

GLOBAL NITROGEN ASSESSMENT NEEDED URGENTLY

HUMANITY'S colossal effect on the global carbon cycle grabs all the headlines. In many ways, our effect on the global nitrogen cycle is as big if not bigger. Now scientists say nitrogen management on a global scale is essential if we are serious about curbing climate change. This is the message from the International Nitrogen Initiative's (INI) side event at COP-15 in December.

Event co-organiser Professor Jan Willem Erisman says, "Nitrogen has effects other than climate: biodiversity loss, human health, ecosystem eutrophication and water pollution for example."

"But our understanding of the nitrogen cycle in relation to climate is poor. We are not even sure if nitrogen fertilisation leads to long-term carbon sequestration in forests," says Erisman, who is based at the Netherland's Energy Research Centre.

During the last few decades, the global increase in reactive nitrogen from human sources – largely fertiliser manufacture – has far outstripped natural production, on land at least. Since the 1960s, the rate of increase has accelerated sharply and since the 1980s the anthropogenic production exceeded natural



Humans have radically altered the global nitrogen cycle.

Credit: istockphoto

production.

All predictions are that changing diets towards more meat and food production particularly in developing countries will lead to more reactive nitrogen in circulation. But the nitrogen cycle is yet to be adequately brought into climate models.

The INI side event, spon-

sored by IGBP, the US State Department, the UK's Department for Environment, Food and Rural Affairs, the Dutch Ministry of the Environment, Housing and Spatial Planning and others, highlights the urgent need for a global nitrogen assessment.

INI is co-sponsored by IGBP. www.initrogen.org



Between ice ages

THE OSCILLATION between ice ages and interglacials, the relatively warm intervals of time separating ice ages, has been a persistent feature of Earth's climate since about three million years ago.

Ice core records dating back 800,000 years show how interglacials differed widely in terms of their duration as well as climate. Given that interglacials are broadly governed by predictable cyclical changes in astronomical variables such as the tilt of Earth's rotational axis, a mystery remains as to the cause of this variability.

Researchers led by Chronis Tzedakis of the University of Leeds, UK surveyed recent progress in understanding interglacials. The group, part of IGBP's Past Global Changes project, compiled existing palaeoclimate data – such as ice volume inferred from the oxygen isotopic composition recorded by an ice core from Antarctica – to record the characteristics of interglacials.

"The occurrence of interglacials with differing characteristics is an intriguing aspect of the ice ages that raises fundamental questions about the Earth's climate", say the researchers.

What might have led to the interglacial variability? Initial findings seem to implicate changes in parameters such as the atmospheric concentrations of carbon dioxide. For example, interglacials prior to about 400,000 years ago, which were generally cooler as compared to those occurring later, were characterised by lower atmospheric carbon dioxide levels.

The maximum sea level during the penultimate interglacial was several metres higher than that today, and has been linked to melting of the Greenland and Antarctic ice sheets. This scenario is rather similar to that predicted to occur during the coming centuries, as atmospheric CO₂ concentrations peak. So, a better handle on the controls on past interglacials may hold the key to predicting how exactly the most recent interglacial that we are living in will respond to the impact of humans.

Tzedakis P C, Raynaud D, McManus J F, Berger A, Brovkin V, Kiefer T (2009) *Nature Geoscience*, 2:751-755.

On the move

IGBP SECRETARIAT

NINAD BONDRE joined IGBP as science editor in October. Until recently, Ninad was based in London as an associate editor of *Nature Geoscience*. He replaces Suzanne Nash, who was IGBP's interim information officer.

FROM 1 JANUARY 2010 IGBP Scientific Committee members

Incoming: Ray Bradley and Jean Palutikof

Outgoing: Mark Stafford Smith and Steven Running

IGBP project's Scientific Steering Committee chairs

Incoming: IGAC co-chair Paul Monks

Outgoing: Kathy Law

Incoming: ILEAPS co-chair Markku Kulmala

Outgoing: Meinrat Andreae

Incoming: IMBER chair Eileen Hoffman

Outgoing: Julie Hall



Planetary conference to be announced

A CALL to host a major planetary conference in 2012 focusing on solutions led to proposals from six countries.

The conference, entitled Planet Under Pressure: new knowledge, new solutions, hopes to attract 2500 world-leading global-change experts. It will be a key gathering of the global-change research community in the aftermath of the Copenhagen climate negotiations.

The initiative, led by IGBP, will be co-sponsored by other major international programmes. The successful host nation will be announced shortly.

Ocean acidification summary published

SCIENTISTS are calling for a global observations network to monitor ocean acidification. This is one of the key recommendations from a summary for policymakers on ocean acidification based on the outcomes of the Monaco symposium on the Oceans in a High CO₂ World.

Nine thousand copies of the English language version of the summary have been distributed to 74 nations. Demand has exceeded expectations and the summary has already been reprinted. The summary will now be translated into French and Spanish, other languages are also being planned.

The publication was written and produced by the co-sponsors of the symposium, the Scientific Commission on Oceanic Research, IGBP, the International Oceanographic Commission and the International Atomic Energy Agency. The conference also produced another publication, a short article in the journal *Oceanography* by James C. Orr and

colleagues, which summarises key scientific results and the outcome of the discussions. The authors emphasise that human activities have increased the acidity of oceans, and that its ill effects on life in the oceans are likely to be felt within the coming decades. The third symposium is planned for 2012. For copies of the summary email: comms@igbp.kva.se www.ocean-acidification.net

A call for increased south-south collaboration

A MUCH stronger network of researchers in the southern hemisphere would be “invaluable” to the Intergovernmental Panel in Climate Change, according to a workshop on climate impacts, adaptation and vulnerability in the developing world.

The workshop, convened by IGBP chair Carlos Nobre, was sponsored by IPCC and IGBP. It brought over 80 researchers, predominantly from developing countries, to São Paulo, Brazil to outline effective ways to translate research into action.

Among the principles identified at the workshop is to encourage the greater “south-south” collaboration between Africa, South America and south Asia. IPCC working-group two co-chair Chris Field said, “South-south networks are invaluable to IPCC.”

IPCC wants to encourage greater participation from authors from developing countries. Each country has an IPCC focal point that nominates experts from his or her country, but nominations are not received from all countries.

The workshop called for ways to improve the publication success rate of developing-country researchers in international journals. Two possible reasons for poor success rates are lack of confidence and the language barrier: English is rarely an author’s first language. Richard Klein from the Stockholm Environment Institute discussed his plan to develop week-long writing workshops in developing countries to overcome these barriers.

The next workshop will be held in Australia in 2010.

TEN AREAS IDENTIFIED FOR MAJOR INTERNATIONAL SYNTHESIS



Coastal megacities under the microscope.

Credit: istockphoto

A GLOBAL nitrogen assessment, coastal megacities and geoengineering are three of ten areas in the pipeline for a major international integration, synthesis and exploration exercise led by IGBP.

The initiative, which will contribute to a baseline for international research and

policy in the next decade, will bring together economists, ecologists, oceanographers, atmospheric physicists and many other disciplines to synthesise current knowledge, identify gaps and reduce uncertainties.

IGBP’s scientific committee has developed the first ten

integration topics with input from IPCC, the World Climate Research Programme, the International Human Dimensions Programme on Global Environmental Change, DIVERSITAS and others.

The full list under consideration is: geoengineering; the role of changing nutrient loads in coastal zones and the open ocean in an increased CO₂ world; a global nitrogen assessment and future outlook; Earth-system resilience and prediction; Earth-system impacts from changes in the cryosphere; megacities and coastal zones; global

environmental change and sustainable development; the needs of least developed countries; the role of land cover and land use in modulating climate; aerosols; and finally, supporting adaptation responses to climate change (this final topic remains provisional at this stage).

All nine IGBP core projects and four joint projects will contribute to the process. Products will include reports, review papers, briefings, summaries for policymakers and online resources. **Consultation opens 1 January 2010. www.igbp.net**

Human impacts on ecosystems

HUMAN SOCIETIES alter the productivity of natural ecosystems in myriad ways, be it by clearing forests to grow crops or by expanding grasslands to provide fodder for livestock. In a series of articles in press with the journal *Ecological Economics*, scientists associated with IGBP's Global Land Project elucidate the complex linkages between social and ecological systems.

More efficient agricultural practices can limit the human impact on ecosystems in spite of increasing populations. But as discussed in Annabella Musel's study of the human modification of ecosystems in the United

Kingdom over the past two centuries, such practices tend to rely on extensive inputs of fossil fuels and fertilisers. This suggests that the burden of maintaining relatively stable ecosystems may be borne by other components of the Earth system.

Karl-Heinz Erb and colleagues analyse the ecological impacts of the global trade in biomass products. They elaborate on how ecological effects of consumption in one part of the world are often felt far away. This is because nations with low population densities – which include some of the most industrial nations such as the United States – tend to satisfy the biomass needs of

densely populated countries. This finding is “counterintuitive in light of results indicating that industrialised countries increasingly rely on raw materials from developing nations”, say the researchers. The flow of carbon associated with such trade in biomass is significant compared to major global carbon flows, for example, the amount of carbon released by industrial processes.

Future work of this kind is expected to help evaluate the ecological impacts and sustainability of socio-economic policies such as the reliance on biofuels.

Ecological Economics 69 (2): 250-334.

Tackle climate and air quality simultaneously, say researchers

THE BENEFITS of simultaneously tackling air quality and climate change in megacities are too great to ignore, say US and Chinese researchers working on IGBP's International Global Atmospheric Chemistry project.

David Parrish from the National Oceanic and Atmospheric Administration and Tong Zhu from Peking University argue in *Science* that some of the first megacities like Los Angeles could teach other megacities how to reduce pollution.

Over half of the world's population lives in cities. Nineteen cities have populations greater than ten million making them megacities. By 2025, eight more cities will likely join their ranks.

This concentration of people has potential benefits – more energy efficient buildings and transport systems, for example. But population density is linked closely to poor health,



Credit: Morguefile

particularly respiratory and cardiovascular problems due to air pollution.

City traffic is responsible for high concentrations of surface-level ozone and particulates – small particles. Both are lung irritants and affect climate. Control strategies in Los Angeles led to lower ozone levels, but it took three decades. Ozone peaked later in Mexico City and likely never reached LA levels, before declining rapidly. Recently, Beijing authorities have aggressively clamped down on emissions from cars and trucks, even banning trucks from the city during the day to improve poor air quality.

Parrish and Zhu say that

evidence from these cities shows it is “efficient and ultimately cost effective for megacities to introduce vehicle emissions controls” as part of the growth of cities, long before pollution reaches harmful levels. The bottom line is, paying to avoid the problem is cheaper than solving it.

Zhu, IGAC's co-chair, is leading an effort to generate an “IGAC Assessment on Impacts of Megacities on Air Quality and Climate”. IGBP is producing a synthesis of research on megacities and coastal zones (see page 5) and has a fast-track initiative on air-sea interactions around megacities. Both initiatives will involve IGAC researchers.

2009

December

7-19. COP-15 side event. IGBP co-sponsors a side event on changes to the nitrogen cycle hosted by the US State Department. Copenhagen, Denmark.

7-13. Deltas: vulnerability and coastal management conference, LOICZ. Chennai, India.

2010

February

10-12. IGBP's International Project Office meeting. Stockholm, Sweden.

March

16-17. Adaptation to climate change in the Maghreb. IGBP National Committee of Morocco. Casablanca.

16-19. IGBP Scientific Committee meeting plus one-day science symposium. Grenoble, France.

May

10-13. AIMES Earth-System Science: Climate, Global Change and People open science conference. Edinburgh, UK.

June

5-8. PAGES regional workshop and scientific steering committee meeting, Nagoya, Japan.

July

11-16. Eleventh IGAC conference (with CACGP). Halifax, Canada.

September

13-17. LOICZ congress on risk and management of current and future storm surges. Hamburg, Germany.

13-15. PAGES global monsoon symposium. Shanghai, China.

October

17-19. Global Land Project's first open science conference. Phoenix, Arizona, US.

Black carbon assessment underway

AN ASSESSMENT report on the role of black carbon in climate is being led by IGBP's International Global Atmospheric Chemistry project along with the World Climate Research Programme's SPARC project (Stratospheric Processes and their Role in Climate).

Black carbon – soot – has a warming effect on the planet. The dark-coloured small particles, from vehicle emissions and industry, absorb heat. It is thought that black carbon on Arctic snow has contributed to a larger than expected warming in the region.

The assessment, part of the Atmospheric Chemistry and Climate Initiative, will have key players in the US, Europe, China and India. The report could be ready by summer 2010.



Farewell to GLOBEC

One of IGBP's most high profile and successful programmes, the Global Ocean Ecosystem Dynamics project (GLOBEC), chaired by Ian Perry, finishes in 2009. A book synthesising ten years of GLOBEC research, *Marine Ecosystems and Global Change* (Barange *et al.*, Oxford University Press, 2010) will be published in 2010.

"GLOBEC has been an outstanding success", said IGBP executive director Sybil Seitzinger. The project brought together the global scientific community to understand the complex dynamic interactions between ocean physics, climate, fishing and ecosystems.

IGBP will continue to build on the success of GLOBEC by



Credit: Marguefile

Amazon destined to become savannah?

THE AMAZON forest is in danger of turning into a grassland if deforestation and global warming continue unmitigated, suggests a review of the anthropogenic impact on this important ecosystem. The forest acts as a vast reserve of carbon, and thereby plays a potentially crucial role in regulating local and regional climate.

The review, conducted by IGBP chair Carlos Nobre and Laura de Simone Borma from the National Institute for Space Research, São Paulo, Brazil, sought to evaluate the capacity of the Amazon forest to defend itself from the twin

threats of deforestation and a warming climate. The results suggest that a loss of about 40% of the forest area and regional warming to the tune of 3-4°C could push the forest beyond a point of no return – that is, to becoming an ecosystem dominated by grasses rather than trees. The forest has already shrunk by 15% during the past four decades, while temperature has risen by about a quarter of a degree per decade. Current estimates suggest that the forest will lose a further 25% of its original area by the year 2050. "Regional climate changes induced by

the large-scale deforestation itself could prevent the re-establishment of the forest", say the researchers, highlighting the positive feedback between changes in climate and modifications to forest ecosystems.

Increasing levels of atmospheric carbon dioxide and expected higher rainfall in the region could lead to more growth and increase the forest's longevity, but gauging their precise impact awaits the results of advanced models.

Nobre C and Borma L (2009) *Current Opinion in Environmental Sustainability*, 1:28-36.

expanding the Integrated Marine Biogeochemistry and Ecosystems (IMBER) project. The details of this plan are outlined in a supplement to the IMBER science plan to be published before the end of 2009.

GLOBEC activities have been supported in numerous countries around the world, and those funding agencies are thanked for their role in its success. In particular, the US National Science Foundation and the UK Natural Environment Research Council. The UK's Plymouth Marine Laboratory successfully hosted the international project office, under the direction of Manuel Barange. GLOBEC is sponsored by IGBP, the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC).

See next issue for a feature on GLOBEC science.

To pollute or not to pollute

AEROSOLS – tiny fluid droplets or solid particles suspended in air – are responsible for pollution, and much effort has thus been invested in controlling their atmospheric concentration. But certain aerosols (sulphate aerosols, for example) also hinder the penetration of sunlight through the atmosphere, thereby leading to cooling. Reducing their concentrations may ironically facilitate global warming. So are aerosols good or bad for Earth's climate?

In a short piece published in *Science*, scientists associated with IGBP's Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) underscore the need for unravelling the influence of aerosols on climate processes. Surveying the results of recent work,

Almut Arneth and colleagues (including iLEAPS chair Markku Kulmala) mention that although "the jury is out, the studies available to date mostly suggest that air pollution control will accelerate warming in the coming decades".

To pollute or not to pollute seems to be the rather bizarre dilemma posed by the complex effect that aerosols have on Earth's climate and human wellbeing. Aerosol emissions will obviously need to be controlled to minimise pollution, but Arneth and colleagues suggest that cuts in greenhouse gas emissions will need to be higher to compensate for the warming effects of reducing atmospheric aerosols.

Arneth A, Unger N, Kulmala M, Andreae M O (2009) *Science*, 326:672-673.

Europe dominates alternative quality-of-life index

SWITZERLAND TOPS a quality-of-life index that includes, for the first time, an indication of a country's global environmental impact, or global responsibility.

The index, based on the UN's Human Development Index (HDI), adds a country's carbon emissions into the mix. This new approach considered the top 40 emitters of carbon dioxide, and shows how some countries' high standard of living comes at an environmental price. Compared with the 2009 HDI index, published in October, the US, Australia and Canada perform particularly poorly, dropping in rank from 12 to 39, 2 to 37 and 4 to 36, respectively. European countries tend to fare better in the new system.

Since the 1990s, the HDI has been an immediate and iconic country-by-country snapshot of wellbeing, standard of living and quality of life. But, argues Professor Chuluun Togtokh from the National University of

Human development index (2007)	Alternative index (corrected for per capita CO ₂ emissions)
1 Norway	1 Switzerland
2 Australia	2 Sweden
3 Iceland	3 France
4 Canada	4 Iceland
5 Ireland	5 New Zealand
6 Netherlands	6 Norway
7 Sweden	7 Portugal
8 France	8 Italy
9 Switzerland	9 Spain
10 Japan	10 Austria

Mongolia, human development is closely intertwined with the health of the environment and a concern for the quality of life of others. When the UN released this year's HDI, Togtokh felt the index lacked an important component that would capture this.

"Some developed countries have high index values, but poor carbon footprints. The index must be corrected," said the land-use specialist and vice chair of the Mongolian global environmental-change committee.

When Togtokh added carbon dioxide emissions per capita to the index, the effect was immediate and informing (see table). One could argue that by contributing

(and having contributed) the most to global warming, the developed countries that fell farthest are having the largest impact on the livelihoods of those in other countries, particularly in the developing world – the countries most affected by climate change.

"The index seems an effective tool for reflecting a country's quality of life, while respecting the quality of life of others," reflects Togtokh.

In addition to the GDP, the recent Human Development Index includes two additional parameters: a health indicator, longevity, and education indicators, literacy and the number of children in education. Togtokh added CO₂ emissions. He believes with his index, the new leaders, Switzerland and Sweden, are prime examples for developed countries to show that it is possible to keep human development high and reduce emissions. "Given the importance of equity at the Copenhagen climate negotiations, the index provides a clear indicator of which countries are taking their global responsibility seriously," he added.

But Pep Canadell from the Global Carbon Project points out that while some countries' domestic emissions are encouraging, the index does not take into account a country's emissions due to imported goods made in countries such as China.

Togtokh accepts this is an issue that needs addressing – he says the new index will develop over time – but believes it does not distract from its overall value.

Elinor Ostrom wins Nobel economics prize

THE NOBEL PRIZE for economics was awarded to a former member of the International Human Dimensions Programme's scientific committee, Elinor Ostrom. Ostrom is the first woman to win the prize since it was founded in 1968, and the fifth woman to win a Nobel award this year – a Nobel record.

The award was given jointly to Ostrom and Oliver Williamson for their analyses of economic governance. The Royal Swedish Academy of Sciences said Ostrom's work demonstrated how common property can be successfully managed by groups using it.



J. Lokrantz/Azote

EVENTS

2009

December

7-19. UN Climate Change Conference COP-15. Copenhagen, Denmark.

14-18. AGU Fall Meeting. San Francisco, US.

2010

February

22-23. Greenhouse gases in the Earth system: setting the agenda in 2030. Royal Society, London, UK.

22-26. Ocean sciences meeting. Portland, Oregon. (ASLO, AGU, TOS)

March

16-19. State of the Arctic conference. Miami, Florida. (ARCUS, ISAC, DAMOCLES)

April

7-8. ICSU Geo-Unions. Paris, France.

21-23. Continents under climate change conference. German Foreign Office, Humboldt-Universität zu Berlin, Germany.

26-29. PICES Climate change effects on fish and fisheries: forecasting impacts, assessing ecosystem responses, and evaluating management strategies. Sendai, Japan.

12-13. International symposium on coastal zones and climate change. Monash University, Victoria, Australia. (APN)

May

17-21. Air-water gas transfer conference. Kyoto, Japan. (JSPS, SOLAS)

June

8-10. International Polar Year (IPY) Conference. Oslo, Norway.

13-18. Goldschmidt 2010 - Earth, energy and the environment. Knoxville, Tennessee, US.

Integrated ocean observing system needed

MORE THAN 600 participants from 36 nations met in Venice in October for the OceanObs conference, co-sponsored by IGBP.

The conference resulted in the statement that "Despite the profound importance of marine information to meet the needs of our societies, the resources necessary to observe, assess and forecast global marine conditions are fragile and insufficient." The group wants all governments to commit to international coordination of global biogeochemical and biological observations.

"The global ocean observing system right now is almost purely physical. There are carbon measurements and ocean colour from which we can derive some biological data, but there are very few biogeochemical or biological measurements," said co-organiser, Julie Hall, executive officer of IGBP project IMBER (Integrated Marine Biogeochemistry and Ecosystem Research).

"This conference showed a clear willingness from the physical, biogeochemical and biological communities to work together for an integrated ocean observing system," added Hall.



Clara Natoli

Planetary management project takes off



White House photo

Planetary ecologist?

BARACK OBAMA and colleagues will need help keeping the planet's vital systems stable under the twin pressures of economic and population growth. In December, the International Human Dimensions Programme on Global Environmental Change launched a planetary management initiative – the Earth System Governance project – in Amsterdam to find ways to do just that.

The ten-year scheme will investigate integrated governance systems, from local to global, "that ensure the sustainable development of the coupled socio-ecological system the Earth has become". www.earthsystemgovernance.org

Health and climate change

HEALTH POLICIES need to gear up to respond to the modifications in disease patterns triggered by a changing climate, says a scientist affiliated with the Intergovernmental Panel on Climate Change. Kristie Ebi of the Carnegie Institution for Science, USA points out that existing healthcare strategies assume a stable climate regime.

Using the incidence of malaria in Africa as an example, Ebi discusses how seemingly minor changes in temperature or precipitation may open up new breeding grounds for mosquitoes, while at the same time reducing the risk of other regions to this infectious disease. Ebi recommends that models used for estimating malaria risks incorporate predictions regarding local/regional climate change.

Ebi K (2009) *Current Opinion in Environmental Sustainability*, 1:107-110.

New vision for international Earth-system science



THE SCALE of global change and the need for closer integration between disciplines has prompted the International Council for Science to develop a new vision for Earth-system science. ICSU (IGBP's parent body) and the International Social Science Council launched an online consultation in the summer followed by an expert meeting in September attended by IGBP chair, Carlos Nobre.

The visioning process will outline key research questions and how to address them. Grand challenges under

consideration include increasing knowledge of the coupled human-environment system and developing natural and social observation systems needed to manage the Earth system.

From mid December until mid February the wider community can comment on the draft report from September's meeting. Following this consultation, the next key milestone is a programme co-sponsors' meeting in mid 2010. www.icsu-visioning.org

International climate research plan published

THE WORLD CLIMATE Research Programme has published its implementation plan for 2010 to 2013. The plan outlines interdisciplinary research and modelling initiatives, a focus on regional climate assessments and climate information for decision-makers. www.wcrp.wmo.int