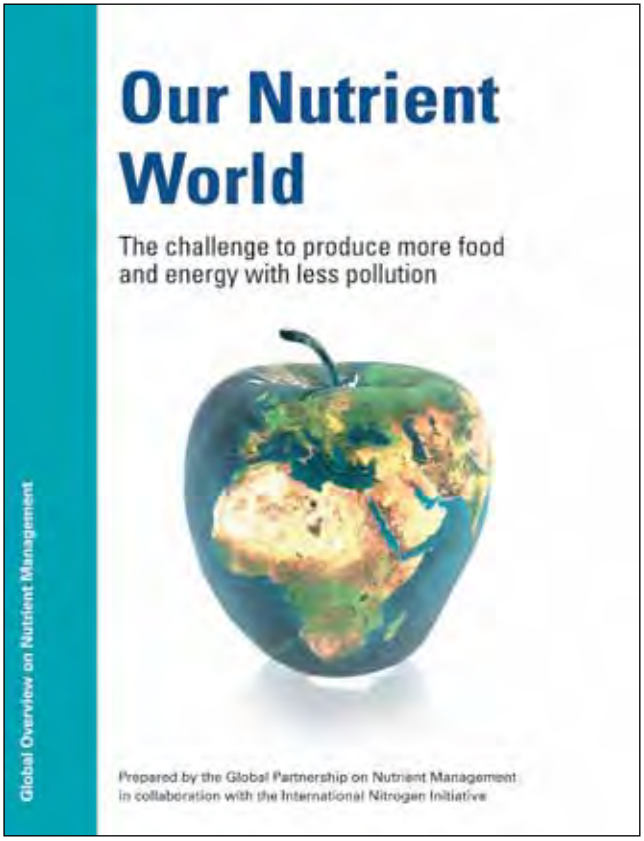
The report stops short of recommending global legislation to control nutrient use, but recognises that this is a global problem, especially given the global trade in agricultural products. It calls for an intergovernmental framework to address these issues.

Pollution sources considered in the report include emissions from agriculture and combustion of fossil fuels. Globally around 80% of harvested nitrogen and phosphorus is consumed by livestock rather than directly by people, showing how global nutrient supply and pollution are dominated by humans' choice to consume animal products.

The report proposes a package of ten key actions to reduce these pollution threats, and makes recommendations for shared action by governments, business and citizens.

This global overview on nutrient management was commissioned by the United Nations Environment Programme (UNEP) and conducted by the Global Partnership on Nutrient Management (GPNM) and the International Nitrogen Initiative (INI), under the lead of the UK's Centre for Ecology & Hydrology.

The study was carried out by nearly 50 experts from 14 countries.



Commissioned by the United Nations Environment Programme, the new report *Our Nutrient World: The challenge to produce more food and energy with less pollution* was produced by the Global Partnership on Nutrient Management in collaboration with the International Nitrogen Initiative, an IGBP-sponsored initiative. The report was published by the UK's Centre for Ecology & Hydrology.

SUSTAINABLE URBANISATION MUST LOOK BEYOND CITY LIMITS

City leaders aspiring to transform their cities into models of sustainability must look beyond city limits. They need to include in their calculation the global flow of goods and materials into their realm, according to a paper published in *AMBIO* in December 2012 following a three-day planetary stewardship workshop, organised by the IGBP Secretariat in partnership with others in 2011.

Many cities are now developing sustainability strategies to reduce pollution and congestion, improve the quality of life of their citizens and respond to growing concerns about human impacts on the climate and environment. But such initiatives often ignore the environmental footprint from imported goods and services such as food, water and energy to cities: sustainability, it seems, stops at the city limits.

The paper argues for broadening the concept of urban sustainability to account for the global flow of goods and materials into urban areas. Because urban areas drive much of the global changes we see, whether in energy use, food supply, resource depletion or land-use change, looking at the sustainability of individual cities is of limited value. The team proposes that cities analyse how resources consumed within a city are sourced, produced and transported from distant places.

Furthermore, given the world is urbanising rapidly – over 50% of the global population lives in urban areas – societies must consider the combined impacts of cities globally. One solution could be to view sustainable urbanisation from the perspective of a system of cities. The benefits of an approach of this kind could be twofold, contributing to "planetary stewardship" whilst providing long-term resource security for cities. But the authors suggest this must be done in collaboration with the areas where the resources are sourced.

Seitzinger S P *et al.* (2012) *AMBIO* 41(8): 787-94, doi: 10.1007/s13280-012-0353-7.

The paper argues for broadening the concept of urban sustainability.

Over half the human population now live in cities. The concept of sustainable cities is gaining momentum among city planners, but urban sustainability must account for the global flow of goods and materials into urban areas argue researchers at a workshop on planetary stewardship organised by IGBP and partners. A key recommendation is that cities analyse how resources consumed within a city are sourced, produced and transported.

OCEANS IN A HIGH-CO_2 WORLD

The Third Symposium on the Ocean in a High-CO_2 World, held in Monterey, September 2012, attracted a record number of participants: 540 people from 37 countries. Numbers were about double the previous symposium illustrating how rapidly this field is expanding. Women made up about 40% of the speakers and social scientists too joined in force. This symposium marked a surge in interest in the social and economic dimensions of ocean acidification.

The overarching message from the conference was that the world's oceans are under stress from a combination of factors including acidification, warming, the loss of oceanic oxygen and overfishing. These present significant challenges to marine ecosystems. Within decades the chemistry of the tropical oceans may hamper or prevent coral reef growth while large parts of the polar oceans will become corrosive to calcareous marine organisms.

Many organisms already show adverse effects, for example, reduced ability to form shells, shifts in microbial species composition, reduced egg production in zooplankton, delayed larval development and abnormal flight behaviour in fish. However, there is evidence that some organisms can adapt to or even thrive in conditions of increased ocean acidity.

The three-day symposium, convened by IGBP, the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission, was followed by a policy day involving Prince Albert of Monaco, NOAA's former chief Jane Lubchenco, a Californian congressman Sam Farr and the shellfish industry. This event was co-sponsored by Google.

IGBP worked with a US organisation COMPASS to develop a media engagement strategy for the conference. Over 30 journalists attended from *The Guardian*, *The Washington Post*, *Science*, *Nature*, *New Scientist*, *The Los Angeles Times* and other outlets. The conference generated over 50 stories in a range of media.

The plenary sessions of the conference were streamed live and have had over 2000 views.

The world's oceans are under stress from a combination of factors.

Blue Ocean Film Festival/ Daniel Fox

The Ocean in a High-CO_2 World symposium high-level policy day: Dan Laffoley, Sylvia Erle, Prince Albert II of Monaco, Haley Jackson, Jane Lubchenco and Richard Vevers.

PLANET UNDER PRESSURE

The Planet Under Pressure conference (London, 26-29 March 2012) was the largest and most ambitious engagement effort in IGBP's 25-year history. The IGBP Secretariat coordinated the management and delivery of the conference in partnership with the other global-change programmes and ICSU.

The four-day conference was designed to build and strengthen the global-change research community, in particular to form closer links between natural and social sciences. It helped spearhead a new direction for international research focusing on global sustainability. There was a strong emphasis on reaching out to a broader community – the development community, policy, industry, media and the general public. Furthermore, the Planet Under Pressure conference was timed to contribute to the UN's Rio+20 conference, the largest such event in UN history. The UN recognised Planet Under Pressure as part of the official preparations for Rio+20.

Outcomes:

- 3000 delegates from 107 countries.
- Launch of the new Future Earth initiative.
- Publication of the first State of the Planet Declaration.
- High-level policy day introduced by UN Secretary-General Ban Ki-moon via video.
- Special issue of the journal *Current Opinion in Environmental Sustainability* and the production of nine policy briefs on global sustainability for the UN's Rio+20 summit.
- 400+ articles in the mainstream media including *The New York Times*, Forbes, *The Denver Post*, *The Chicago Tribune*, the BBC, *The Financial Times* and *The International Herald Tribune*.
- Major editorials in high-profile scientific journals such as *Nature* and *Science*.
- 150+ public events globally organised with the Association of Science and Technology Centers – a first for this type of global coordination.
- Live streaming of the entire plenary.
- Daily news show (the *Daily Planet*, hosted by leading UK journalist Julian Rush).
- Social media: allowing questions in plenary from Twitter (the conference reached around one million people via Twitter and at times was a "trending topic" on Twitter); building a Facebook following in excess of 2500.
- Launch of the first website on the Anthropocene and the first major data visualisation on the Anthropocene.

Planet Under Pressure helped spearhead a new direction for international research focusing on global sustainability.

Courtesy of Planet Under Pressure 2012; Philip Wade Photography.

Planet Under Pressure co-chairs Lidia Brito (UNESCO) and Mark Stafford Smith (CSIRO).

FUTURE EARTH

The development of the Future Earth initiative is the most significant change in over a decade for the global environmental change (GEC) programmes. Spearheaded by an alliance of international partners, the initiative aims to bring together the social and natural sciences around a common research agenda focusing on global sustainability.

The impact on the GEC programmes, including IGBP, will be significant. IGBP, DIVERSITAS and the International Human Dimensions Programme on Global Environmental Change will merge. The World Climate Research Programme, while retaining its identity, will participate fully. All existing IGBP projects have been invited to join Future Earth.

IGBP is working closely with the alliance* to ensure a smooth transition, including nominating members for the first Future Earth Scientific Committee. IGBP has contributed to the development of regional workshops in Latin America, Africa, Asia, North America and Europe, and proposed members of the IGBP community from national committees and projects. In addition IGBP helped co-develop a 2012 workshop, held in Paris, for the projects within the GEC programmes and, in January 2013, IGBP's leadership met with the alliance and other GEC programmes to discuss Future Earth.

Throughout 2012, the Future Earth transition team, which included representation from the GEC programmes as observers, developed a final report that was published in 2013. The report outlines the proposed research and organisational structure of the new initiative. A Scientific Committee and interim director will be appointed in 2013.

To facilitate the switch to Future Earth, the Earth System Science Partnership, which coordinates joint projects for the GEC programmes, dissolved in December 2012. Existing joint projects are now coordinated directly by the GEC programmes. At IGBP's 25th Officers' meeting in Canberra in 2012, it was proposed that IGBP should officially close in December 2015, which was unanimously agreed by IGBP's officers. This proposal was then approved at IGBP's 28th Scientific Committee meeting in Bern, 2013. The 2015 closure date will allow time for a coordinated transition to Future Earth.

*** The Future Earth alliance is made up of:**

- International Council for Science (ICSU)
- International Social Science Council (ISSC)
- Belmont Forum (a high-level group of major research funders)
- UN Educational, Scientific and Cultural Organization (UNESCO)
- UN Environment Programme (UNEP)
- UN University (UNU)
- World Meteorological Organization (WMO) as an observer.

In January 2013, IGBP's leadership met with the alliance and other GEC programmes to discuss Future Earth.

ICSUnews./Joan Roels Conesa.

The final Future Earth transition team meeting was held in Paris, September 2012.

COMMUNICATIONS

IGBP's flagship product, the *Global Change* magazine, continues to be published twice a year and distributed to over 5000 researchers and stakeholders. In 2012, subjects covered included the Anthropocene, urbanisation and global resource use. IGBP's regional office in Brazil distributes the magazine to the IGBP community in developing countries.

IGBP's relaunched website, which boasts more multimedia, more news and more features, has seen its audience grow by more than 60%. Our Facebook presence is growing rapidly. Our Global Change and Planet Under Pressure accounts have a combined community of over 3800 people.

Use of Twitter, the online networking tool that limits input to just 140 characters per "tweet", is exploding in the scientific community. Several major conferences and symposia, including Planet Under Pressure and the Ocean in a High CO_2 World symposium, were enriched by rapid-fire online debate, discussion and dissemination of information to the wider world. The Planet Under Pressure conference was one of the leading discussion topics worldwide on Twitter during the event.

Our internal communications have been bolstered by the launch of a new director's report to our community outlining activities of the secretariat. In addition, we have updated and revamped the regular email bulletin.

The communications team is working closely with Future Earth to develop a strong engagement strategy to ensure the new initiative delivers on its vision and engages the IGBP community more closely.

The communications team is working closely with Future Earth.

IGBP produces the *Global Change* magazine twice a year as well as many other products.

WELCOME TO THE ANTHROPOCENE

In 2012, IGBP and partners launched the world's first website dedicated to the concept of the Anthropocene at the Planet Under Pressure conference.

The website uses state-of-the-art graphics and visualisations to take the viewer on a tour of humanity's impact on the planet. The site has been a huge hit, with articles in mainstream media such as *The New York Times*, *The Atlantic* and *Time* magazine.

The centrepiece of the site is a three-minute data visualisation, which takes the viewer on a crash course in global sustainability based on IGBP's first synthesis and the so-called "Great Acceleration" in human activity.

The film has had around 850,000 views worldwide and was used to open the United Nations Rio+20 Summit, the UN's largest meeting to date. It was introduced by UN Secretary-General Ban Ki-moon to 188 heads of state and ministers.

State-of-the art graphics take the viewer on a tour of humanity's impact on the planet.

Anthropocene.info is the first dedicated website about the concept of the Anthropocene. It was developed by a partnership of IGBP, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), GLOBIA and the Stockholm Resilience Centre for the Planet Under Pressure conference in March 2012.

THE STOCKHOLM SEMINARS: BUILDING LINKS WITH SWEDEN

The Stockholm Seminars, held regularly throughout the year at IGBP's host, the Royal Swedish Academy of Sciences, cover a broad range of perspectives on sustainability issues. The seminars are organised by Albaeco, IGBP, Stockholm Resilience Centre, the Beijer Institute of Ecological Economics, Stockholm Environment Institute and the Swedish Secretariat for Environmental Earth System Sciences (SSEESS).

Speakers:

Tim Lynam. Making sense of climate change and adaptation

Karine Nyborg. The ethics and politics of environmental cost-benefit analysis

Henrik Österblom. Tipping points and why seabirds depend on access to one third of the world's fish

Oran Young. The effectiveness of international regimes: research opportunities

John Ingram. Food security and planetary boundaries

Jean-Marc Jancovici. Going carbon-free, a mere joke?

Mark Swilling. Is a just transition possible? – A southern perspective on the global polycrisis and what happens next

Rolph Payet. Climate change and sea-level rise: can we adapt?

John Tanzer. Institutional entrepreneurs and the emergence of international institutions for ecosystem stewardship

Robert Costanza. Solutions for a sustainable and desirable future

Steve Lansing. Did a butterfly effect change the history of the Pacific?

Marianne Krasny. Civic ecology: social-ecological innovations in human-nature connections in cities

François Bouquet. Collective action and conservation of identities

Scott Barrett. Climate negotiations and approaching catastrophes

Villy Christensen. Ecological networks – from who did it to future food webs

Cindi Katz. Resilience in a social field – response to transition

Anantha Duraiappah. Inclusive Wealth Report: transition to sustainability

Charles Hall. Improving real productivity: from labour productivity to multidimensional measure of productivity

Lance Gunderson. The nature of change and the change of nature: obstacles and opportunities for building adaptive capacity

Brigitte Baptiste. Questions and challenges for the governance of biodiversity and ecosystem services in Colombia

The Stockholm Seminars cover a broad range of perspectives on sustainability issues.

Jerker Lokrantz/Azote.se

IGBP co-sponsors the Stockholm Seminars, which are held at the Royal Swedish Academy of Sciences. The seminars are one example of several IGBP activities in Sweden.

POLICY ENGAGEMENT

Inputs to international assessments and advisory bodies

Intergovernmental Panel on Climate Change

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.

Over 70 individuals from the IGBP community have been appointed as lead authors, coordinating lead authors, or review editors of the forthcoming Fifth Assessment Report.

UNFCCC's Subsidiary Body for Scientific and Technological Advice

A key event in IGBP's diary is to provide updates on the latest climate-related research to the UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA). IGBP prepares reports and presentations to SBSTA that focus on policy-relevant science.

Recent inputs have focused on climate and the oceans, for example, IGBP has provided crucial updates on issues related to ocean acidification and the oceans as a sink for carbon dioxide.

Rio+20

The Planet Under Pressure conference was acknowledged by the UN as the major scientific conference in support of the Rio+20 summit. Several bridges were built between the two events. The high-level policy day at Planet Under Pressure began with a video introduction by Ban Ki-moon, the UN Secretary-General. The science conference held the first science-policy dialogue on proposed sustainable development goals. Furthermore, Planet Under Pressure produced a suite of nine policy briefs and the State of the Planet Declaration, which were presented at events in Rio.

Future Earth, the new ten-year research initiative, was launched for the science community at Planet Under Pressure and to a broader group of stakeholders at the Rio summit.

In addition, the International Council for Science (ICSU) developed a week-long science and technology forum in Rio. This event was strategically developed with former IGBP Chair Carlos Nobre and involved several IGBP scientists including Mercedes Bustamante and Togtokhyn Chuluun.

Furthermore, IGBP is acknowledged in Ban Ki-moon's high-level panel on global sustainability report, *Resilient People, Resilient Planet*.

Ocean in a High CO_2 World

IGBP's Owen Gaffney and IUCN's Dan Laffoley organised the policy day of the international ocean acidification symposium, sponsored by IGBP and partners including Google. The event involved HSH Prince Albert of Monaco, NOAA's former chief Jane Lubchenco, Californian congressman Sam Farr and the shellfish industry. Google launched the Google Earth ocean acidification animation produced by Gaffney and Laffoley and the XPRIZE announced a major prize for ocean acidification technology.

Recent inputs have focused on climate and the oceans.

ICSUnews

The UN's Rio+20 summit hosted a science and technology forum co-sponsored by the International Council for Science. Many IGBP scientists including Chuluun Toghtokh, Vice-Chair of the Mongolian National Committee, spoke at the event.

Business and industry

Partnerships among academia, business and industry are increasingly seen as integral to achieving sustainability. The Planet Under Pressure event attempted to bring these sectors together through a series of participatory sessions.

In 2012, IGBP ran a "World Café"-style workshop focusing on links to the private sector at its annual Scientific Committee meeting. IGBP is now building on the insights gained from these sessions to explore increased engagement with the private sector. A series of recommendations were presented last year to the Future Earth initiative.

In October 2012, IGBP's director Sybil Seitzinger and Jae Edmonds from the AIMES Scientific Steering Committee led a round-table discussion at the Corporate Responsibility Officers Association meeting – a major business event in New York. The focus of the discussion was on how businesses can use integrated assessment models in planning and decision-making.

A short movie on the Anthropocene, co-produced by IGBP, was screened to 300 partners of Ernst & Young and at several other business-related events worldwide during the past year.

In addition, IGBP has attended several meetings organised by the World Business Council for Sustainable Development and the Stockholm Resilience Centre to begin developing realistic sustainability targets for industry.

IGBP ran a "World Café"-style workshop focusing on links to industry.

Courtesy of Planet Under Pressure 2012; Kim Davis

Links with the private sector were explored at a participatory session that IGBP organised at the Planet Under Pressure conference. This unconventional format led to much brainstorming and concrete recommendations for engagement.

PARTNERSHIPS

Global environmental change programmes

The International Council for Science (ICSU) co-sponsors four global-environmental-change (GEC) programmes: IGBP, DIVERSITAS, the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP). The programmes collaborate on many fronts and coordinate several activities under the umbrella of the Earth System Science Partnership (ESSP). ESSP officially dissolved in December 2012 in anticipation of the start of the new Future Earth initiative, but the GEC programmes continue their close collaboration with joint projects now directly beneath the GEC umbrella.

Co-sponsors of IGBP projects

- 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

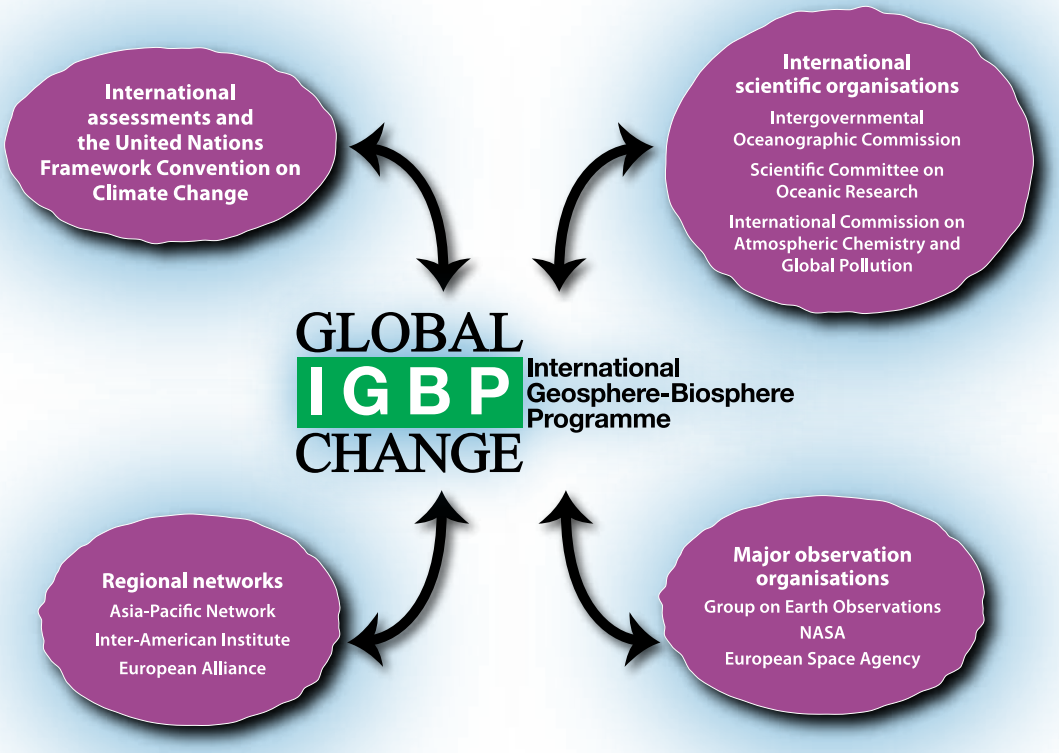
- Monsoon Asia Integrated Regional Study (MAIRS)
- African Monsoon Multidisciplinary Analysis (AMMA)
- Asia-Pacific Network for Global Change Research (APN)
- Inter-American Institute for Global Change Research (IAI)
- Global Change System for Analysis, Research and Training (START)

Monitoring, measuring and Earth observation

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 has co-sponsored two recent workshops: *Earth observation in support of research for Millennium Development Goals and sustainability* in September 2012, with the Global Earth Observation System of Systems; and *Observation needs for adaptation* with the Global Climate Observing System in February 2013.

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



IGBP works closely with the United Nations through the UN's assessment processes, other international scientific organisations, major observation organisations and regional networks.

National Committees and the Brazil Regional Office

IGBP's 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.

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.

IGBP nominated experts from national committees to attend Future Earth regional workshops. We are currently involved in communicating feedback from national committees to the Future Earth transition team, for example, through commissioning reports from the Swedish and Swiss national committees on opportunities within Future Earth.

Selected highlights

In March 2012, the European Alliance of Global Environmental Change national committees hosted an international "national committees" day immediately following the Planet Under Pressure conference (30 March) in London. The meeting provided a platform to discuss the new Future Earth initiative and the role of national committees.

In November 2012, IGBP's Australian national committee hosted the Ticking Time Bombs in the Earth System conference, the second Australian Earth-system outlook conference. The two-day event focused on four themes: the mismatch between scientific evidence relating to climate and policy responses; polar de-glaciation and sea-level rise; multiple stressors on the Great Barrier Reef; and food security. It attracted Australia's leading scientists, as well as policymakers and industry.

The conference, hosted at the Australian Academy of Science, coincided with IGBP's Officers meeting – the executive committee of IGBP. IGBP Chair James Syvitski and Executive Director Sybil Seitzinger both spoke at the symposium, highlighting the work of the IGBP projects.

Other national committee highlights include the Swiss national committee, ProClim, which organises an annual Global Change one-day symposium that attracts researchers, policymakers and the media.

Furthermore, the Brazilian regional office developed a workshop to build capacity in ocean acidification research in developing countries. The national committee of Cameroon is contributing to the development of Cameroon's climate adaptation plan based on IPCC climate scenarios. The committee has also been requested by the government to propose how schools can introduce climate change into their curriculum.

Finally, the vice-chair of Mongolia's national committee has been appointed to oversee the creation of Mongolia's green development strategy. And the Polish national committee regularly publishes a journal *Papers on Global Change*.

In November 2012, IGBP's Australian national committee hosted the Ticking Time Bombs in the Earth System conference.

Australian chief scientist Professor Ian Chubb speaking at the Ticking Time Bombs in the Earth System conference in Canberra, November 2012, organised by the Australian national committee.

National Committees and Regional Alliances

IGBP has 51 national committees across Africa, the Americas, Asia-Pacific, Europe and the Middle East (as per the latest audit completed in April 2013). Some of these committees are global-change committees that also represent partner programmes. IGBP also has a regional office in Brazil located at the Instituto Nacional de Pesquisas Espaciais (INPE).

IGBP national committees listed by region

Africa

Botswana
Cameroon
Congo, Democratic Republic of
Ivory Coast
Kenya
Morocco
Mozambique
South Africa
Zimbabwe

Americas

Argentina
Bolivia
Brazil
Colombia
United States*

*Through the US National Academies

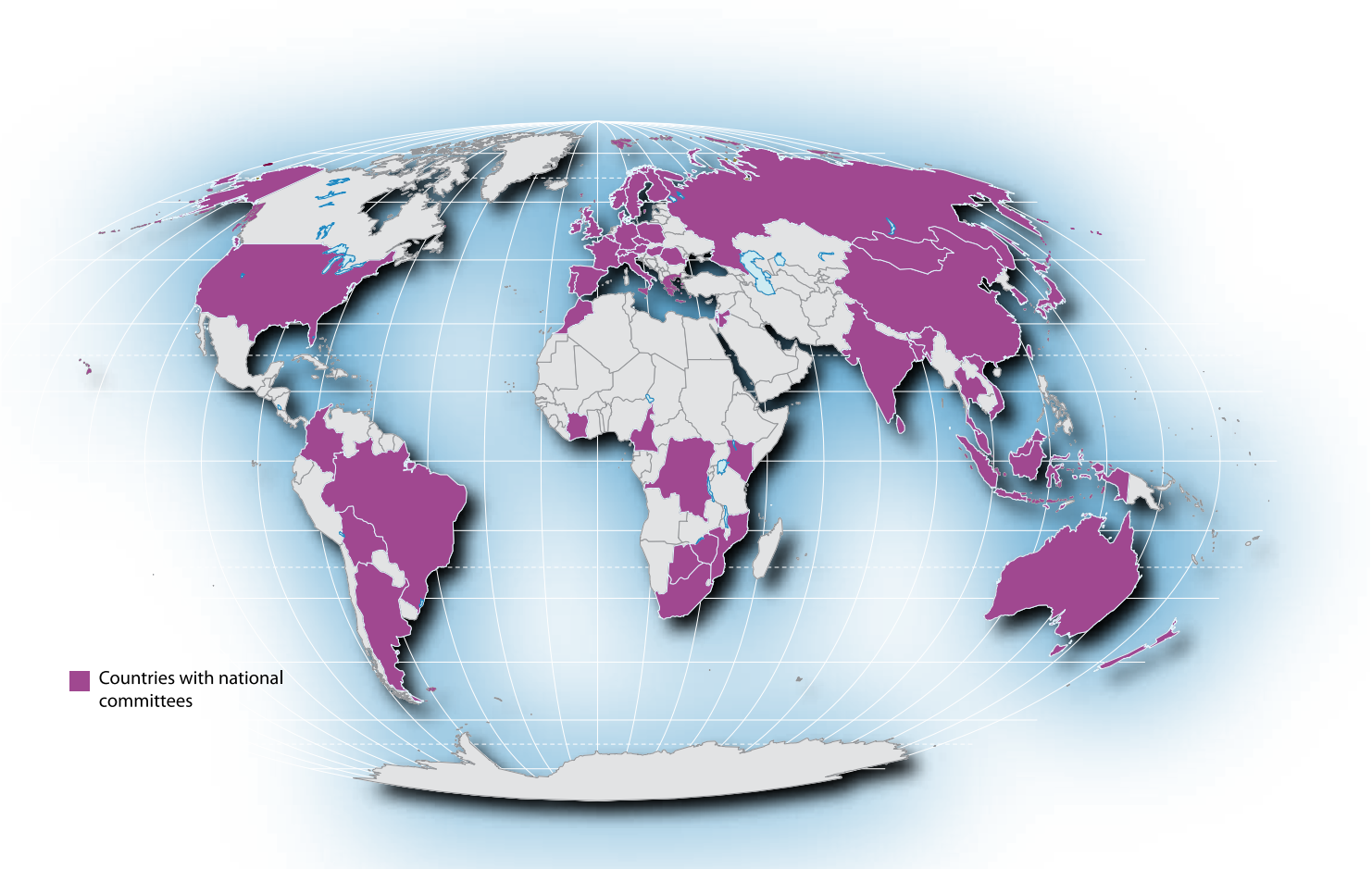
Asia-Pacific and the Middle East

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

Europe

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

National Committees



IGBP has 51 national committees around the globe.

IGBP Scientific Committee (2012)

ICSU-appointed members

James P M Syvitski (Chair)
University of Colorado
UNITED STATES

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

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

Jean Palutikof (Vice-chair)
Griffith University
AUSTRALIA

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

Martin Claussen
Max Planck Institute for Meteorology
GERMANY

Christiane Lancelot
Université Libre de Bruxelles
BELGIUM

Patricia A Matrai
Bigelow Laboratory for Ocean Sciences
UNITED STATES

Cheikh Mbow
Université Cheikh Anta Diop de Dakar-Senegal
SENEGAL

Dahe Qin
China Meteorological Administration
CHINA

S K Satheesh
Indian Institute of Science
INDIA

Mitsuo Uematsu
The University of Tokyo
JAPAN

Project chairs and co-chairs

Peter Cox (Co-chair AIMES)
University of Exeter
UK

Hubertus Fischer (Co-chair PAGES)
University of Bern
SWITZERLAND

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

Alan C Mix (Co-chair PAGES)
Oregon State University
College of Oceanic and Atmospheric Sciences
UNITED STATES

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

Ramesh Ramachandran (Chair LOICZ)
Anna University
Institute for Ocean Management
INDIA

Eric Saltzman (Chair SOLAS)
University of California at Irvine
UNITED STATES

Peter Vierburg (Chair GLP)
VU University Amsterdam
Institute of Environmental Studies
NETHERLANDS

Tong Zhu (Co-chair IGAC)
Peking University
CHINA

International partner chairs

Antonio J Busalacchi (WCRP)
University of Maryland
UNITED STATES

Georgina Mace (DIVERSITAS)
Imperial College
NERC Center for Population Biology
UK

Partha Dasgupta (IHDP)
University of Cambridge
UK

Rik Leemans (ESSP)
Wageningen University
NETHERLANDS

IGBP Project Offices

Core projects

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

Currently no international project office

Global Land Project (GLP)

Executive Officer: Giovana Espindola

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

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

Executive Officer: Bernard Avril

Executive Officer: Lisa Maddison (until June 2012)

International Project Office:
Institute of Marine Research
Bergen, Norway (from April 2012)

Institut Universitaire Européen de la Mer
Brest, France (until April 2012)
Node:
Shanghai, China

International Global Atmospheric Chemistry (IGAC)

Executive Officer: Megan Melamed

International Project Office:
University of Colorado, CIRES
Boulder, Colorado USA

Integrated Land Ecosystem–Atmosphere Processes Study (iLEAPS)

Executive Officer: Tanja Suni

International Project Office:
University of Helsinki
Helsinki, Finland
Nodes:
Tsukuba, Japan; Nanjing, China

Land–Ocean Interactions in the Coastal Zone (LOICZ)

Executive Officer: Hartwig Kremer

International Project Office:
Institute for Coastal Research, Helmholtz-Zentrum
Geesthacht, Germany
Nodes:
Rio de Janeiro, Brazil; 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 (until May 2012)

International Project Office:
GEOMAR Helmholtz-Centre for Ocean Research
Kiel, Germany
Node:
Norwich, UK (closed in 2012)

Joint projects

Global Carbon Project (GCP)

Executive Directors: Josep (Pep) Canadell; Shobhakar Dhakal

International Project offices:
CSIRO Marine and Atmospheric Research
Canberra, Australia

Asian Institute of Technology,
School of Environment Resources and Development,
Pathumthani, Thailand

Global Water System Project (GWSP)

Executive Officer: Anik Bhaduri

International Project Office:
University of Bonn
Bonn, Germany

Climate Change, Agriculture and Food Security (CCAFS)

Program Director: Bruce Campbell

CCAFS Coordinating Unit:
University of Copenhagen
Frederiksberg C, Denmark

National Committee Chairs/Contacts

Africa

BOTSWANA
Opha Pauline Dube
University of Botswana

CAMEROON
Maurice Tsalefac
University of Yaoundé

CONGO, DEMOCRATIC REPUBLIC OF
Nsalambi Nkongolo
Lincoln University of Missouri
United States

IVORY COAST
Abdourahamane Konaré
University of Cocody

KENYA
Raphael M Munavu
Kenya National Academy of Sciences

MOROCCO
Mohammed Saïd Karrouk
Hassan II University

MOZAMBIQUE
Patricio Sande
Scientific Research Association of Mozambique

SOUTH AFRICA
Guy Midgley
National Botanical Institute

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

UNITED STATES
Laurie Geller (contact)
National Academy of Sciences

Asia-Pacific and the Middle East

AUSTRALIA
Roger Gifford
Australian Commonwealth Scientific and Research Organisation

BANGLADESH
Mesbahuddin Ahmad
Bangladesh Academy of Sciences

CHINA: BEIJING
Zhongli Ding
Chinese Academy of Sciences

CHINA: TAIPEI
Chen-Tung Arthur Chen
National Sun Yat-sen University

INDIA
S K Satheesh
Indian Institute of Science

INDONESIA
Bambang S Tejasukmana
National Aeronautical and Aerospace Agency

ISRAEL
Dan Yakir
Weizmann Institute of Science, Tel Aviv University

JAPAN
Tetsuzo Yasunari
Nagoya University

JORDAN
Dia-Eddin Arafah (Co-chair)
University of Jordan
Tareq Hussein (Co-chair)
University of Jordan

KOREA
Chae-Shik Rho (Chair)
The National Academy of Sciences

MALASIA
Ahmad Ibrahim
Academy of Sciences Malaysia (ASM)

MONGOLIA
Togtohyn Chuluun (Contact)
National University of Mongolia

NATIONAL COMMITTEE CHAIRS/CONTACTS (CONT.)

NEW ZEALAND
Julie Hall
National Institute of Water & Atmospheric Research

SINGAPORE
Karina Gin
Nanyang Technological University

SRI LANKA
Janaka Ratnasiri
Sri Lanka Association for the Advancement of Science

THAILAND
Kasem Chan Kaew
Kasetsart University

VIETNAM
Dao Trong Thi
Vietnam National University

Europe

AUSTRIA
Georg Grabherr
University of Vienna

BELGIUM
Philippe Bourdeau (Co-chair)
The Free University of Brussels
Oscar Vanderborght (Co-chair)
Royal Belgian Academy of Sciences

CZECH REPUBLIC
Ondrej Prasil
Academy of Sciences of the Czech Republic

DENMARK
Kim Pilegaard
Technical University of Denmark
Department of Chemical and Biochemical Engineering

FINLAND
Tuula Tuhkanen (Chair)
Tampere University of Technology
Sanna Pynnönen (Contact)
Tampere University of Technology

FRANCE
Hervé Le Treut
Laboratory of Dynamic Meteorology

GERMANY
Martin Visbeck
GEOMAR, Kiel

GREECE
George Contopoulos
Research Center of Astronomy, Academy of Athens

HUNGARY
Attila Borhidi
University of Pécs, Biological Institute

IRELAND
J Ray Bates
University College Dublin

ITALY
Sandro Fuzzi (contact)
National Research Council

NORWAY
Anne Lyche Solheim
Norwegian Institute for Water Research (NIVA)

POLAND
Andrzej Kedziora
Polish Academy of Sciences

PORTUGAL
Nelson Lourenço
Atlântica University

ROMANIA
Dan Balteanu
Institute of Geography, Romanian Academy

RUSSIAN FEDERATION
Evgeny A Vaganov
Russian Academy of Sciences

SPAIN
Fernando Valladares
Spanish National Research Council (CSIC)

SWEDEN
Dan Wilhelmsson (contact)
Swedish Secretariat for Environmental Earth System Sciences

SWITZERLAND
Ulrike Lohmann
Institute for Atmosphere and Climate

UNITED KINGDOM
Paul Monks
University of Leicester

IGBP Secretariat

The Royal Swedish Academy of Sciences
Box 50005, SE-104 05, Stockholm, Sweden
Tel: +46-8 166448

Ninad Bondre	Senior Science Editor
Britta Boström	Finance Coordinator
Wendy Broadgate	Deputy Director, Natural Sciences
Hilarie Cutler	Graphic Designer
Reed Evans	Science-policy Manager (until July 2012)
Owen Gaffney	Director of Communications
João M F de Morais	Deputy Director, Social Sciences (until September 2012)
Sri Sahlin	Administrative Assistant
Sybil Seitzinger	Executive Director
Karen Smyth	Science-policy Project Manager and acting Deputy Director, Social Sciences
Charlotte Wilson-Boss	Office Manager

Brazil Regional Office

IGBP Regional Support Office in Brazil
Instituto Nacional de Pesquisas Espaciais (INPE)
Avenida dos Astronautas,
1758 - Jd. Granja
São José dos Campos, Sp 12227-010, Brazil
Tel: +55-12 3208 7338

Patricia Pinho	Science Officer
Ana Amélia Kobayashi	Assistant

PUBLICATIONS

A selection of the top 10-15 scientific publications from core projects and fast-track initiatives published in 2012, or in some cases early 2013.

IGBP

Brito, L (2012) Analyzing sustainable development goals. *Science* 336 (6087), 1396, doi: 10.1126/science.1224531.

Nobre, C (2012) UNsustainable? *Science* 336 (6087), 1361, doi: 10.1126/science.1225343.

Seitzinger, S P *et al.* (2012) Planetary stewardship in an urbanizing world: beyond city limits. *AMBIO*, 41 (8), 787-794, doi: 10.1007/s13280-012-0353-7.

Stafford Smith, M (2012) Change the approach to sustainable development. *Nature* 483 (7390), 375, doi: 10.1038/483375a.

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.

Coordination of nine policy briefs for the 2012 UN Conference on Sustainable Development, Rio+20, with international partners:

- Water security for a planet under pressure.
- Food security for a planet under pressure.
- Biodiversity and ecosystems for a planet under pressure.
- Transforming governance and institutions for a planet under pressure.
- Interconnected risks and solutions for a planet under pressure.
- Human well-being for a planet under pressure.
- An energy vision for a planet under pressure.
- Global health for a planet under pressure.
- A green economy for a planet under pressure.

Analysis, Integration and Modelling of the Earth System

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International Global Atmospheric Chemistry

Dameris M, Spracklen D and Tost H, eds (2012) The Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). Special Issue jointly organized between *Atmospheric Chemistry and Physics* and *Geoscientific Model Development*

Mahajan A S, Gómez Martín J C, Hay T D, Royer S-J, Yvon-Lewis S, Liu Y, Hu L, Prados-Roman C, Ordóñez C, Plane J M C and Saiz-Lopez A (2012) Latitudinal distribution of reactive iodine in the Eastern Pacific and its link to open ocean sources. *Atmospheric Chemistry and Physics*, 12, 11609-11617, doi:10.5194/acp-12-11609-2012, 2012.

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Surface Ocean–Lower Atmosphere Study

Boyd P W, Arrigo K R, Strzepek R and van Dijken G L (2012) Mapping phytoplankton iron utilization: insights into Southern Ocean supply mechanisms. *Journal of Geophysical Research: Oceans* 117 (C6), doi: 10.1029/2011JC007726.

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Russell L M, Rasch P J, Mace G M, Jackson R B, Shepherd J, Liss P, Leinen M, Schimel D, Vaughan N E, Janetos A C, Boyd P W, Norby R J, Caldeira K, Merikanto J, Artaxo P, Melillo J and Morgan M G (2012) Ecosystem impacts of geoengineering: a review for developing a science plan. *AMBIO* 41 (4), 350-369, doi: 10.1007/s13280-012-0258-5.

Williamson P, Wallace D W R, Law C S, Boyd P W, Collos Y, Croot P, Denman K, Riebesell U, Takeda S and Vivian C (2012) Ocean fertilization for geoengineering: a review of effectiveness, environmental impacts and emerging governance. *Process Safety and Environmental Protection* 90 (6), 475-488, doi: 10.1016/j.psep.2012.10.007.

Fast-Track Initiatives and Synthesis

Megacities in the coastal zone: air-sea interactions

von Glasow R, Jickells T D, Baklanov A, Carmichael G R, Church T M, Gallardo L, Hughes C, Kanakidou M, Liss P S, Mee L, Raine R, Ramachandran P, Ramesh R, Sundseth K, Tsunogai U, Uematsu M, Zhu T (2012) Megacities and large urban agglomerations in the coastal zone: Interactions between atmosphere, land, and marine ecosystems. AMBIO, doi: 10.1007/s13280-012-0343-9.

Ecosystem impacts of geoengineering

Russell L M, Rasch P J, Mace G M, Jackson R B, Shepherd J, Liss P, Leinen M, Schimel D, Vaughan N E, Janetos A C, Boyd P W, Norby R J, Caldeira K, Merikanto J, Artaxo P, Melillo J and Granger Morgan M (2012) Ecosystem impacts of geoengineering: a review for developing a science plan. *AMBIO* 41: 350-369.

Upper-ocean nutrient limitation: processes, patterns and potential for change

Moore C M, Mills M M, Arrigo A R, Berman-Frank I, Bopp L, Boyd P W, Galbraith E D, Geider R J, Guieu C, Jaccard S L, Jickells T D, La Roche J, Lenton T M, Mahowald N M, Marañón E, Marinov I, Moore J K, Nakatsuka T, Oschlies A, Saito M A, Thingstad T F, Tsuda A and Ulloa O (2013) Processes and patterns of oceanic nutrient limitation. *Nature Geoscience*, doi: 10.1038/NGEO1765.

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 for 2012 supported 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, IGBP interactions with other partner organisations, and communication and outreach activities.

National contributions 2012

National contributions received arranged by level of contribution

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

National contributions received for previous years

Malaysia 2011

* Some countries pay above this scale.

FINANCIAL STATEMENT

Income and expenditure for the year ending December 2012

INCOME	EURO
National contribution	1,278,675
In kind support Scientific Committee and Officers' meeting*	117,650
Australian direct support Officers' meeting	8,339
Brazil in kind support	20,340
Other network income	41,287
Interest on bank account	25,977
Reallocated from previous year	144,998
Carry-over network funds from previous year	352,797
TOTAL INCOME **	**1,990,063**

EXPENDITURES	EURO
Core Science Projects	251,101
IGBP Synthesis & Fast-track Initiatives	100,882
Planet Under Pressure 2012 (excl. external grants)	190,823
Communications and Publications	215,918
Partner Activities	89,500
Future Earth	83,211
Scientific Committee and Officers	331,485
Funding and Budget	79,467
National Committees and Adhering Bodies	10,607
Secretariat Administration	160,110
Professional Development	1,771
TOTAL EXPENDITURE	**1,514,876**
Reallocated funds for next year	75,883
Carry-over network funds ***	**399,304**

* Norway (SC-meeting)
total EURO 52,000

Australia (Officers' meeting)
total EURO 65,650

** In addition to the income presented above, IGBP received additional grants for workshops and Planet Under Pressure conference activities.
total EURO 37,500
(a breakdown is listed in the table "Administered Grants Income 2012" page 62)

*** 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 INCOME 2012

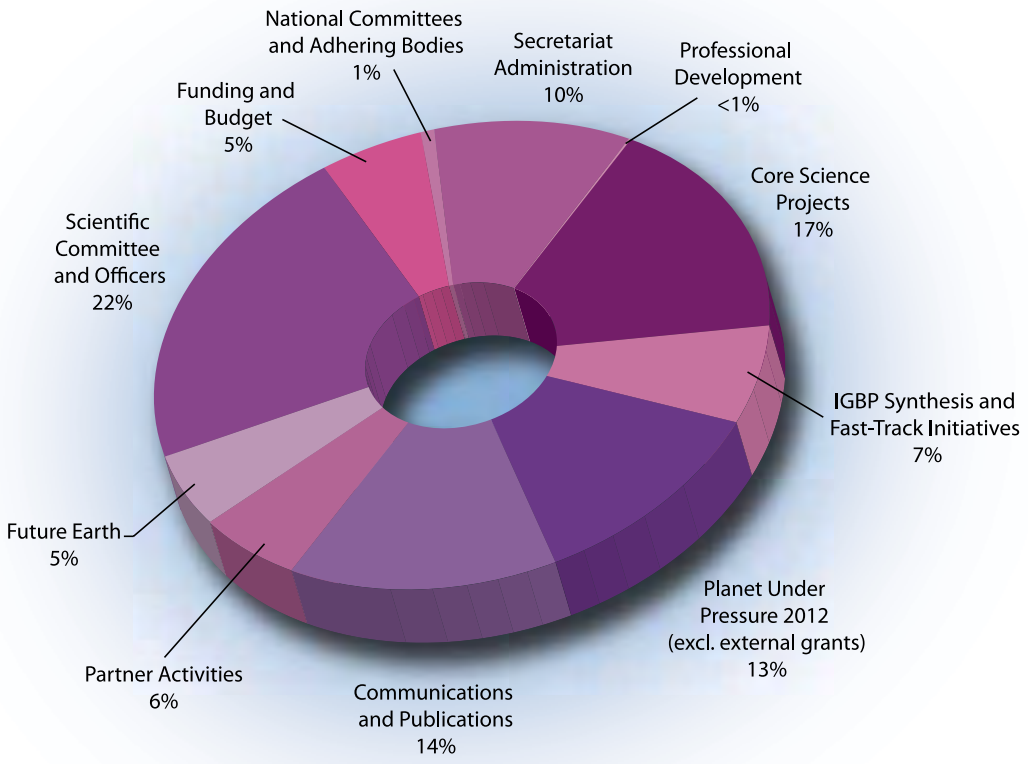
(not included in the financial statement 2012)

ACTIVITY/FUNDER	EURO
High CO_2 symposium Monterey	
Fondation Prince Albert II de Monaco	12,500
Planet Under Pressure conference	
ICSU	15,000
Germany DFG	10,000
SUBTOTAL	**37,500**
Committed grant funds from 2011	
European Space Agency (ESA)	37,033
ICSU PUP* 2012	22,889
US NSF PUP* 2012	308,225
Research Council of Norway PUP* 2012	60,000
SIDA Sweden PUP* 2012	158,009
India PUP* 2012	15,760
SUBTOTAL	**701,916**
GRAND TOTAL	**739,416**

* PUP = Planet Under Pressure conference

PROPORTIONAL EXPENDITURE 2012

(Excluding administered grants)



Percentage of budget used for core activities.

2012 FUNDING FOR INTERNATIONAL CORE PROJECT OFFICES

Project	Country/Organisation	USD	EURO
AIMES* USA	IGBP 2012 + carry-over from 2011	35,530	27,500
	AIMES Total Income	**35,530**	**27,500**
GLP Brazil	INPE-Brazilian National Institute for Space Research	346,411	268,122
	IHDP	19,000	14,706
	IGBP 2012	17,765	13,750
	GLP Total Income	**383,176**	**296,578**
IGAC USA	US NASA	98,112	74,663
	US NOAA	54,980	41,840
	US NSF	98,112	74,663
	European ACCENT Plus	23,653	18,000
	The Academy of Sciences located in Taipei, China	3,000	2,283
	IGBP 2012	35,530	27,500
	IGAC Total Income	**313,387**	**238,949**
iLEAPS Finland	University of Helsinki, Department of Physics	258,398	200,000
	Finnish Meteorological Institute	45,220	35,000
	IGBP 2012	35,530	27,500
	iLEAPS Total Income	**339,147**	**262,500**

* AIMES is in the process of restructuring.

** PAGES income is particularly high because of a supplement for the Open Science Meeting.

Project	Country/Organisation	USD	EURO
IMBER Norway	US NSF via SCOR	50,000	38,910
	French sponsors (2011-2012)	92,000	71,600
	Institute of Marine Research, Norway and Research Council of Norway (2012-2013)	38,800	30,200
	Other French sources (carry-over from earlier IMBER activities)	32,100	24,980
	IGBP 2012	17,600	13,750
	IMBER Total Income	**230,500**	**179,440**
LOICZ Germany	Institute for Coastal Research, Helmholtz-Zentrum Geesthacht, Germany	387,597	300,000
	IHDP	19,000	14,500
	IGBP 2012	17,765	13,750
	LOICZ Total Income	**424,362**	**328,250**
PAGES** Switzerland	Swiss NSF (1 August 2012–31 July 2013)	481,805	372,917
	US NSF (1 August 2012–31 July 2013)	406,747	314,822
	IGBP 2012	35,530	27,500
	PAGES Total Income	**924,082**	**715,239**
SOLAS Germany/ UK	UK Natural Environment Research Council (1 Jan 2012–31 March 2012)	40,405	31,123
	BMBF, Germany (1 Jan 2012–31 Jan 2013)	81,356	62,675
	GEOMAR, Germany	142,782	110,000
	US NSF via SCOR	25,000	19,260
	IGBP 2012	17,847	13,750
	SOLAS Total Income	**307,390**	**236,808**

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)
CSIC	Spanish National Research Council
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIVERSITAS	An international programme of biodiversity science
ESA	European Space Agency
ESSP	Earth System Science Partnership
EU	European Union
FTI	Fast-Track Initiative
GCP	Global Carbon Project
GEC	global environmental change
GECHH	Global Environmental Change and Human Health
GEO	Group on Earth Observations
GLP	Global Land Project
GPNM	Global Partnership on Nutrient Management
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
IFM-GEOMAR	Leibniz Institute of Marine Sciences
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions Programme on Global Environmental Change

ACRONYMS (CONT.)

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
IPCC	Intergovernmental Panel on Climate Change
ISSC	International Social Science Council
LOICZ	Land–Ocean Interactions in the Coastal Zone
MAIRS	Monsoon Asia Integrated Regional Study
NASA	National Aeronautics and Space Administration
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
PETM	Paleocene–Eocene Thermal Maximum
RCN	Research Council of Norway
SBSTA (UNFCCC)	Subsidiary Body for Scientific and Technological Advice
SCOR	Scientific Committee on Oceanic Research
SIDA	Swedish International Development Cooperation Agency
SSEESS	Swedish Secretariat for Environmental Earth System Sciences
SOLAS	Surface Ocean–Lower Atmosphere Study
START	Global Change System for Analysis, Research and Training
UNEP	United Nations Environment Programme
UNESCO	UN Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
UNU	United Nations University
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

International Geosphere-Biosphere Programme