New IGBP vision published

IGBP IS UPDATING its strategic vision. The new draft vision, now online, states that the role of IGBP 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 ten-year vision has been developed by a small team led by the IGBP secretariat, IGBP's senior decision-making bodies and former IGBP chair Guy Brasseur. It has three key components: understanding our planet, understanding the pressure it is under and "transformation in an era of rapid global change". The vision refocuses on and re-emphasises some of the questions the IGBP research community has been addressing. For example, how are Earth's ecosystem processes, society and biogeochemical cycles linked, and how will they behave in the future? What and where are the boundaries, tipping elements and thresholds in the Earth system? How are Earth's marine, terrestrial, atmospheric and cryospheric systems linked? More emphasis will be placed on the planet under pressure. New research questions include: how is human activity affecting Earth's biogeochemical cycles? And, how are Earth-system changes affecting society? Providing useful information to society will feature prominently.

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EMISSIONS: BEYOND THE USUAL SUSPECTS

A KEY UNCERTAINTY in climate-change research is how life on land will react to higher levels of atmospheric carbon dioxide. Will trees grow bigger and faster, soaking up some of the excess carbon and eventually cooling the climate? Or will life decay rapidly emitting more carbon and leading to warming?

A recent review, published in *Nature Geoscience*, suggests that with elevated atmospheric carbon dioxide levels, we can anticipate additional greenhouse-gas emissions from soils, forests and wetlands, leading to more warming.

The terrestrial biosphere – life on land – is a key regulator of climate and atmospheric chemistry. Climate change will lead to increases in CO_2 and methane emissions from wetlands, nitrous oxides from soils, volatile organic compounds from forests, plus more trace-gas emissions and soot from fires. Some of these processes are reasonably well understood. But others have been largely ignored until recently.

The review finds that the combined estimated warming from feedbacks associated with terrestrial carbon, nitrogen and atmospheric-chemistry interactions could potentially be large enough to offset a significant proportion of the cooling due to additional plant growth stimulated by CO_2. The researchers conclude that while carbon cycle-climate interactions are a major focus of modelling work, other biogeochemistry feedbacks could be at least equally important for future climate change.

But the scientists caution that the uncertainty levels are still high. Lead author Almut Arneth from Lund University, Sweden, said, "There are large uncertainties associated in these feedbacks, especially in how changes in one biogeochemical cycle will affect other cycles."

Policymakers need to know when the uncertainties will start becoming certainties. At least enough to be included in, for example, the Intergovernmental Panel on Climate Change's assessment of global radiative forcing. "Ask us again in five years," says Arneth.

Arneth is part of the Scientific Steering Committee of the IGBP project Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS).

Arneth A *et al.* (2010) *Nature Geoscience* 3: 525-532.

IGBP DIARY

2011

March

1-3. IGBP International Project Officers meeting. Bern, Switzerland.

15-17. SOLAS Scientific Steering Committee meeting. Tsukuba, Japan.

22-24. DIVERSITAS Scientific Committee meeting. Paris, France.

28 March-1 April. IGBP Scientific Committee meeting. Washington, DC, USA.

April

4-8. WCRP Joint Scientific Committee meeting. Exeter, UK.

11-13. IMBER Scientific Steering Committee meeting. Marseille, France.

May

9-11. GLP Scientific Steering Committee meeting. Maryland, USA.

23-27. ESSP Scientific Committee meeting. Wageningen, Netherlands.

July

29-30. PAGES Scientific Steering Committee meeting. Bern, Switzerland.

September

8-10. LOICZ Scientific Steering Committee meeting. Yantai, China.

8-15. Young LOICZ Forum. Yantai, China.

12-15. LOICZ Open Science Conference. Yantai, China.

18-23. iLEAPS Open Science Conference. Garmisch-Partenkirchen, Germany.

October

24-28. WCRP Open Science Conference. Denver, Colorado, USA.

26-28. ICSU General Assembly, Italy.

TERRESTRIAL CARBON BUDGET REFINED

RESEARCHERS have announced that each year global vegetation draws down 123 billion tonnes of carbon from the atmosphere. The most accurate measurement to date of the carbon exchange between atmosphere and land was made possible by a global network of over 250 measuring stations.

The result will help improve climate models because the terrestrial carbon balance is a major area of uncertainty. The research supports outputs from process-oriented models that estimate terrestrial carbon movement as a function of environmental conditions.

The highest gross carbon uptake in terrestrial ecosystems is found in tropical forests – over a third (34 percent) of the carbon dioxide (CO_2) uptake from the atmosphere. Savannahs cover twice the area but account for about one quarter (26 percent) of the global CO_2 uptake.

The researchers used FLUXNET, a global network of observation towers. The towers measure how CO_2, water vapour and energy move between the atmosphere and the main ecosystems on land: temperate, tropical and boreal forests, crops, grasslands, chaparral, wetlands and tundra.

The research team, from 18 institutes, also discovered that rainfall plays a more significant role than previously thought in determining the amount of carbon captured by plants during photosynthesis. Precipitation rates were found to have considerable influence in more than 40 percent of vegetated regions, and in half of all croplands. This has important implications for global food production.

The reason rainfall is crucial is down to plants' response to soil moisture. Low rainfall leads to dry soils. In such conditions, root-water uptake cannot keep up with transpiration and plants close the small holes on the surface of leaves (stomata) to prevent drying out. But this reduces the amount of CO_2 the plants take up because this gas, in addition to water, is exchanged through stomata.

Lead author Christian Beer, from the Max Planck Institute for Biogeochemistry in Germany, said: "We reached a milestone with this paper by using plenty of data from FLUXNET in addition to remote sensing and climate reanalysis."

"With our estimation of global gross primary production (GPP), we can do two things – compare our results with Earth system process models and further analyse the correlation between GPP and climate," he added.

Reseachers associated with IGBP's iLEAPS project contributed to this work.

Beer C *et al.* (2010) *Science* 329: 834-838.

Ocean acidification symposium announced

THE THIRD symposium on The Ocean in a High-CO_2 World will be held in Monterey, California, September 24-27 2012. The symposium aims to attract more than 300 of the world's leading scientists to discuss the impacts of ocean acidification on marine organisms, ecosystems, and biogeochemical cycles. It will also cover socio-economic consequences of ocean acidification, including policy and management implications. The symposium is sponsored by the International Geosphere-Biosphere Programme (IGBP), the Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

Humboldt medal for Nobre

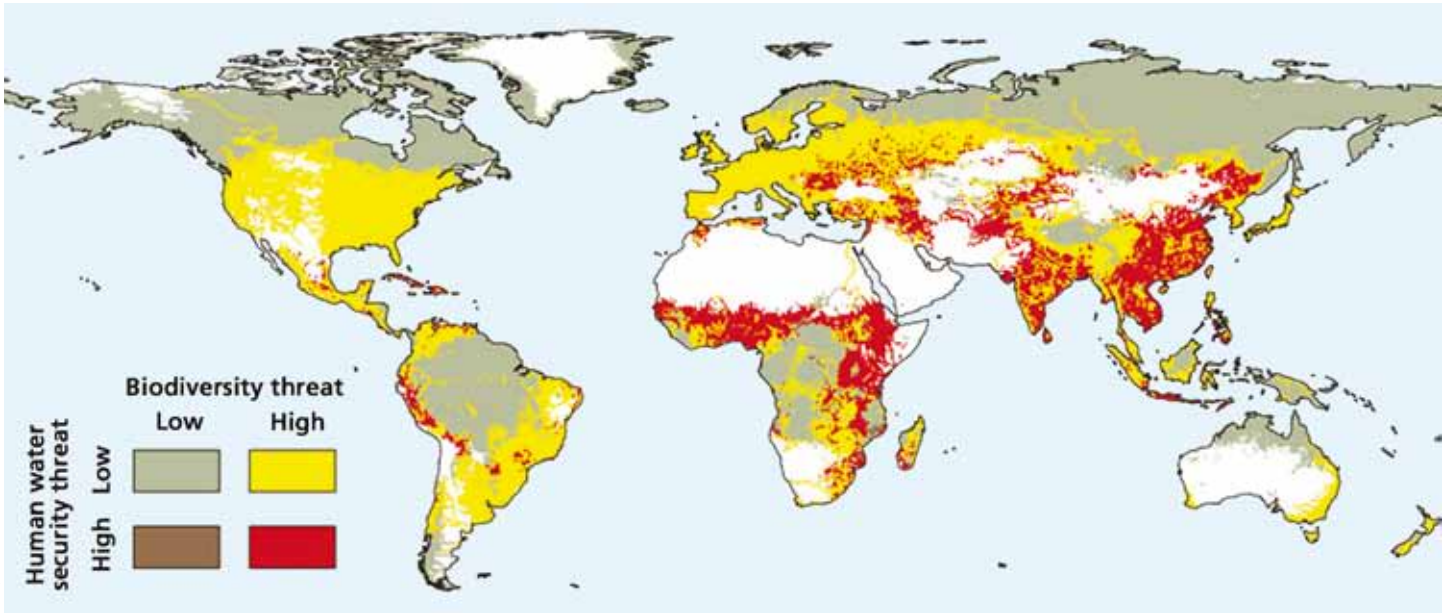
IGBP CHAIR Carlos Nobre is the recipient of this year's Alexander von Humboldt Medal, awarded by the European Geosciences Union (EGU). According to the EGU, the medal has been awarded to Prof. Nobre for his outstanding work on biosphere-atmosphere interactions, with particular emphasis on the Amazonian forests and their role in Earth's climate system. The medal is reserved for scientists from developing countries, particularly from Latin America and Africa, who have achieved exceptional international standing in the geosciences, and planetary and space sciences.

New IGBP website launching soon

BY THE END of 2010, IGBP will relaunch its website. The new website will aggregate news from across the IGBP research community more effectively. It will make more use of imagery, multimedia tools and new digital technology. The site will be easier to navigate and provide more background information on global change. IGBP intends to work with data visualisation experts to make our data more accessible. www.igbp.net

Global change conference update

A MAJOR international conference, Planet Under Pressure, organised by the four global-environmental-change programmes and their partnership, will be held in London 26-29 March 2012. Elinor Ostrom (winner of the 2009 Nobel Prize in economics), Lidia Brito (UNESCO's Director of Science Policy and Sustainable Development) and Mark Stafford Smith (Science Director of the Climate Adaptation Flagship of CSIRO) will lead the scientific organising committee. www.planetunderpressure2012.net/



GLOBAL WATER INSECURITY ANALYSED IN MAJOR STUDY

THE WATER security of around five billion people – 80 percent of the human population – is threatened, according to research published in the journal *Nature*.

Scientists associated with the Global Water Systems Project have created a global database of rivers pinpointing risks to human water security and biodiversity. They took 23 parameters affecting river health including, for example, water diverted to cropland, livestock density, nitrogen enrichment, pesticide levels, sediment deposits, damming and invasive species.

By combining these parameters, the scientists, led by Charles Vörösmarty and Peter McIntyre, produced a set of global maps showing areas at high risk.

Densely populated regions face the highest risk to their water security. "A strikingly small fraction of the world's rivers remain unaffected by humans," the authors report.

Countries facing the highest joint threats to water supply and biodiversity are in the developing world: China, India, Peru, sub-Saharan Africa, parts of Central Europe and Central Asia.

Rich nations – Europe, Australia and North America – have avoided threats to water security by expensive engineering projects: building dams and treatment plants, managing rivers and erecting barriers to allow crops on flood plains. But these technical fixes have reduced biodiversity. The authors note that with instant access to clean water, people in these countries have largely ignored the growing threats to biodiversity.

The authors argue these technological solutions are often unnecessary. Vörösmarty told the Reuters press agency: "If your concern is flooding you might wish to preserve flood plains and wetlands in low-lying areas as they absorb the shock of floods."

Now decision-makers are caught in a dilemma. Societies in poorer countries face the highest risk to their water security. If they adopt the same solutions as rich nations it will be costly, further harm ecosystems they depend upon and fail to deal with the underlying cause.

The paper says, "The decision to construct large-scale dams is a prime example of how development pressure is often at odds with biodiversity conservation."

It adds that human water security must be established in the developing world "while preserving biodiversity". This will be an additional financial burden if these countries follow practices in Europe and North America. But another route is open: "integrated water resource management that expressly balances the needs of humans and nature".

Vörösmarty and colleagues conclude, "Although our results offer *prima facie* evidence that society has failed to institute this principle broadly, there are promising, cost-effective approaches to preserve and rehabilitate ecosystems. Engineers, for instance, can rework dam operation rules to maintain economic benefits while simultaneously conveying adaptive environmental flows for biodiversity.

"Protecting catchments reduces costs for drinking water treatment, whereas preserving river flood plains sustains valuable flood protection and rural livelihoods. Such options offer developing nations the opportunity to avoid the high environmental, economic and social costs that heavily engineered water development systems have produced elsewhere."

The authors are not expecting a quick fix, arguing that if climate negotiations are any guide, "a generational timeframe may be necessary to stimulate sufficient political willpower to address the global river health challenge."

Meanwhile, the majority of people on the planet and countless freshwater species remain living on the edge.

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

ICSU CALLS FOR "UNPRECEDENTED DECADE OF RESEARCH"

Global-change programmes may shift focus to global sustainability research.

THE INTERNATIONAL Council for Science (ICSU) is calling for its four global-change programmes to rally around "an unprecedented decade of research" to provide the science to put society onto a sustainable pathway.

ICSU wants the four programmes, including IGBP, to switch focus to policy-relevant research relating to global sustainability. This is the outcome of ICSU's lengthy "visioning process" now led by Johan Rockström from the Stockholm Resilience Centre.

The new vision is split into five grand challenges. The first is to build coordinated global and regional monitoring systems. The second, better prediction. The third, how do we avoid or cope with "massive cascading environmental shocks"? The fourth, what economic systems and institutional systems will contribute most to global sustainability? And finally, the fifth challenge asks what are the technological, social and political innovations needed to transform society?

But the first challenge for ICSU and the global-change programmes, including IGBP, is to work out how to reorganise existing international research to achieve these new goals.

Rockström and the rest of the task team meet early 2011 to decide the next move.

Arguably the biggest hurdle will be finding funding agencies to stump up the cash in an age of austerity. But in a separate initiative, some of the world's leading funding agencies of environmental science have met to agree a focus for future funding: "regional environmental change: human action and adaptation".

The proposal from funders in the USA, UK, Japan, Germany, France, Canada and Australia calls for better dialogue between funding agencies and ICSU's global-change programmes.

This new scheme, called the Belmont Challenge because it was first proposed at a meeting in Belmont, Maryland, USA, has outlined the most urgent global environmental challenges: coastal zones, water, sustainable economies and the most vulnerable societies.

The Belmont group of funders commissioned ICSU to produce a report, "What does it take to meet the Belmont Challenge?" The report, led by former IGBP chair Guy Brasseur, states that regional and decadal prediction, advanced observing systems and more inclusion of social sciences are needed urgently.

www.icsu-visioning.org
http://www.icsu.org/2_resourcecentre/ICSU_Belmont_report/

FOOD FOR THOUGHT

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INCREASED carbon dioxide concentrations could lead to higher yields of most crops by the middle of the century, according to a recent review. Moreover, crops will consume less water in such an environment. This may offset to an extent the negative consequences of climate change, for example the anticipated increases in ozone and decreases in rainfall.

The review was one of a series published by the UK Royal Society that sought to explore whether and how we can feed nine billion people in the year 2050. Some of the reviews investigated factors that could shape future demand and the potential pitfalls in meeting that demand, whereas others sought to explore the links with economics and implications for human health.

As summarised by Charles Godfray and colleagues in the introduction to the special issue, the challenges are many and include limited availability of fertile land, climate variability and the socio-economic consequences of increasing urbanisation. For example, industry and urban regions are expected to compete with agriculture for water, and expanding farmland might come at the expense of forests and wetlands.

At the same time, the anticipated stabilisation of population and demand, and the willingness to contemplate sustainable application of technology present real opportunities. And even climate change may bring unexpected benefits, as the review on the influence of increased carbon dioxide concentrations on crop yields shows.

Godfray and colleagues point out that the policy choices we make today will determine future food security. And they highlight the need for ongoing research – involving natural and social scientists, economists and policymakers – that will provide the knowledge to understand and cope with the challenges.

Philosophical Transactions of the Royal Society 365 (1554).

ASIA'S WATER FUTURES

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WATER AVAILABILITY in the Indus and Brahmaputra river basins is likely to be affected substantially by climate change, thereby threatening the food security of populations in these basins, a recent study suggests. Basins of Asian rivers such as the Ganges and Yangtze will be less affected, whereas the Yellow River basin might even benefit.

Many of the glaciers in the Himalaya and on the Tibetan Plateau are receding. Glaciers and melting snow supply some water to rivers that originate in this region, but how critical is this meltwater to each basin?

To quantify this, the study's lead author – Walter Immerzeel of FutureWater, the Netherlands – and colleagues turned to satellite data. They found that meltwater is indeed an important contributor to the total discharge of the Indus and Brahmaputra rivers, whereas the Ganges, Yangtze and Yellow rivers get just a limited amount of their water from melting glaciers and snow.

The researchers used several model simulations to come up with predictions about how a changing climate – and the changes in glacier volume and rain/snow fall that would result – would affect water availability in upstream areas by the middle of the century. Upstream areas are important, the researchers point out, because they hold reservoirs that modulate water supply to more populated downstream regions.

The results suggest that the upstream supply of meltwater will decrease considerably for most rivers. But this will be compensated partially by the predicted increase in rainfall in upstream areas. As a result, the effects on the rivers will be less severe than predicted by the fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change.

In fact, the Yellow River basin might actually benefit: simulations by the researchers show an increase in early spring precipitation for this river during the coming decades, which will help agriculture in the basin. Nevertheless, rivers such as the Indus and Brahmaputra, with large downstream populations, will experience substantial decreases in spring and summer discharges after the middle of the century. The study estimates that this could threaten the food security of 60 million people.

An important result of the study is the variability in the response of various rivers to climate change, which results from a complex range of variables. Plans aimed at adapting to the inevitable effects of climate change in this region would do well to bear this complexity in mind to achieve the most effective results.

Immerzeel W W, Van Beek L P H and Bierkens M F P (2010) *Science* 328: 1382-1385.

Call for international carbon office

SCIENTISTS from the Global Carbon Project have called for the creation of an international carbon office, to collect, analyse and provide information to help policymakers limit global warming to 2°C. Writing in *Current Opinions in Environmental Sustainability*, the scientists say that existing institutions are inadequate to provide a full accounting of the balance of greenhouse gases, including their sources and sinks.

At present, several organisations provide bits and pieces of information pertaining to greenhouse-gas cycles. However, no organisation has been mandated to pool such information together, either at the regional or global scale. As a result, there is no mechanism to determine, for example, whether the measures instituted to stabilise emissions are working. The Global Carbon Project attempts to synthesise relevant information on a yearly basis. But, say the scientists, it has neither the long-term mandate nor the resources to do a full accounting.

A new office would eventually provide advance warning of changes in the sources or sinks of carbon; this would help shape adequate policy responses.

Events

2010

December

13-17. AGU Fall Meeting. San Francisco, USA.

2011

January

9-11. Innovation and sustainability transitions in Asia. Kuala Lumpur, Malaysia.

February

13-18. ASLO Aquatic sciences meeting. San Juan, Puerto Rico.

March

27 March-1 April. Arctic Science Summit Week, Seoul, South Korea.

April

4-8. EGU annual meeting. Vienna, Austria.

June

14-18. 22nd Pacific Science Congress. Kuala Lumpur, Malaysia.

20-24. Ocean Acidification: Consequences for marine ecosystems and society, 7th EGU Alexander von Humboldt Conference. Penang, Malaysia.

July

20-27. 18th INQUA Congress. Bern, Switzerland.

August

14-19. Goldschmidt 2011. Prague, Czech Republic.

September

26-30. World Conference on Marine Biodiversity. Aberdeen, Scotland, United Kingdom.

November

2-4. Sixth International Symposium on Non-CO_2 Greenhouse Gases (NCGG-6): Science, Policy and Integration. Amsterdam, the Netherlands.

December

12-16. AGU Fall Meeting, San Francisco, USA.

New book on acidification

THE US National Academies Press has published a book entitled *Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean*. The book, published by the US National Research Council, reviews the current state of knowledge of ocean acidification, explores gaps and identifies key findings. http://www.nap.edu/catalog.php?record_id=12904#description

Economic slowdown led to emissions fall in 2009

In 2009, emissions of carbon dioxide from fossil fuels dipped by over one percent, according to scientists from the Global Carbon Project. Writing in *Nature Geoscience*, the scientists attribute the fall to the global financial crisis that began in 2008.

Because modern economic growth relies on burning fossil fuels, carbon dioxide emissions tend to track the gross domestic product (GDP) of nations. A study published last year in the same journal predicted that as the global economy faltered, GDP would shrink and emissions would decrease by almost three percent. Just half of that expected decrease seems to have materialised. What happened?

Developed nations such as the US, UK and Germany did indeed emit lower quantities of carbon dioxide relative to 2008 levels. But the financial crisis did little to slow down the growth in emissions in China and India: these nations emitted more carbon dioxide in 2009 relative to 2008. As a result, the net reduction in emissions was less than anticipated.

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

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

Friedlingstein P *et al.* (2010) *Nature Geoscience*.

FALLING GLOBAL PLANT GROWTH

BETWEEN 2000 and 2009 global plant growth on land – net primary productivity (NPP) – fell slightly. Widespread droughts are largely to blame. The fall reverses growth seen in previous decades (1982-1999). Reduced NPP could threaten global food and biofuel production.

Maosheng Zhao and Steve Running from the University of Montana's Numerical Terradynamic Simulation Group used satellite data and observation towers to piece together a picture of global productivity patterns. NPP fell in some regions and rose in others. It increased slightly over the northern hemisphere. Around 65 percent of vegetated land in this hemisphere saw a rise including large areas of North America, Western Europe, India, China and the Sahel region. But NPP decreased in Eastern Europe, Central Asia and high latitudes of West Asia.

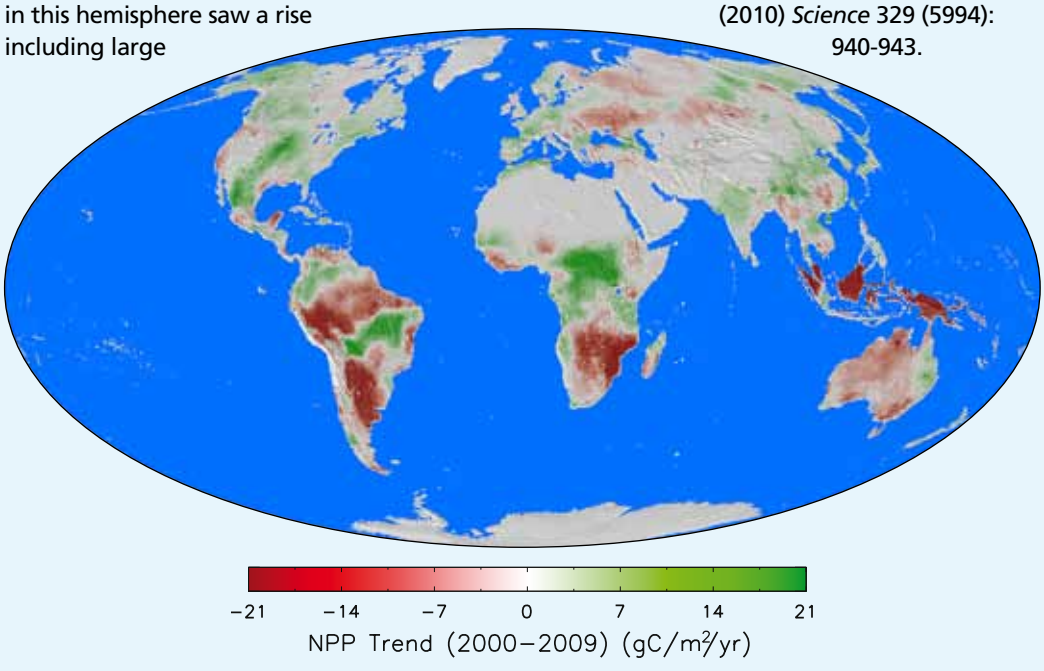
In northern high latitudes, warming lengthens the growing season promoting plant growth. Nitrogen deposition and fertilizer use also stimulated a rise in NPP in the northern hemisphere.

A different picture emerges in the southern hemisphere, which accounts for 41 percent of global NPP. Here, NPP reduced markedly, a fall that more than counteracted the northern hemisphere rise. In the south, 70 percent of vegetated lands saw a decrease in NPP including large parts of South America, Africa and Australia.

Severe regional droughts have become more frequent. For example, droughts reduced NPP in North America and China in 2000, in Europe in 2003, and in Australia from 2007 to 2009.

Plant productivity increased between 1982 and 1999, according to a 2003 study. Researchers at that time attributed that trend to a warmer climate and increased solar radiation. The new findings highlight the need to monitor NPP continuously to determine whether the trend is decadal variation or a long-term decline in the terrestrial carbon sink.

Zhao M and Running S (2010) *Science* 329 (5994): 940-943.



Steve Running

Global Net Primary Productivity (2000-2009). The Southern hemisphere suffers a significant decrease in productivity.