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The International Geosphere–Biosphere Programme (IGBP): A Study of Global Change of the International Council for Science (ICSU)

International Geosphere-Biosphere Programme: A study of Global Change, some reflections

by Berrien Moore III, Chair SC-IGBP

It has now been just over 13 years since the 21st General Assembly of The International Council of Scientific Unions (ICSU; now the International Council for Science) instituted the International Geosphere-Biosphere Programme (IGBP). Shortly thereafter, in 1987, the IGBP Secretariat was established at the Royal Swedish Academy of Sciences.

The Programme was and has been and will continue to be focused on acquiring basic scientific knowledge about global environmental change and particularly the interactive processes of biology and chemistry of the Earth system. This is well expressed in the original goal of the Programme. (See ingress)

To describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions.

Original Goal of the IGBP

From the earliest period of the IGBP, it was recognized that the functioning of the planet and particularly the biogeochemical system of the planet must be understood in the context of natural variability as well as changes induced by human activities. An extraordinary foundation for understanding this "natural variability" has been established by the Past Global Changes (PAGES) Core Project.

The carbon cycle is a central case in point.

From measurements of air trapped in ice-cores and from direct measurements of the atmosphere, we know that in the past 200 years, the abundance of CO_2 in the atmosphere has increased by over 30%, from a concentration of 280 parts-per-million by volume (ppmv) in 1700 to nearly 370 ppmv as we enter 2000. We also know that the concentration was relatively constant (roughly within +/-10 ppmv of 275) for more than 1000 years prior to the human-induced rapid increase in atmospheric carbon dioxide.

But looking further back in time, we find an extraordinarily regular record of change.

The Vostok core (see the paper in Nature (3 June 1999) by Petit *et al.*) captures a remarkable and intriguing signal of the periodicity of interglacial and glacial climate periods in step with the transfer of significant pools of carbon from the land (through the atmosphere?) to the ocean and then the recovery of terrestrial carbon

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back from the ocean. The repeated pattern of a 100-80 ppmv decline in atmospheric CO_2 from an interglacial value of 280-300 ppmv to a 180 ppmv floor and then the rapid recovery as the planet exits glaciation suggests a tightly governed control system with firm stops at 280-300 and 180 ppmv. There is a similar CH_4 cycle between 320-350 ppbv (parts-per billion by volume) and 650-770 (ppbv). What beg explanation are not just the linked periodicity of carbon and glaciation, but also the apparent hard stops in the carbon system. What were the controls, and why are there the apparently "hard stops"?

Today's atmosphere, imprinted with the fossil fuel CO_2 signal, stands at nearly 80-100 ppmv above the previous "hard stop" of 280-300 ppmv. The current methane value is even further (percentage-wise) from its previous interglacial high values. In essence, carbon has been moved from a relatively immobile pool (in fossil fuel reserves) in the slow carbon cycle to the relatively mobile pool (the atmosphere) in the fast carbon cycle, and the ocean, terrestrial vegetation and soils have yet to equilibrate with this "rapidly" changing concentration of carbon dioxide in the atmosphere.

Given this remarkable (and unprecedented in the period that humans have been on the planet) event one can not help but wonder about the characteristics of the carbon cycle in the future regardless of possible changes in climate.

And yet, we know that the planet's biogeochemical system is intimately linked with the physical-climate system. Carbon dioxide and methane are but two of the biogenic greenhouse gases. But this, that CO_2 and CH_4 are greenhouse gases, is a narrow view of the biogeochemistry-climate linkage.

The marine carbon cycle plays an important role in the partitioning of carbon dioxide between the atmosphere and the ocean. The primary controls are the circulation of the ocean, a function of the climate system, and two important biogeochemical processes: the solubility pump and the biological pump, both of which act to create a global mean increase of dissolved inorganic carbon with depth, and therefore to maintain atmospheric CO_2 at a level considerably lower—about a factor of three—than it would be otherwise.

The interplay between the circulation of the oceans and the biogeochemical "pumps", which are themselves dependent on ocean circulation, determine the sea surface pCO_2 and hence are the primary determinants (with atmospheric pCO_2 and sea surface winds) of the air-sea exchange rates of carbon dioxide. Advances in this understanding have been important, and these advances are directly tied to the World Oceans Circulation Experiment (WOCE) of the World Climate Research Programme (WCRP) and the Joint Global Ocean Flux Study (JGOFS) of IGBP. These ocean surveys are now being exploited (and thereby even further linked) by ocean carbon cycle modellers. The Ocean Carbon Cycle Model Inter-comparison Project (OCMIP[1]) was initiated in 1995 by the IGBP Task Force on Global Analysis, Interpretation, and Modelling (GAIM) to investigate to what extent predictions from 3D ocean carbon cycle models vary and to understand why. These models are essentially extensions of ocean circulation models used in climate models (general circulation models or GCMs), and in this sense, they are a clear expression of the coupling between the climate system and the biogeochemical system

A similar case of coupling occurs on land. The metabolic processes, which are responsible for plant growth and maintenance, and the microbial turnover, which is associated with dead organic matter decomposition, cycle carbon, nutrients, and water through plants and soil on both rapid and intermediate time scales. Moreover, these cycles affect the energy balance and provide key controls over biogenic trace gas production (i.e., both are climate couplings). Looking at the carbon fixation-organic material decomposition as a linked process, one sees that some of the carbon fixed by photosynthesis and incorporated into plant tissue is perhaps significantly delayed from returning to the atmosphere until it is oxidized by decomposition or fire. This slower carbon loop through the terrestrial component of the carbon cycle affects the rate of growth of atmospheric CO_2 concentration and, in its shorter term expression, imposes a seasonal cycle on that trend.

The structure of terrestrial ecosystems, which respond on even longer time scales, is the integrated response to changes in climate and to the intermediate time scale carbon-nutrient machinery. The loop is closed back to the climate system, since it is the structure of ecosystems, including species composition, that largely sets the terrestrial boundary condition on the climate system in terms of surface roughness, albedo, and latent heat exchange.

At each step toward longer time scales, the climate system integrates the more fine-scaled processes and applies feedbacks onto the terrestrial biome. At the finest time scales, the influence of temperature, radiation, humidity and winds has a dramatic effect on the ability of plants to transpire. On longer time scales, integrated weather patterns regulate biological processes such as timing of leaf emergence or excision, uptake of nitrogen by autotrophs, rates of organic soil decay and turnover of inorganic nitrogen. The effect of climate at the annual or interannual scale defines the net gain or loss of carbon by the biota, its water status for the subsequent growing season, and even its ability to survive. As the temporal scale is extended, the development of dynamic vegetation models, which respond to climate and human land use as well as other changes, is a central issue. These models must not only treat successional dynamics, but also ecosystem redistribution.

Modelling interactions between terrestrial and atmospheric systems requires coupling successional models to biogeochemical models to physiological models that describe the exchange of water and energy between vegetation and atmosphere at fine time scales. In the IGBP, this is a central area for Global Change and Terrestrial Ecosystems (GCTE), Biological Aspects of the Hydrological Cycle (BAHC), and, again, GAIM. It is important to acknowledge that this coupling across time scales represents a significant challenge.

Water further couples the terrestrial biogeochemical system to the climate system. The availability of water is, obviously, an important regulator of plant productivity and sustainability of natural ecosystems. In turn terrestrial ecosystems recycle water vapor at the land-surface/atmosphere boundary, exchange numerous important trace gases with the troposphere, a central concern of the International Global Atmospheric Chemistry Project (IGAC) and, in turn, the Stratospheric Processes and their Role in Climate (SPARC) project of the WCRP. Moreover, soil moisture is a key component in the land surface schemes in GCMs, since it is closely related to evaporation and thus to the apportioning of sensible and latent heat fluxes. Scientists working through the Global Energy-Water Experiment (GEWEX) of the WCRP and BAHC have significantly extended our understanding of this coupling over the past ten years of work.

Soil moisture is pivotal in the formation of runoff and hence riverine flows. Further, soil moisture is an important determinant of ecosystem structure and hence a primary means by which climate regulates (and is partially regulated by) ecosystem distribution. Finally, adequate soil moisture is an essential resource for human activity. Consequently, accurate prediction of soil moisture is crucial for simulation of the hydrological cycle, of soil and vegetation biochemistry (including the cycling of carbon and nutrients), of ecosystem structure and distribution, and of climate.

River systems are linked to regional and continental-scale hydrology through interactions among soil water, evapotranspiration, and runoff in terrestrial ecosystems. River systems, and more generally the entire global water cycle, control the movement of constituents over vast distances from the continental landmasses to the world's oceans and to the atmosphere. Rivers are a central feature of human settlement and development. Rivers begin with soil moisture and runoff; each of these is linked directly to land-

use and land-cover, which is the focus of Land-Use/Cover Change (LUCC), a joint project of the International Human Dimensions Programme on Global Environmental Change (IHDP) and the IGBP. Rivers end in and are key features of the coastal zone and hence of central consideration of Land-Ocean Interactions in the Coastal Zone (LOCIZ) project. Finally, rivers deliver more than water to the ocean; rivers contribute significant quantities of nutrients to coastal oceans and hence are linked to coastal fisheries. The climate-fishery-human dynamics link is just now being fully appreciated because of the work of the Global Ocean Ecosystem Dynamics (GLOBEC) Core Project with LOCIZ and JGOFS. Such studies will clearly play an increasingly important part in the future of the multi-faceted Global Change System for Analysis, Research, and Training (START). Finally, each of the Core Projects as well as the cross cutting efforts are data and information dependent (e.g.., in part on the IGBP-DIS).

Thus understanding the hydrological cycle and water resources is bound up with understanding the human system as well as understanding the biogeochemical and climate systems. Hence two, studies of the global carbon and water cycles, of the three new "overarching" activities of the IGBP are themselves linked. The third activity of Food and Fiber is obviously strongly linked across the IGBP and out to WCRP and IHDP.

When the IGBP was first established, it was recognized that the achievement of its science goal and objectives required an unprecedented degree of international cooperation and interdisciplinary. Much effort has been expended on the development of an organizational structure and activities which promote the formation of research networks transcending national and disciplinary boundaries. This "carbon story" reveals just how important such "transcending is". These networks have not only allowed the identification of the key scientific priorities based on a global consensus view, but they also allow the closely coordinated development and execution of nationally funded research efforts, maximizing the scientific progress achievable. This is especially the case when results are pooled and outcomes and conclusions synthesized, both at the Programme Element and Programme level.

The first Five year Implementation Plan, "IGBP in Action" (Report #28), provided an overview of the research activities planned for the period 1994-1998. During the implementation period, substantial scientific progress has been made. As the lighted sign on the Eiffel Tower tells us, we are now about to enter the next millennium. The beginning of the new millennium is a good target date for the production of an IGBP synthesis. No doubt it will be a time when humanity takes stock of where it has come and where it is going. Similarly, it is appropriate for the IGBP to pull together and synthesize what we have learned. How much more do we know about the Earth system, and how humans are affecting it, than we did in 1990? How much of this new understanding has IGBP contributed?

During the past year, the IGBP has made extraordinary progress toward the first Programme-wide synthesis. We have achieved increased coordination between IGBP, WCRP, and IHDP. Within the IGBP, there is the sense of a common challenge, and a shared desire to make the whole more than the sum of the individual parts.

In the last 14 months, the IGBP conducted two very important Programme-wide meetings. First, The Fifth Science Advisory Committee (SAC-V) in September 1998 in Kenya contributed to clarifying the IGBP approach to regional studies, and in May 1999, we hosted a remarkably successful IGBP Congress in Japan. The organization is well positioned for the important decisions that will set the direction for IGBP in the next decade.

In looking to the future, we ask naturally what should be the guiding principles that could serve as beacons for the evolution of the IGBP. Amongst these beacons are those ideas and tenets which have served the IGBP so well over the past decade. Amongst these are that the IGBP should focus on the important scientific questions of global environmental change recognizing that, by definition, this implies that the IGBP will be addressing issues of societal and, hence, political relevance. Within the context of global environmental changes, the primary niche for the IGBP is the chemical and biological processes and the associated biogeochemical subsystem and the interplay with the physical-climate subsystem. This implies, in part, that we must seek to understand global environmental change in the context of the Earth system. This focus has been central to the IGBP since its foundation. Coming out of the SAC-V meeting in Nairobi is the recognition that this global focus should be complemented by a set of regional strategies and foci.

This capacity of the IGBP to change and evolve while preserving its core strengths and focus is central to the long-term sustainability of the IGBP and to its ability to remain effective. This is important to bear in mind as we go through this phase of synthesis and transition. It is also important to remember always that the IGBP's most important resources are people and their scientific credibility and insights. This implies strongly that any evolution must always proceed with care and with attention to the human aspects of the organization.

At the recent IGBP Congress at Shonan Village in Japan and again in a recent IGBP Newsletter, I discussed what might be some of the characteristics of the future structure of the IGBP. Amongst the elements that I see in the future IGBP are a core Earth system science activity and crucial focussed programs. These focussed programs will tend, in the future, to be concentrated at important interfaces in the Earth system, but these "interface efforts will be buttressed by continuing certain "within component" activities. Complementing these Earth system component and interface investigations, the future IGBP will include program-wide, crosscutting studies along key thematic lines such as the carbon system, the global water cycle, and food and fiber.

Regional themes will expand slowly and carefully. Such regional studies will allow specific linkage to societal issues; moreover, regional studies will allow "full" system studies. Finally and importantly, regional studies will allow a connecting of the global with the local while avoiding confronting directly internal national issues and the associate political questions.

For the IGBP, there are several important "next steps":

- complete the core project syntheses
- develop the cross-cutting themes (*i. e.*, carbon, water, food and fiber)
- clarify the outstanding new scientific challenges, and
- host an open science meeting in July 2001.

And as we look further to the future, I believe that the IGBP ten years hence will be perhaps larger and definitely even more international; hopefully it will be younger and more reflective of the world; almost certainly, it will have closer working relationships with WCRP and the IHDP; it will be more capable and braver, and finally and in some ways unfortunately, the IGBP will be even more necessary.

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[1] OCMIP has been led since inception by the Institut Pierre Simon Laplace (IPSL).

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Global Change science in the next century, a personal perspective

by Will Steffen

As we move into a new decade, a new century, and a new millenium, it is natural to look back on where IGBP as an international scientific research programme has come from and where it is going to. Berrien Moore's lead article in this NewsLetter gives an excellent overview of the evolution of the IGBP and the challenging and exciting directions we are heading towards. Here I would like to add some personal reflections on that journey, perhaps less organised and coherent than Berrien's.

My introduction to global change came on a hot summer day in December 1990 in Canberra at the CSIRO Division of Wildlife and Ecology, where I went for an interview for the position of Core Project Officer for Global Change and Terrestrial Ecosystems (GCTE). Brian Walker, the Chair of GCTE, put down a copy of IGBP Report No. 12 on the table in his office and emphatically impressed upon me that if I was to have any hope of doing the job, I would need to understand thoroughly and completely everything that was in that document.

Report No. 12 was indeed visionary for its time, and set out the big questions that IGBP would need to address. But in the usual way of the natural sciences, the big questions were narrowed down into ever more disciplinary, specific and targeted questions until very small pieces of the puzzle were being addressed. This, at least in GCTE, was the well-known hierarchy of Foci, Activities and Tasks. This is a well proven and very powerful approach, and over the last decade has produced many of the building blocks that we need to understand Earth's dynamics better and much science of considerable value in its own right. Somehow, though, IGBP's big questions were pushed into the background.

We have now come a long way since the publication of IGBP Report No. 12. Starting with the first IGBP Congress and now the more recent Congress in Japan, we are witnessing a return to the big questions of IGBP, but now tackling them with (i) the experience of working on ever larger pieces of the puzzle, and (ii) the intellectual and mathematical rigour which typifies work on subcomponents of the system.

In fact, the recent Congress at Shonan Village signals, I believe, a new effort towards truly quantitative, rigorous interdisciplinary science. As I noted at the Congress (see Figure 1), the rapid increase in interest in and work at the systems level is not at the expense of disciplinary, 'component' science, but rather is complementary to it. BOTH are necessary to understand the Earth system, and in Phase II of IGBP, both, working together, will be required to answer the big questions.

The nexus between disciplinary and systems-level approaches was explored in more detail at a recent meeting in Bonn sponsored by the German National Global Change Committee. The final day featured a pair of talks organised in a debate-style fashion, arguing for disciplinary v. systems approaches. Hartmut Grassl, the ex-Director of the World Climate Research Programme (WCRP), was assigned the pro-disciplinary approach. Much to his credit, Hartmut threw away the script and gave an eloquent argument in support of the application of BOTH approaches, synergistically, to address global change questions. It was a testament not only to the evolution of thinking in WCRP, but also to the advances made in IGBP.

No better example of this new ethos in IGBP can be found than the recent synthesis workshop in Stockholm that examined carbon-nutrient interactions across marine and terrestrial systems (see upcoming article in *Science* and in the next NewsLetter on the workshop). Unlike many other such workshops that have attempted to be interdisciplinary, this one broke through the barrier of 'talking at' one another across disciplines. Much more time was spent listening and asking questions, genuinely trying to understand what someone else's discipline might bring to a common problem. Participating in the workshop was a fascinating, stimulating and inspiring experience.

There are an increasing number of examples across IGBP of a systems-level approach, transcending disciplines, being applied to global change questions. For example, the work of BAHC, reported in the previous special issue of the NewsLetter, and other research in IGBP demonstrate that the terrestrial biosphere is a fully interactive, essential 'player' in the dynamics of the Earth system and not a 'passenger' passively impacted by whatever changes a coupled ocean-atmosphere system dishes out. 'Impact studies' have evolved from being simple 'driver-impact-consequence' sequences based on linear thinking to integrated assessments, in which a complex, linked biophysical-socioeconomic system is influenced by mul-

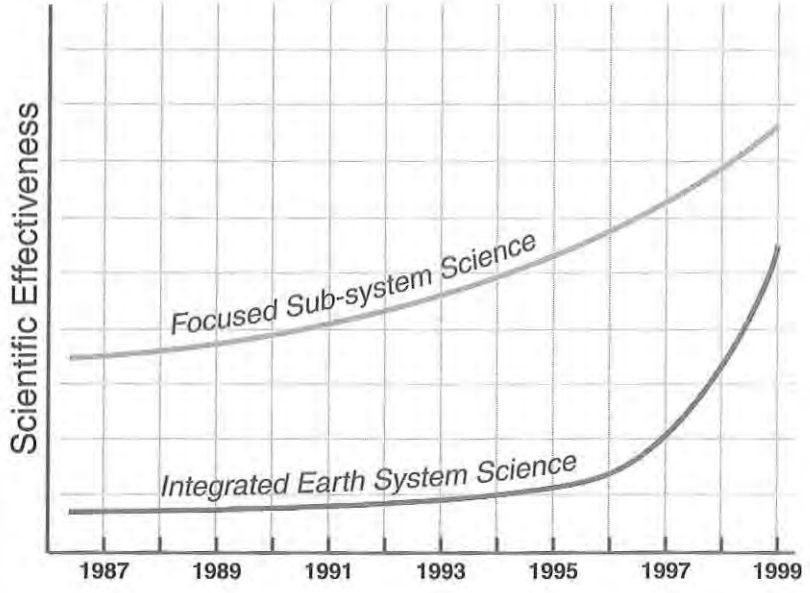

Figure 1. Understanding Earth system dynamics requires a solid foundation of disciplinary science.

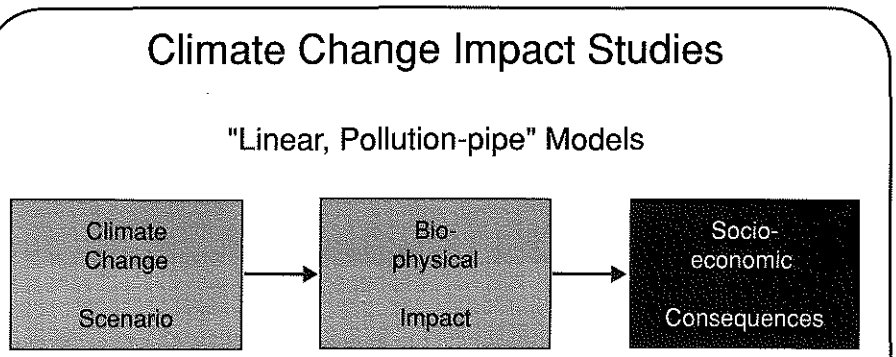

Figure 2. The old "pollution pipe" approach to climate change impact studies (L. Kohln, personal communication).

tiple, interacting drivers. The subsistence rangelands project in southern Africa, which contributes to GCTE and LUCC, is a good example of this approach (see Figures 2 and 3).

Although progress has been impressive over the past 10 years, there are numerous challenges facing IGBP Phase II over the next decade, and I'll conclude by focusing on three of them.

The first is a somewhat practical issue yet is more profound than most people realise. Despite much progress in the global change research community towards making its work truly global, it is still far too dominated by the North America-Western Europe axis. This has become exceedingly obvious to me, having shifted my working base and residence from Australia to Sweden. How often have you heard the timing of a future activity described as being in spring, summer, autumn or fall, without the preface 'northern hemisphere' being used? This is more than a simple oversight; it represents a deeper cultural and geographical bias that pervades IGBP and its partner global change programmes. We all know intellectually that planetary dynamics must be understood beyond the North Atlantic axis, but there is still a very long way to go to internalise this message across the entire range of global change people and organisations.

Second, the global environmental change research community must be careful in developing its scenarios of the future never to forget or underestimate the ingenuity of humans and their societies to adapt to change, a point made frequently to me by the new Executive Director of ICSU, Larry Kohler. For example, according to some earlier scenarios of environmental degradation, London should now be about five metres deep in horse manure. And we must not forget that the Stone Age did not end because of a global shortage of stones.

Nevertheless, the current range of global environmental problems are unprecedented in their complexity and extent, and to deal with them will require the full range of both cleverness and wisdom that humans can muster. This raises the third challenge to the scientific community – we must effectively integrate the social and natural sciences, and this requires, most of all, mutual respect and an ability to look beyond one's own paradigms and world views. I know that this has by now become somewhat of a mantra and that we are beginning to develop ways of working across the natural and social sciences, but it is very much still a beginning. Too often the social sciences are viewed as an 'add-on' at the end of a project. Effective integration must start at the design itself of the work, with some fundamental issues: whose questions? whose agenda? whose paradigms? whose approaches?

As Berrien noted in his article, the IGBP (and WCRP and IHDP) of the next decade will need to tackle questions of major societal importance, and hence intrinsically of a policy and political nature. Perhaps IGBP's overarching goal, set out clearly in IGBP Report No. 12, needs now to broaden, perhaps to be common across all of the global environmental change programmes, and to move the next step from description and understanding to proactively providing the knowledge base needed to help societies live with global change:

"How can the increasing 'human enterprise' be adapted or managed to develop in synchrony with the dynamics of the Earth system?"

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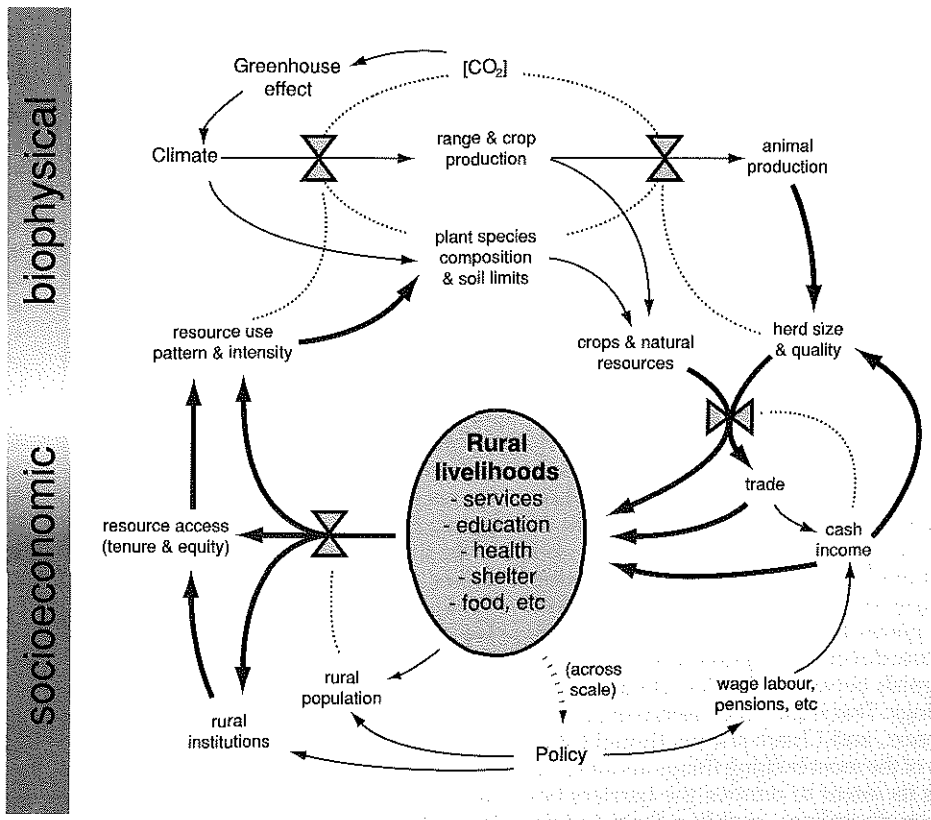

Figure 3. An integrated systems approach to global change studies (from GCTE/LUCC Substance Rangelands Project)

Assembling an Earth System Puzzle: A personal perspective

by Neil Swanberg

Not long ago, my two-year-old son was playing with two puzzles from the same company. As his assistant, I noticed that whilst the pictures were different, the factory had used the same template in cutting the wooden pieces, so that the corresponding bits of the two puzzles were identical in shape. Feeling rather mischievous (or perhaps bored with the puzzle after the tenth time or so), when he wasn't looking I scrambled the pieces from the two puzzles and assembled both with about half the pieces from each. Needless to say, though the pieces fit perfectly, the pictures resulting were chaotic and made little sense. When he saw it, he was not amused, making it clear in no uncertain terms that Papa had done this completely incorrectly, would kindly not mess around with the puzzles in future, but was welcome to do it properly. Clearly in his view the object of assembling the puzzle was both to get the pieces to fit together physically, and to discover the resulting picture, which was not to be a surprise.

The IGBP is methodically pursuing a vast array of carefully planned and detailed scientific stories, each of which might be thought of as a piece of some colossal hierarchical puzzle of nature. We have the task of not only constructing these pieces of the scientific puzzle, but also assembling them into larger and larger pictures to resolve an emerging understanding of the Earth System. We do not have my son's advantage of knowing how the final picture will look.

We have some other challenges to consider as well. We can think of the shapes of the pieces of our puzzle as relating to the way scientific disciplines are constructed, they may also be geographic, and they relate to the scientific picture they carry. Often as not they are a function of our very human way of looking at and dividing up the world. In our scientific puzzle, we must ensure that the shapes of the pieces have minimal impact on the picture developed. People, not nature distinguish between physics, chemistry or biology. This is the very essence of system science., and I have always thought that one of the most exciting things about IGBP was its intent to remove the barriers between disciplines, enabling them to join forces to attack difficult problems. If IGBP succeeds at that, it may well have done much more for science than achieving an understanding of the Earth System - hardly a small accomplishment in itself.

When I started with IGBP in 1993, it was comprised of a number of separate projects, each struggling mostly with its own agenda. As I attended meetings of various of these projects, I soon realised that invariably each of these groups considered their projects to be very unique, facing far more complicated scientific problems than any of the other projects. There was keen interest in the goals of their project, but not always a real sense of that project's function in the programme as a whole. It was as though the largish bits of the puzzle were being built very carefully from their sub-bits, but without a great deal of attention to how they would fit with the other large bits of the IGBP puzzle. I am happy to say that in 6 years, this situation has changed dramatically. The projects are now eagerly looking over the shoulders of their nearest partners, both within and outside of the programme, as they build and assemble their bits, and are making adjustments as they progress. Indeed, this is the main thrust of the synthesis, and it represents a significant movement towards a truly coherent programme.

I still have a nagging concern though. Think back to my son's two puzzles. Being cut from the same template, they fit perfectly together, but resulted in what seemed to him a nonsensical, disturbing whole picture. Even if we can fit our puzzle pieces together, what will happen if we don't continually ensure that we are all working on the same puzzle? It is necessary, but not sufficient that each puzzle bit be properly designed. It must also fit within the context of the whole. That requires serious efforts at an early stage to gain a glimpse of the whole picture. This is the thrust of the programme-wide synthesis.

The problem is that whilst the picture we are trying to construct derives from nature, we have not really built our puzzle by cutting up a known picture, but are trying to do the opposite. We have identified bits and pieces that we think belong together in a picture of somewhat vague form. We have no guarantee that once we assemble the pieces we will either use all the bits, or complete our picture. We may need to discard some pieces, surely we will find that some bits were just done wrongly, and probably we will find holes in the final puzzle, that require new bits to be constructed.

As humans we need to be able to believe what we see: this is what upset my son so much. He can surely be forgiven, for he was only two, but IGBP must be prepared for the possibility that the picture emerging is not what it expects. This is why we must constantly engage in an iterative process that attends to both the detailed scientific content and correctness of the small bits of each puzzle, and also addresses the way the various puzzles we are constructing fit together in a larger picture. This will require painstaking vigilance, patience, and hard decisions, both from those trying to achieve a grand view and from those working on the detailed bits of the puzzle.

Barry Hubert, for whom I have the highest respect, recently used an interesting phrase in this NewsLetter. *'If you only look up, you will likely trip on a crack in the sidewalk and fall flat on your face.'* The moral (assuming one was in motion and not just gazing at the sky) was that to make progress one also has to keep looking down. The operative phrase is 'keep looking' - implying to me 'periodically'. It should be obvious that if one only looked down, one would probably not get to where one thought one was going. Personally I usually even try to cast a glance to the side now and again to enjoy the scenery.

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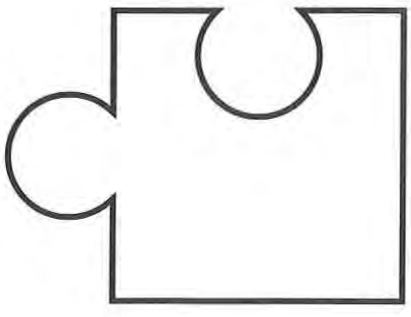

World's Manifold Webs

by João Morais

A number of contributions in this issue sum-up eloquently the essence of IGBP's lessons learned over the past decade and present us with well articulated visions of the path ahead. I would also want to make reference to an informative article published in the IHDP Newsletter (1) addressing an aspect of the rationality principle in social science research, as well as to a complementary reflection published elsewhere (2). In my perception they highlight, among other ongoing work, a clear opportunity for an open discussion of problems, theories and the criticism which will help in proceeding down the path.

Here I will try to add briefly a note concerning the opportunities and the challenges of addressing global change research under a highly diversified and ever changing social and scientific kaleidoscope. A new millennium emerges as an analogue for a renewed effort to find a panacea for the world's many problems. History will never repeat itself, but reviewing its major steps critically, particularly making use of what the history of science has to offer, may help us better understand where we are as well as the obstacles or progresses that shaped particular world views (3).

Practical solutions are what societies and good governance eagerly strive for. For scientists this provides the social context for aiming to explain the nature of today's problems. Such needs are increasingly reflected in the nature of the scientific debate and are at the core of the Global Environmental Change Programmes. To have reached a programmatic level of scientific criticism, questioning how to go beyond disciplinary and international barriers and *modus operandi*, is in itself an important achievement. The social awareness and responsibility of the scientific community involved is a good example of the type of rationality and civility that governments and civil society should learn from, to pro-actively support and to further promote.

As I drafted the figure annexed to illustrate one of the many ways of representing the nature of global change I realise that one of its strengths is to address a common problem situation *and* to do so at a long time scale, being in that sense at the core of epistemology itself. It is indeed in beginning with a common problem that science, beyond any disciplinary divides, can be best understood and make progress. Additionally, the degree and magnitude of extant challenges very much require new tentative knowledge. Such a process of questioning for relevant answers, is as old as humanity itself and prominent since the ancient Greek atomism of the fifth century BC. Interestingly, my illustration still reflects the quest for explanations of the continuum and the void which are at the base of western philosophy from where modern science emerged. Historically, science's frontiers will always preserve the universal principle regarding the explanatory power of theories until they are proven wrong and replaced by new ones.

The (environmental) ethical dimension of the global change debate, which is a fundamental responsibility of scientists and intellectuals, is one way to directly address shared societal concerns. In tandem with a common sense of corporate identity, there are methodological principles which are being reflected positively in a better perception of the similarities and the differences between natural and social sciences. Both, in studying either 'singular' or 'typical' events, rely on the importance of models. However, social sciences operate mostly through characterisation of typical situations and hardly find applicable the usage of universal (singular) laws. Operating around such 'typical' situations is sometimes wrongly identified with methodological vagueness. There is clearly less 'explanation in detail' and more 'explanation in principle'. It is expected that social scientist will revise their tools as they increasingly operate at larger spatial scales and will fine-tune applicable models.

For social sciences the fundamental problem is to explain events in terms of human actions and social situations. Social science models aim at reconstructing 'typical social situations', which in the natural sciences realm would be labelled as 'initial conditions'. However, typical social situations (e.g. 'social institutions') are well embedded in physical bodies as illustrated, among other examples, in the type of human habitat or socially constructed systems impacting biophysical changes, namely at the level of production, distribution and consumption of goods and services at larger spatial scales. Such

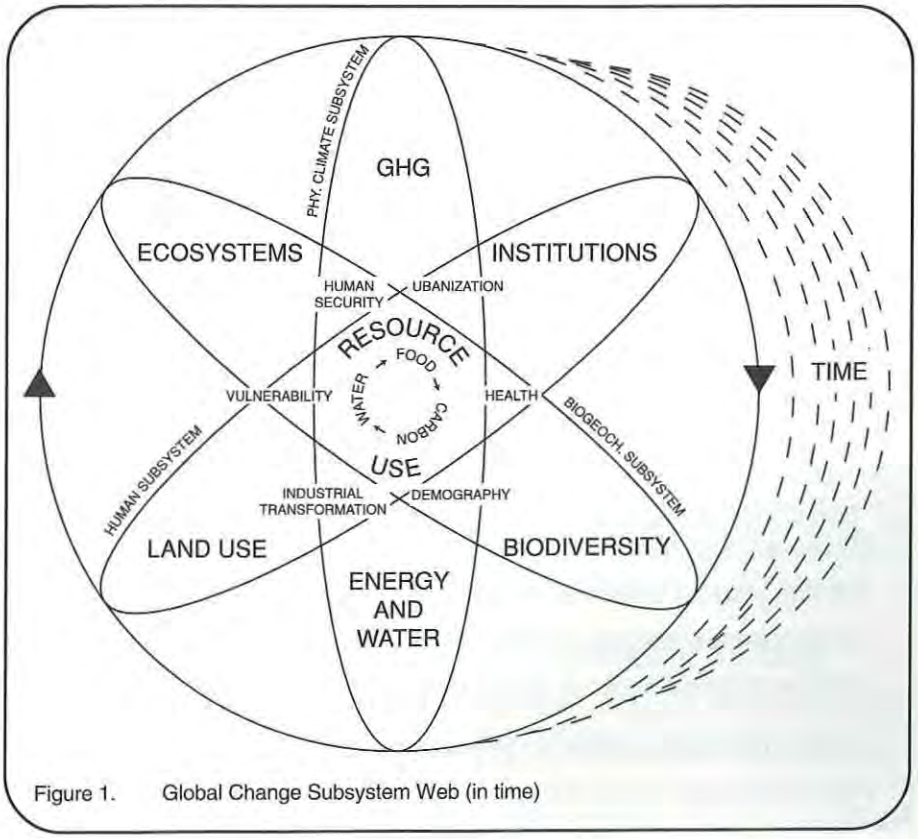

Figure 1. Global Change Subsystem Web (in time)

'indicators' expressing a rationality principle are reflected in accumulated societal knowledge and cultural behaviour, criteria which are being integrated in new global change modelling efforts and of crucial importance for their calibration and validation where historical output is the best approximation to a 'real system' (4).

To better understand the relationships between objective typical social situations in the context of global change is to be able to model or find theories that best explain 'initial conditions' rather then universal laws. In the social sciences the testability of models depends upon various situational analyses (which as in the physical sciences can also involve a low degree of testability) against the background as provided by historical research and insights learned from the history of science. But both physical or social science models, like any other model, are oversimplifications, and can never be 'true'. Still, it might be arguable the possibility to draw the parallel between some laws of the natural sciences and the rationality principle of social sciences.

A school of thought has emerged from the 80's attempting to view social science from the perspective of modern systems theory (5), which has been particularly useful in developing historical descriptions of evolutionary systems. It is a tantalising challenge to operate in empirically testable principles common to human and natural environments that would make comparable concepts like self-organisation, pathway dynamics, multiple feedbacks and threshold change. This might be something to explore by the global change research community beyond the sociological applications with which that school has been mostly identified. Promising analytic tools are now emerging from ongoing IHDP-IGBP collaborative efforts, such as the one addressing problems of 'fit', 'interplay' and 'scale' in social institutions and biogeophysical systems (6), which should provide us with new testable social theories.

Never before has humanity been able to impact and witness feedbacks of our imprint in the biophysical world at such extensive spatial and temporal scales. Global Change research offers the opportunity to attempt to get nearer to 'the truth', both in favour of scientific realism (an epistemological principle) and as a matter of human sustainability and universal well being (an ethical imperative). The extant socioeconomic and environmental disruption provides the social sciences with new case studies which may shed some light on the reasons why particular competing theories offer a better approximation to the truth than others. Questions originate from paramount problems, such as how best to implement international regimes, why there is poverty and how to improve human security. Social sciences and *humaniora*, in such a context, are well placed not only to avoid pseudo questions but to further aim at solving practical problems. It is therefore arguable that never as before was the scientific enterprise in a position to aim at achieving a unified methodological approach to explanatory situational models *and* to be critically able to witness the consequences of irrational actions. Hopefully both are acting together towards reaching a more intellectually and materially fulfilling world.

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Second General Assembly of the WCRP project on Stratospheric Processes and their Role in Climate (SPARC)

Date: 6-10 November 2000

Location: Mar del Plata, Argentina

The second General Assembly of the SPARC project will review current research on the role of the stratosphere in the climate system and in global change.

The four sessions will be on the following themes:

- stratospheric processes and their role in climate,
- stratospheric indicators of climate change,
- modelling and diagnosis of stratospheric effects on climate,
- UV observations and modelling.

Further information is available at: www: http://www.sparc2000.at.fcen.uba.ar/ E-mail: sparc2000@at1.fcen.uba.ar

Abstract deadline: 30 April 2000

Freshwater resources research in Africa

by Mike Fosberg, John Gash, Eric Odada, Lekan Oyebande and Roland Schulze

From 26 to 30 October 1999 sixty-seven scientists, policy makers and representatives from funding organizations got together in Nairobi for a workshop to discuss freshwater resources in Africa. The participants, who came mostly from African nations, but also from Europe and North America, were given the task of developing an integrated physical and social science agenda to identify the best way for IGBP and IHDP research to contribute to the development of African water resources.

Arid and semi-arid lands make up one third of the Earth's land area and support twenty per cent of its population. The extreme variability of precipitation, both in time and space, and the high potential evapotranspiration in drylands makes water resources, and hence plant productivity unpredictable - often resulting in high cost through human suffering, especially in developing economies. Today, human population growth with its associated changes in land use, and potential climate change threaten the integrity of dryland ecosystems and the success of traditional agricultural practices in these regions.

Freshwater resources and changes in those resources are perhaps the most important global change issues in sub-Saharan Africa. Water availability, vulnerability of natural and socio-economic systems, changes in land use, and a sound science base for developing policies for sustainable use of water resources are the major issues. Behind these issues are the science questions of how to assess water resources and their vulnerability, and the driving forces behind land use change. These issues call for integrated studies of the interactions between land use and climate which address not only natural, but also social systems.

A number of challenges were addressed during this workshop. We needed to define issues and problems, not in the context of disciplinary science, but in the broader context of integrated and complex systems science, and to structure thinking around the environment within which a policy maker works. We needed to develop a vision of the future, a realistic and achievable future.

Water and human health

Human health depends on an adequate supply of safe water. The consumption of water containing bacteria and parasites, water borne diseases, and the consumption or contact with water containing non-biological pollutants all impair human health. The workshop identified a number of priority responses where, by linking the natural and social sciences to the health sciences, the problems of poor water quality could be reduced. Education (both formal and informal), the provision of safe water, the maintenance of water standards and building capacity in analysis, and monitoring of systems were highlighted as needing interventions. The problems of provision of safe water in the fast expanding urban areas were emphasised as needing urgent new thinking - particularly for informal urban settlements.

Hydrology

Water resources can be divided into "blue" water: surface water, which is in, or bound for, rivers, and "green" water: water used by plants.

There are large amounts of data available on "blue" water, but they are fragmented, difficult to obtain and the collection networks are deteriorating. There is a need to revisit these data and to improve their quality and accessibility. There is no single institution with responsibility for developing this capacity, but there is an excellent precedent in ACMAD (African Centre of Meteorological Applications for Development), which is active in building this type of capacity in meteorology and climatology.

Most of the population does not live near large rivers, but obtains its water from small catchments or groundwater. Water implies food security, and there is a need to increase the knowledge of the "green" water component - how that water can be used most effectively to increase food production. However, the conventional physical approach to studying water use needs to be integrated with a social science approach which includes the human aspects. In this context the workshop welcomed the first plans of the new UNESCO initiative, HELP (Hydrology, Environment, Life and Policy): a coordinated international network of catchments based on this philosophy, which aims to provide policy makers a steady flow of water-related information.

Integrated Land and Water Management

Integrated Land and Water Management was recognised as the essential framework needed to bring together the physical, social, economic and legal aspects of water resource management and development. Integrated Land and Water Management aims to optimise simultaneously: social equity, economic efficiency and environmental sustainability.

Integrated Land and Water Management entails:

- horizontal integration: integration among adjacent land users and land uses within catchments; between upstream and downstream users; among domestic, industrial, urban and other users; and among governments sharing river systems; and
- vertical integration: integration among the range of organisations and institutions functioning at different scales and strives to achieve;
- maintenance of adequate amounts and quality of water to all water users
- prevention of soil degradation
- food security, and
- prevention and resolution of conflicts between water users

While there have been successful examples in developing an integrated approach to land and water management, there are many examples of failure. It is important to investigate the reason for failure.

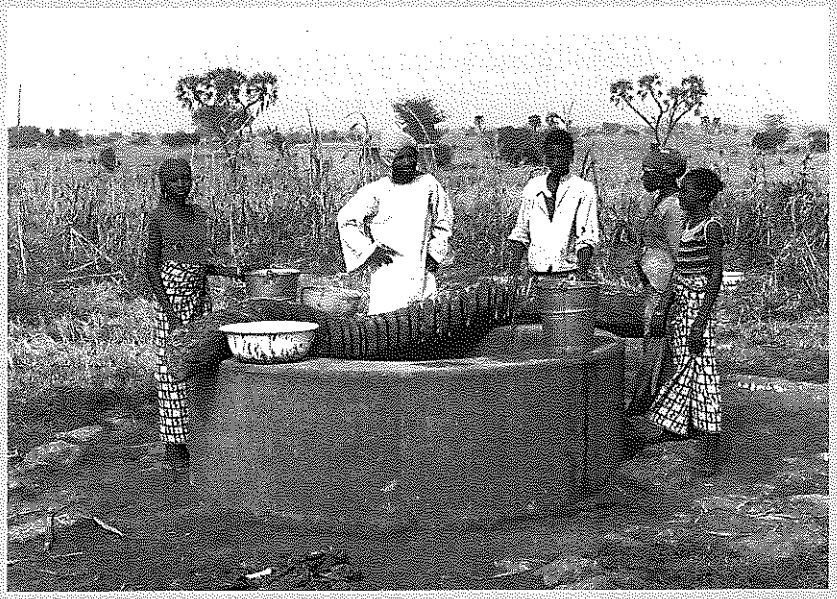
Capacity Building

The need for capacity building is ubiquitous throughout water resources science and management and, therefore, all the working groups at the meeting considered capacity building. But capacity building

Understanding groundwater recharge is emerging as a priority research topic: but an integrated approach is required to fill the gaps in the underpinning physical and social knowledge.

In much of semi-arid Africa groundwater is the only source of water during the dry season. Yet groundwater may often be an under-utilised resource - there is a need to identify those areas where the sustainable yield of aquifers is not being fully exploited. In Africa the process of groundwater recharge is complex: episodic in time and spatially localised, often occurring only through riverbed transmission losses. This is especially the case in semi-arid regions, where recharge is unlikely to occur over the whole landscape, but to occur only where factors such as topography or anomolies in rainfall act to maintain the necessary saturated soil moisture profile. Research is needed into how and where these factors can combine to give groundwater recharge. Global climate change and the natural variability in rainfall climate exacerbate the problem of estimating the long-term, sustainable yield of aquifers. Better, quantitative estimates of aquifer recharge, and thus their sustainable yield, will only come from taking an integrated approach which includes, not just the hydrogeology and soil physics, but also the vegetation, weather and climate.

The approach of integrated catchment management recognises that, in many cases, a loss from one part of the system is a gain to another. In this context, the concept of sustainable groundwater yield is itself open to question. Exploitation of an aquifer in one place may lead to a reduction in the groundwater available in other places. Over-exploitation of groundwater may lead to reduced base flow in rivers fed from aquifers. Managing groundwater exploitation in a sustainable way thus requires knowledge of the resource, but also an understanding of the social structures needed to ensure equitable allocation of that resource. The sustainable management of the water resource can also not be separated from the management of the infrastructure, in terms of operation and maintenance. The social and legal problems associated with allocating groundwater are thus likely to increase as this resource is further exploited. Integrated catchment management should include integrated aquifer management.



Courtesy of Jon Finch

In much of semi-arid Africa groundwater is the only source of water during the dry season.

must not be restricted to the Eurocentric view of human resources, institutions and infrastructure. Water resources in the developed world are managed within organisational and legal frameworks that are very different from those usually encountered in Africa, and a more Africentric approach should be developed. Freshwater resource experts should be trained, not just in scientific and technological methods, but also in institutional management, the appropriate legal frameworks, and in the skills of community involvement.

Issues

The workshop identified six constraints or deficiencies, which must, and can be, addressed by the scientific community.

- *Deficiency of information and understanding*. These include recognizing that water has value, and what the value of that water is, and using that value in project planning and evaluation. It also includes collation and assessment of the information from data and the mechanisms for disseminating that data and information. Much information has been collected in the past to support disciplinary science and knowledge. One of the recommendations of the workshop was to revisit that information and knowledge in the context of an integrated system.
- *Deficiencies of governments.* How strong are our institutions? Do we need new institutions? How aware is the public of water issues? Do we have adequate and appropriate networks of institutions, policy makers, managers, stakeholders and scientists? Are the national and international and regional policies and legal mechanisms consistent and appropriate?
- *Deficiencies in capacity.* Do we have the appropriate technical skills to address water resource issues? Do we have the mechanisms to pass on skills, knowledge and information to the public? Do networks and extension services exist to promote information sharing?
- *Deficiencies in land management options.* How do we develop coping and adaptation mechanisms, and share this information? How do we identify trade offs? How do we create stakeholder buy in?
- *Deficiencies in water management options.* What are the optimal

This article continues on page 15.

The PAGES/CLIVAR Intersection: providing the paleoclimate perspective needed to understand climate variability

by Keith Alverson

The PAGES/CLIVAR Intersection seeks to promote international, interdisciplinary collaboration between paleoscientists and the climate modeling community. The four principal areas of research emphasized are:

- Extending the instrumental climate record back in time with quantitative, annually resolved proxy data.
- Documenting and understanding rapid climate change events.
- Documenting and understanding natural climate variability during warm interglacial periods with background climatic states similar to those of today.
- Testing the ability of climate models to capture known past climate variability.

Extending the instrumental record

The instrumental record of climate change is too short to capture the full range of climatic variability on decadal and century timescales. However, numerous proxy records of climate variability exist, often with annual resolution, during the period prior to the beginnings of instrumental records. Annual, or better, resolution records of temperature and precipitation include, but are not limited to, documentary evidence, ice cores, tree rings and speleothems (figure. 1), varved lake sediments (figure. 2), and corals (figure. 3). Individual proxy records such as these can be combined to produce global reconstructions of the spatial and temporal patterns of climate variability during recent centuries (Jones et al 1998, Mann et al 1999). Such reconstructions show that recent rise in northern hemisphere temperature is unprecedented within at least the past 1000 years.

In addition to individual climatic variables, major dynamical phenomena are also captured by proxy records, and can therefore be reconstructed. Examples include the North Atlantic Oscillation, which has been reconstructed with monthly resolution extending back to 1675 (Luterbacher et al, 1999) as well as the Southern Oscillation Index (Stahle et. al., 1998). Proxy data also provide a record of past changes in climatic forcings. Greenhouse gas levels, for example, are measured from air pockets trapped in ice cores. Records of volcanic eruptions, and their climatic influence, have been compiled (Zielinski, 2000). Proxy records of insolation variation are also available, for example from measurements of ^{10}Be in ice cores (Beer et al 2000).

Warm climate variability

There are numerous examples of climate change on societally relevant timescales during the relative warmth of the Holocene (roughly the past 10 millennia). Understanding climate variability during warm interglacials is of particular importance for improving predictive climate models which are initiated from modern, warm, background climate conditions. For example, century scale variations in hydrologic balance reconstructed for two widely separated lakes in tropical Africa imply dramatic shifts in the precipitation/evaporation balance much greater than any to be found in the modern instrumental record (Gasse and Van Campo, 1994). Lake level records in the Central USA also reveal periods of intense, multi-decadal drought which far outweigh even the severest events in the historical record (Woodhouse and Overpeck, 1998). Looking further back in time, there are signs from several high resolution archives, for example ice core records and Chinese loess, that at least one major interruption occurred during prevailing warmth of the last interglacial (some 115 - 125k years ago).

Rapid climate shifts

The proxy record is replete with examples of rapid climate change. Such events indicate that strong non-linearity exists in the dynamics of the climate system and present particularly vexing problems for predictability. One well known example is the termination of the Younger Dryas cold event, some 11.6k years ago, an abrupt climatic shift with a probable global signature, albeit with different phasing in different locations (Blunier et al 1997, Steig et al 1998, Thompson 2000). In the record from Central Greenland, this abrupt shift is manifested as a warming of around 15 °C, accompanied by a doubling in annual precipitation volume, occurring in less than a decade (Alley et al, 1993). The Younger Dryas is not a unique event. During the last glacial period, a series of rapid and large climatic shifts occurred which are well documented in a variety of proxy indicators around the world. At present perhaps the most widely accepted explanation for these climatic instabilities is based on thermohaline circulation changes induced by fresh water pulses into the northern North Atlantic due to continental ice sheet instabilities.

However, rapid climatic shifts do not depend on the presence of large ice sheets, as they are not limited to glacial times. Slowly changing insolation forcing, modulated by non-linear oceanic and continental biospheric processes, probably led to "threshold crossing" behavior and the rapid monsoon climate shifts which led to the desiccation of sub-Saharan Africa during the mid-Holocene (DeMenocal et al 2000). The mechanisms for rapid shifts such as that seen in these examples are poorly understood, and have yet to be adequately simulated by the General Circulation Models (GCMs) currently being used for climate prediction.

Paleoclimate modelling

Paleodata can provide real scenarios against which to test the performance of climate models. For example, a first-stage comparison has been performed between numerous GCM simulations and African lake level data for 6000 years before present. Despite reasonable agreement between models over the Sahara/Sahel region of Africa, all models initially failed to simulate the strong positive hydrological balance demonstrated by the paleodata (Joussaume et al 1999). Recognition of this initial mismatch has led to a fruitful interaction between data and modelling communities out of which is emerging a better understanding of the sensitivity of models, and of the climate systems which they represent, to changes in vegetation, land cover and surface moisture (DeMenocal et al 2000).

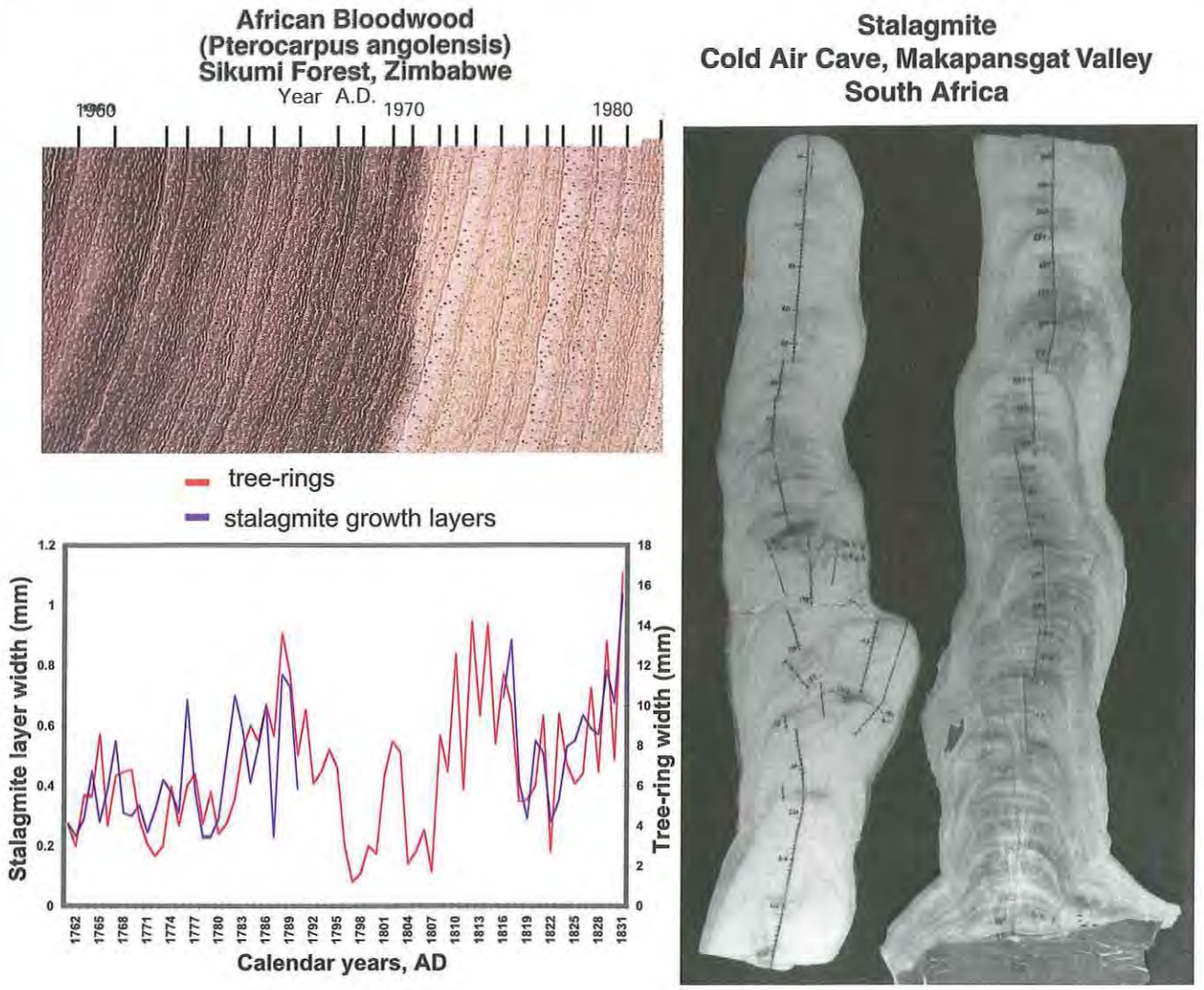


Figure 1. A comparison of Makapansgat Valley, Cold Air Cave T7 stalagmite growth layers with tree ring widths from a *Podocarpus falcatus* specimen taken from the Karkloof about 1000 km to the southeast of Makapansgat Valley (Holmgren et al 1999). The gap in the stalagmite growth layer curve corresponds to an area where growth layers were too thin and indistinct to be measurable. Both of these proxies are thought to respond primarily to moisture availability as a climatic control. Comparison of the two proxies adds confidence in the reconstruction techniques. The high correlation is, for example, one strong argument for interpreting the stalagmite banding as annual growth layers. The accompanying photos show (1) the stalagmite used to produce this data with markings indicating where isotope samples were taken (courtesy: Ola Svanered) and (2) annual rings in *Pterocarpus angolensis* from Sikumi Forest, Zimbabwe, another southern African tree species with growth controlled primarily by moisture availability (courtesy: D. Stahle, in Dunbar and Cole 1999).

As part of the Paleoclimate Modelling Intercomparison Project (PMIP), 19 Atmospheric GCMs have been run with identical boundary conditions (i.e. ice sheets, atmospheric CO_2 concentration, sea surface temperature, sea ice extent, and the Earth's orbital parameters) relevant to the conditions at two time slices: the Last Glacial Maximum and the so called "Holocene Optimum," 6000 years ago. Alongside such comparison efforts, paleoclimate modellers have begun to employ both intermediate complexity models capable of creating long time series to compare with the proxy record, as well as fully coupled ocean-atmosphere, and even ocean-vegetation-atmosphere, GCMs.

Future plans

Interaction between PAGES and CLIVAR is driven by the overlapping interests of the paleoclimate and climate prediction research communities. Paleoscientists rely on modern instrumental records in order to calibrate and validate their proxy climate reconstructions while climate prediction relies on the information about decadal and century scale variability which long, high resolution, multi-proxy paleorecords provide. Project-driven interactions of this nature have led to significant scientific advances. However, the tremendous range of proxy material needs to be harmonized and made readily available to the wider climate research community. The task of coordinating this effort is central to the PAGES/CLIVAR Intersection. Following on from the initial success of the first PAGES/CLIVAR Intersection meeting (Duplessy and Overpeck, 1996), and riding the momentum from the CLIVAR international meeting (Alverson et al 1999), an ambitious series of PAGES/CLIVAR workshops, open meetings and short courses, with equal representation from the paleoclimate and climate dynamics communities, is underway.

October 1999, Venice: **Climate of the last Millennium**

November 2000, Hawaii: **ENSO and Monsoon Variability in the Pacific**

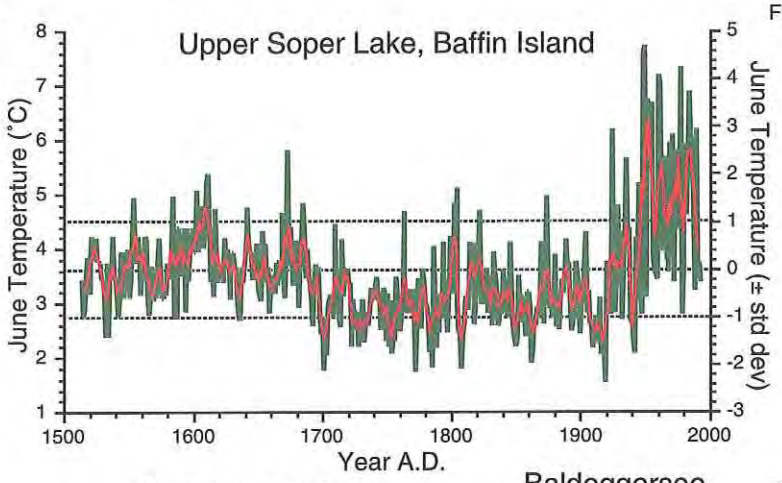


Figure 2. Quantitative temperature reconstruction based on calibration of boreal spring/summer laminae thickness in Upper Soper Lake near the north end of the Labrador Sea on southern Baffin Island (Hughen et al, in press). The time series clearly shows the Arctic Little Ice Age and also the dramatic warming of this century. The standard deviations for the record show that this century is statistically unprecedented in the last 500 years. The accompanying photos show examples of varved sediments (1) as an X-ray radiograph of 14 mm of fresh sediment from Lake Korttajarvi Finland together with a scanned greyscale sediment image of the same sample in epoxy resin (courtesy: Timo Saarinen) and (2) a freeze core with annually laminated sediments from Baldegger See, Switzerland (courtesy: Andre Lotter).

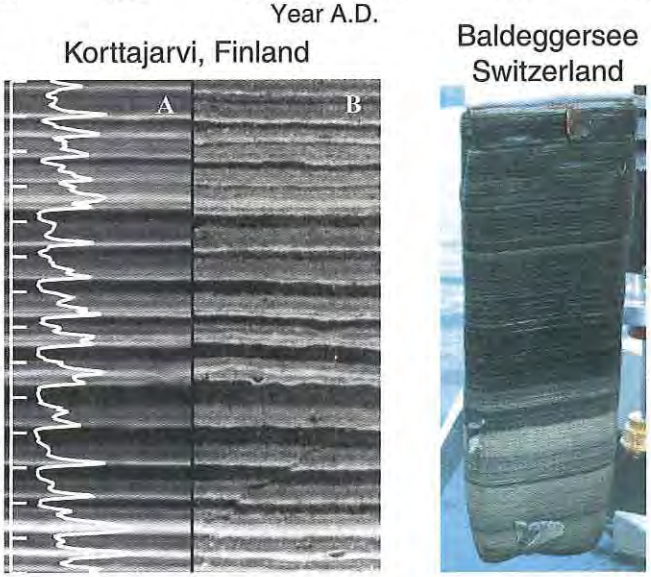
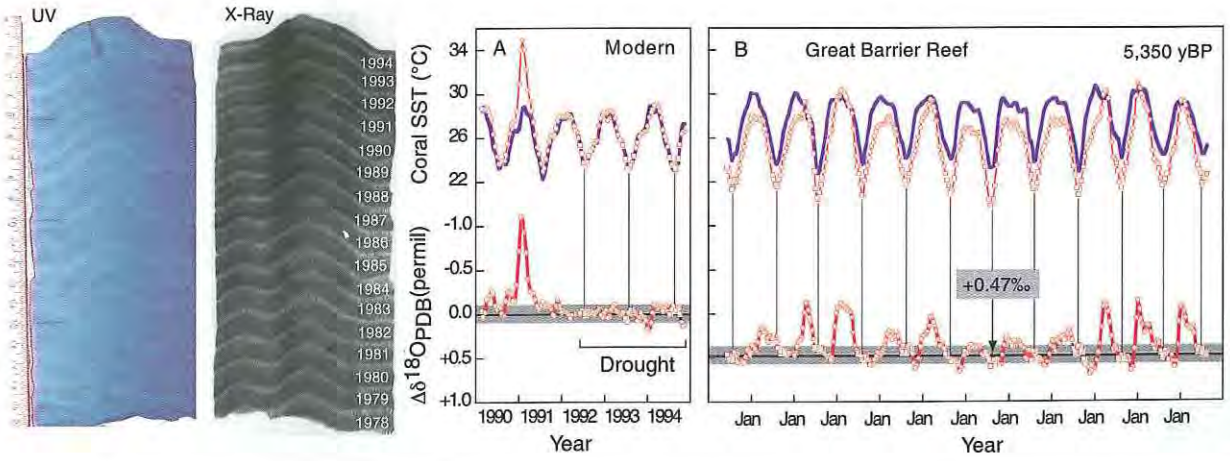


Figure 3. Comparison between sea surface temperatures calculated from coral Sr/Ca ratio (blue curves) and $d^{18}O$ (upper red curve) for modern (left) and 5,350 yrs BP (right) Porites corals from Orpheus Island, central Great Barrier Reef, Australia (Gagan et al 1998). Differences in seawater $d^{18}O$ (lower red curves), relative to the modern mean, are obtained by removal of the temperature component of the $d^{18}O$ signal ($Dd^{18}O$). The horizontal lines show the mean $Dd^{18}O$ of seawater, as defined by the seven $Dd^{18}O$ values (squares) falling in the austral winters (vertical lines). Relative to the mid-Holocene, the modern coral indicates cooler average water temperatures (by 1.2°C) and the characteristic interannual variability in salinity (~$d^{18}O$ seawater) that accompanies the ENSO cycle. The accompanying photo shows an X-radiograph (left) and photograph of a coral specimen from Malindi Marine Park, Kenya illuminated under ultraviolet light (courtesy: J. Cole in Dunbar and Cole 1999)



November 2001, Europe: **Abrupt Climate Change Dynamics**

TBA 2002, USA: **Regional Hydrologic Variability**

October 2003, Europe: **North Atlantic Variability**

TBA 2004, Switzerland: **PAGES/CLIVAR Synthesis Meeting**

Each individual meeting is organized around a specific, well defined topic. As a series they will provide continuity and momentum to this interdisciplinary effort, and help to develop the PAGES/CLIVAR Intersection. Further details on any of these meetings will be published in an upcoming (April/May 2000) special jointly produced IGBP-PAGES and WCRP-CLIVAR newsletter and can be obtained from Keith Alverson by email.

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Satellite Imagery
An Objective Guide

The Business Image Group and SPOT Image Corporation have recently published a booklet designed to introduce potential users to the jargon and basic concepts of remote sensing technology and to familiarise them with current and future satellite systems. This information, presented in a clear and concise form, should provide scientists with no or limited experience in remote sensing with the basic knowledge to ask the right questions when considering using satellite imagery for their research. The following topics are addressed in the booklet:

- Why use satellite imagery?
- Basic concepts and satellite terminology
- Understanding and evaluating satellites and sensors
- Understanding image characteristics and products
- Introduction to application software (extracting information)
- Imagery applications

This document is available, upon request, from each IGBP International Project Office and from the IGBP Secretariat.

...continued from page 10.

means of addressing water storage, water quality, water treatment and re-use,and efficient and equitable distribution? That is, do we have a master plan for water resources in Africa?

- *Deficiencies in stakeholder involvement.* How do we address conflict resolution and arbitration? How do we create an enabling environment for stakeholder involvement and actually involve them from the outset in project planning and development?

What next?

One lesson that should be learnt from the workshop is that research agendas drawn up by scientists from the developed world are unlikely to be of immediate relevance to African scientists or policy makers. Global change is happening slowly. In the developed world where there are relatively stable populations and little change in land use, the priorities are different and the timetable of research can afford to be more measured than in the developing world. In Africa there is a dynamic situtation, with rapid population growth and large-scale population movement. As a consequence, not just landscapes but also social structures are undergoing rapid change. Above all there is the urgent problem of poverty. In Africa the problems of global change are so interwoven with the problems of development that it is difficult, and probably not even sensible, to separate them.

IGBP and IHDP are, of course, not donor nor development organisations - their primary role is to foster global change research. However we must acknowledge that in Africa the over-riding priority is for development; albeit development that is taking place in, and contributing to, a changing global environment. For the development of water resources, much can be achieved through the application of existing knowledge, particularly in the framework of Integrated Land and Water Management. The problem is not just lack of knowledge itself, equally the problem is how to bring that knowledge together and how to apply it. This is where the integration of physical and social science has so much to offer. Single-disciplinary studies should not be carried out in isolation - the individual components of the hydrological cycle, and how it is managed, must be integrated through multi-disciplinary research into the system as a whole.

The next step is to specify the research needed in those general areas where development is constrained by lack of underpinning knowledge and understanding. Integrated Land and Water Management is clearly a vehicle for taking this forward, and within that the exploitation of groundwater is perhaps an area where research might be effective (see Box). A small, follow up meeting will be held early in 2000 to draw up plans for moving towards an achievable programme of practical research.

The workshop was sponsored by the European Union, DG12 (under contract ENV4-CT98-0771); The International Geosphere - Biosphere Programme, as part of the IGBP Results Transfer Project; the IGBP BAHC International Project Office; the International Human Dimensions Programme; The United Nations Environment Programme; the World Bank funded Global Environmental Facility; The Pan African START Secretariat of the IGBP, IHDP and the World Climate Research Programme; MEDIAS France; and the African Ministers Conference on the Environment.

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LOICZ 4th Open Science Meeting

by Chris Crossland & Hartwig Kremer

LOICZ followed in the footsteps of Charles Darwin and HMS Beagle, holding its 4th Open Science Meeting in Bahia Blanca, Argentina 15-18 November 1999. Like Darwin 166 years earlier, the participants engaged in hard scientific thought about large questions. Unlike Darwin, we were many (about 170 international coastal zone scientists and managers) and had a number of pieces of scientific information, knowledge and new tools to assist the effort. Also, unlike Darwin, we could rely on the excellent support and infrastructure of the Argentinian host, the Instituo Argentino de Oceanographia.

The OSM aimed to review the status of the program, extend networks and to recommend on further research, and to relate the unfolding science to the key LOICZ questions dealing with material fluxes and people in the global coastal zone. More than 120 presentations and posters provided the platform for lively and constructive discussion addressing the theme: Regimes of Change in the Coastal Zone. The human dimension provided a vital strand in the tapestry of the OSM discussions, working groups and three pre-Meeting workshops. Keynote presentations gave the context of the IGBP umbrella for LOICZ (Neil Swanberg) and, IOC Coastal-GOOS relationships (Eduardo Marone) exemplified the increasing agency/user links being developed. A public evening session engaging end-users of science in Bahia Blanca was

well attended (government, community, navy, coast guard, industry, academe) and resulted in fruitful discussion about potential science-user interaction in the region and the role of science communication and education.

In the OSM, we asked leading questions in order to: a) identify the land-based activities (drivers) which affect the flow of material through the coastal zone, b) influence the cycling of these materials, and c) explore the interaction of respective flux changes with the socio-economic drivers. A regional session addressed the pressure on and state of the coastal zone, demonstrating similarities and differences regarding coastal issues and human interventions. For example, the most prevalent coastal issue in West Africa is sediment flux in the coastal area while coral reef health is a dominant issue in East Africa. It was clear that a comprehensive scientific understanding of the links between human intervention and coastal changes has not yet occurred, especially in the fast growing developing areas of the world. The level of relevant science and information currently available in some regions is sparse. In developed countries, coastal management built on adequate scientific information can be comparatively good but even here it remains a relatively rare encounter. However, in North America for example successful cases have led to initiatives to ensure sustainable management of coastal areas and resources.

The Driver-Pressure-State-Impact Response (DPSIR) framework, of OECD in the early 90ies, has been used and developed further by LOICZ to combine natural and social science issues. Outcomes of the presented case studies, on local and regional levels around the globe, show that the framework can be useful and is becoming more accepted. For example the science information underpinning the chain of events coming from diversion of rivers and groundwater was discussed in terms of coastal zone effects – from acidification to mangrove die-back. The accumulation of nutrients and contaminants in catchments and the human influence acting on assimilative capacity were considered in the context of spatial and temporal rates of release to the coastal zone.

Sediment flux and budget presentations showed that even relatively simple models developed from global databases allow the estimation of water and sediment fluxes to the coastal zone and subsequent evaluation of the global impact. Discussion of case evaluations concluded that variability on different scales (daily, event, seasonal, annual) dominates our understanding of sediment fluxes, and that the residency time of sediments (sand/mud) within the coastal zone appears to be measurably changing locally due to impacts by people. The Meeting identified that there are two-way interactions between biology and sediments that need to be incorporated into future flux/budget models. Leading questions include:

- What is the input of sediment from the ocean? Does this input take on new importance because of decreases in river loads?
- How do sea level fluctuations (on the time scales of human life spans) affect the exchange of sediment between the land and ocean?
- What is the absolute sea level variation and trend on a global scale?

A session reviewed the current status of the core biogeochemical budgets and modelling activities in LOICZ, including the regional spread of sites information, indicators of trends and initiatives being taken to further develop budgets and upscale estimates of C, N, and P fluxes. The discussion and commentary confirmed the general LOICZ approach and resolve to:

- Continue the strong effort to develop a larger suite of biogeochemical budgets, locally and regionally, adding to the LOICZ Modelling website.
- Continue building a global network of contributing scientists through workshops and training activities (e.g., UNEP-GEF project), and seek their increased involvement in globalisation.
- Seek to widen the dialogue network to address issues and to develop more tools, such as quality control, assessment software (e.g., CABARET)
- Pursue the typology approach for globalisation and trend assessments.

The scaling of findings and modelling from local-to-global continues to be a crucial issue. The broad integrative typology approach taken by LOICZ aims to highlight current and future aspects of the scaling question: this is crucial to LOICZ and its global commitment. The meeting provided examples of a wide variety of typologic approaches (data and methods) to a range of problems, including a vital presentation by Charles Vörösmarty (BAHC). The concept is finding wide acceptance and many applications. Initial results support the potential of classifying and extrapolating small-scale features by using combinations of variables at a larger scale and the LOICZView clustering tool which is in the final stages of development was previewed (and will be ready for testing early in 2000). Agreement between BAHC and LOICZ will provide a powerful, integrated combination of terrestrial river basin typologies with coastal zone data. Ongoing work will aim at beginning to upscale coastal zone function (represented in biogeochemical models and data) in November 2000; and the LOICZ typology database will be revised and reconfigured for more reliable applications with LOICZView and more flexibility to handle additional (user-supplied or higher resolution) datasets.

We aim to have the OSM science and outcomes available early. The proceedings will be published by Christmas 1999, three LOICZ R&S Reports (Latin American biogeochemical budget, river basins, SARCS-WOTRO-LOICZ project-phase 1) are scheduled for early 2000. Special issues of the Journal of Sea Research and the journal, Regional Environmental Change, will contain a number of the presentations.

The OSM was an important milestone in LOICZ's regional engagement: we had a strong participation of Latin American scientists in the OSM and in pre-Meeting budgets and basins workshops. New opportunities were also developed for LOICZ with Caribbean and South Asian/Oceania communities to generate state of the art overviews – two LOICZ R&S reports – addressing the major LOICZ-related issues in the global island regions. Building on this will be integrated models for the island dominated areas, employing scientific approaches used in the SWOL project. This will extend the links established with intergovernmental bodies such as IOC (C-GOOS and ICAM), APN and IAI. The LOICZ SSC took the opportunity to further develop its action plans for additional assessment and analysis work, and for its integration and synthesis phase commencing in 2001. Of great encouragement was the support and attendance of representatives from large number of international and regional agencies, and the involvement and collaboration of IGBP core projects. The Meeting "worked" and was timely in further extending the network of participatory scientists and organisations. I think Darwin would have been happy with our debate and progress.

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Ecosystem function and biogeochemical cycles: The role of the phytoplankton

by Paul G. Falkowski

The biogeochemical cycles of the earth are, by definition, mediated by organisms. The biological assimilation, biogeochemical transformation, physical transport, and geological and chemical mobilization and sequestration of many elements are self-perpetuating and self-regenerating, leading to the cycling of elements. Like life itself, biogeochemical cycles are far from thermodynamic equilibrium. They have evolved over hundreds of millions if not billions of years and are interdependent, forming biochemical systems replete with feedback controls. In addition, biogeochemical cycles depend upon and evolved along with specific metabolic pathways. Hence biogeochemical cycles depend on and are a selective force in biological diversity.

Within each biogeochemical cycle, specific functional groups of organisms have evolved to bring about key metabolic sequences. For example, photoautotrophs and chemoautotrophs reduce oxidized carbon biochemically to form sugars, which are subsequently metabolized to build new cells. Heterotrophs oxidize reduced carbon to produce carbon dioxide (CO_2). Over hundreds of millions of years, reduction exceeded oxidation in the oceans; as a result, oxygen was released into the earth's atmosphere and, simultaneously, a significant fraction of organic carbon was buried in the lithosphere. A small fraction of that organic carbon is available as extractable fossil fuel.

Over the course of evolutionary time, myriad phylogenetic divisions of photoautotrophs have emerged in the oceans. There are 10 divisions (the botanical equivalent of phyla) of phytoplankton alone, yet each has the basic biochemical machinery required to produce oxygen and reduce inorganic carbon. Such deep phylogenetic diversity is unique to aquatic ecosystems. It bespeaks a great degree of "functional redundancy" in photosynthetic carbon fixation.

Within this diverse group, however, some sets of organisms play more important roles than others in biogeochemical fluxes. For example, the emergence of diatoms in the late Triassic, some 200 million years ago, led to the emergence of an especially efficient conduit for exporting fixed carbon from the upper ocean to the interior. In the contemporary ocean, diatom blooms are highly correlated with export production.

Calcifying phytoplankton such as coccolithophores form a second functional group within the oceanic photoautotrophs. In contrast to the diatoms, these organisms contribute to the escape of CO_2 from the ocean into the atmosphere. The process of calcification, which produces the calcium carbonate in the shells of these organisms, also releases CO_2.

A source of fixed nitrogen is required to sustain carbon fixation. The fixation of inert nitrogen gas (N_2) from the atmosphere is a strictly an anaerobic process that evolved in eubacteria. In the oceans, N_2 fixation is medicated almost exclusively by cyanobacteria, of which the genus Trichodesmia appears to be the most important.

The relative paucity of N_2 fixing organisms, also called diazotrophs, in the oceans is puzzling and suggests some constraint on the tempo of evolution. Whatever the cause, there appears to be relatively little functional redundancy amongst the diazotrophs compared to the photoautotrophs.

A major goal of the JGOFS Synthesis and Modeling Project (SMP) is to develop an understanding of the basic "rules" governing the distribution of some key functional groups. For example, is the distribution of Trichodesmium restricted to regions and periods of high fluxes of aeolian iron into the tropical and subtropical oligotrophic ocean? Can patterns in the distribution of coccolithophores and diatoms be discerned in large-scale physical circulation patterns? These biologically important questions require an understanding of fundamental ecology of the functional groups.

In some cases, relatively specific algorithms, based on the unique optical properties of the functional groups, can be used to provide global, monthly or seasonal maps of spatial distributions. In addition to this rich but sometimes ambiguous data set, in-situ observations of nutrient fields, taxonomic composition and the structure of the herbivore community can provide important clues that help in the development of models that incorporate key groups in the contemporary ocean. It is only through such analysis that we can begin to comprehend how changes in ocean circulation and chemistry will affect biological responses and biogeochemical feedbacks in pelagic ecosystems over the coming centuries.

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Ocean Biogeochemistry: A new paradigm

The Second JGOFS Open Science Conference will be held 13-17 April 2000 in Bergen, Norway. It marks a milestone after 10 years of intensive biogeochemical ocean research. This international, multidisciplinary program is now being synthesised to formulate a global view of ocean biogeochemical processes and the role of ocean biogeochemistry in climate change. The conference will provide a venue to summarise JGOFS scientific achievements, to continue a global synthesis of ocean biogeochemical processes, and to discuss topics for future ocean research. The conference will consist of 10-invited keynote speakers with 58 oral and over 100 poster presentations.

For more information about the Science Program, please browse: http://ads.smr.uib.no/jgofs/conference.htm

For information about registration, accommodations and fees, go to: http://www.plus-convention.no/

New ESA policy for provision of data to international research programmes

by Gérard Szejwach

ESA has recently approved a new Earth Observation Data Policy describing the conditions for the distribution of data from its missions: ERS-I, ERS-2 and, in the future, ENVISAT. Different interfaces and conditions are applied for scientific use (category-1) and commercial use (category-2). ESA ensures the service to the scientific community at category-1 conditions.

The new ERS and ENVISAT data policy identifies in particular international research programmes such as IGBP as candidates for negotiating frame agreements with ESA at category-1 conditions, such agreements would allow provision of data from ESA earth observation missions to the researchers contributing to such programmes at very favourable conditions.

As an example the prices for scientific use are restricted to the cost of reproduction, typically between 100 and 300 EURO per SAR scene, depending on the product type. Online data from Low Bit Rate instruments such as ATSR and GOME are made available free of charge. For off-line copies on CD-ROM or exabyte a marginal price is applied. The ESA policy allows for further volume discounts or, even, waivers to the above prices.

ERS mission and satellite status

Data from both ERS-1 and ERS-2 (launched in 1991 and 1995 respectively) are continuing to enable scientists to improve their understanding across all the major Earth science disciplines: oceanography, polar science, coastal zones, glaciology, land studies and atmospheric processes. They have contributed to major research breakthroughs in climate and global change. Example of research studies performed using ERS satellite data include: monitoring, and understanding of El Niño events, monitoring of patterns of change in polar ice sheets, monitoring of large scale changes in tropical forest (forest characteristics, location and area extent, burning patterns, land use/cultivation).

Following the initial 9 months of ERS-1/ERS-2 SAR tandem operations in 1997, during 1998 the tandem coverage over the global land surfaces was completed. Applications of the tandem mission include glacier motion, forest and land cover mapping as well as Digital Elevation Model production from interferometry.

ENVISAT mission and status

ENVISAT is one of the most ambitious Earth Observation missions ever conceived. Its complex payload allows performing a wide range of measurements of most of the main parameters characterizing the earth system, including land and ice masses, oceans and atmosphere. The set of instruments on ENVISAT will allow for the first time contemporary and synergistic measurements in different regions of the spectrum to be performed. The models describing the interactions of the various components of the Earth system will be substantially improved.

In order to favour the exploitation of the data, the ENVISAT ground segment will provide a full range of geophysical products from all its payload instruments.

The project is now in an advanced stage of implementation, for a launch foreseen in June 2001. ENVISAT data will be available for users in mid 2002, after the conclusion of the in flight commissioning activities and the validation of the geophysical products.

More detailed characteristics of Envisat, the mission, the payload, the products are provided on http://envisat.estec.esa.nl/

Events

ESA has been contributing to many workshops and meetings in the sphere of Earth Observation. Proceedings and summaries are available on the ESA web sites or as hard copies from the helpdesk. (eohelp@esrin.esa.it).

ESA is planning a major ERS-ENVISAT Symposium (Looking at our Earth in the New Millenium) in Gothenburg, Sweden, 16-20 October 2000. ESA is expecting between 200 and 300 presentations covering a wide range of disciplines. IGBP scientists are encouraged to send abstracts and participate in this Symposium. A dedicated Global Change session could be envisaged if appropriate. For further information on this Symposium and other ESA supported workshops, please refer to the web site:

http://www.estec.esa.nl/CONFANNOUN/extconf.html

Data exploitation

Some 900 science and applications projects have been given support in past years. The first series (Announcement of Opportunity and Pilot Projects) were completed in 1996 and 1997. The second series of Pilot Projects and the second Announcement of Opportunity have also been closed.

The third Announcement of Opportunity for the Exploitation of ERS data was released last year, addressing specific objectives. ESA received some 335 responses to this announcement of which 238 were accepted. These projects have started to receive data and present their results.

ESA opened the first ENVISAT Announcement of Opportunity. As with the first ERS AO, the ENVISAT AO called for proposals relating to scientific research, application development and demonstration, and calibration and geophysical validation of ENVISAT data products. Nearly 800 replies were received to this AO.

Documents/ publications

Recent years have seen the release of many important publications on remote sensing. For full details concerning available documentation, please contact the ERS Help Desk (E-mail: eohelp@esrin.esa.it fax: 0039 06 94180292, tel: 0039 06 94180777) or consult the on-line library at: http://earthnet.esrin.esa.it/

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From 'system' to 'services': A look at the new IGBP-DIS

by Gérard Szejwach

The logo and acronym may be the same, but the philosophy and *modus operandi* of the new IGBP-DIS (Data and Information Services) are different from those of its predecessor. The name change highlights the strong emphasis on the supporting character of the new DIS.

The 2nd meeting of the IGBP-DIS Steering Group was held recently at the Potsdam Institute for Climate Impact Research (PIK), Germany (new home of the DIS Office). The main objectives of the meeting were (i) to decide on the role and implementation of the "new" DIS Frame work Activity, following the restructuring adopted by the IGBP Scientific Committee in February 1999, and (ii) to develop a workplan for the next three-year period.

One feature of the new DIS reflects the evolving world of global change data. There are many more relevant datasets available now than 10 years ago, when DIS was first launched, and the challenge now is to identify and access data that are useful for IGBP projects rather than to build new datasets from the beginning. The new Steering Group, now chaired by Wolfgang Cramer (PIK) includes representatives of all IGBP programme elements. The DIS office, which is also being relocated to Potsdam, will continue to be managed by Gerard Szejwach. DIS focuses on building and enhancing a wide range of data and information services within the IGBP community.

The Role of IGBP-DIS

Much of the meeting was devoted to a discussion on the roles of IGBP-DIS. The main conclusions are:

- In general, IGBP-DIS should represent a general forum within the IGBP community for discussion and feedback on availability, production, and evaluation of databases. Although the main role of the new IGBP-DIS is not to create data products but to support IGBP data activities more generally, DIS could, if requested, initiate product generation by other bodies under supervision of the Steering Group.
- To achieve its overall objectives, DIS should always maintain a "user-driven" approach and should add value to each Core Project's data and information related activities.
- DIS should essentially be a supporting Framework Activity for the IGBP. The support is not limited to data products alone and should be provided on a request basis, mainly in the following situations: (i) when several Core Projects (or a cross-cutting activity) express a need for the development of a new data set or data related information exchange, (ii) when Core Projects request an evaluation of the usefulness of a potentially valuable data product(s); and (iii) when an individual Core Project has a specific need for support (linked to data or data exchange)
- IGBP-DIS should provide advice, guidance, and support in the production of global or regional 'data bundles' (see below).
- There is a role for IGBP-DIS to promote use of international data formatting and documentation standards where appropriate
- DIS should play a strong role in outreach activities, both towards external agencies, especially to data providers (e.g., space agencies) and towards IGBP programme elements.

Workplan 2000-2002

The new DIS is starting on a firm foundation. Its predecessor had set an ambitious agenda of data production in the early 1990s, and most of the requested data sets have now been developed. Many are in widespread use throughout the community, such as the DISCover data base.

Looking towards the future, the Group identified four major areas where work in the next few years can help meet the data needs of the IGBP community:

1. Global Data Initiatives

Global data sets will continue to be of central importance for IGBP research. However, as noted above, the emphasis will be on identification of and value-adding to existing data sets. Three specific activities were approved:

Carbon 'data bundle': There is much existing data and model output on aspects of the global carbon cycle, such as measurements of ocean pCO_2, modelled oceanic fluxes of CO_2, in situ measurements of terrestrial NPP (Net Primary Production), eddy correlation estimates of terrestrial NEP (Net Ecosystem Production), satellite-derived estimate of NPP, and modelled estimated of terrestrial productivity and of the distributions of sources and sinks in both oceans and land. All such data are useful for analyses of the global carbon cycle. However, the data have not yet been brought together in one place and in a consistent format with consistent units. The creation of a carbon data bundle would be a major value-adding activity in support a research issue of critical importance to IGBP.

Climate data sets: GCTE, GAIM, BAHC, and LUCC all expressed an interest in climate data products. An increasing number of these data bases are coming onto the global change 'research market' and it was agreed to conduct a minimum evaluation of the existing products, such as those elaborated by University of East Anglia Climatic Research Unit (CRU), or in the context of ISLSCP Initiative I.

River basins initiative: A proposal submitted by Michel Meybeck and Charles Vörösmarty on behalf of the IGBP Water Group to produce a CD-ROM containing a global river basin data base created by aggregating the GEMS-Water (UNEP/WHO) and IGBP data bases was accepted. The Group also proposed to review the data set once it has been developed as well as the beta version of the proposed CD-ROM.

2. Regional Data Initiatives

Regional aspects of global change research are becoming increasingly important, and there is some concern that more coordination is required so that a 'global picture' can still be built up from the individual regional studies. An important aspect of this integration of regional studies is the

creation of compatible and comparable regional data bases or data bundles. Some regional data bases/bundles have been and are being developed (e.g., the Miombo Network CD-ROM), but there is not yet an agreed standard format and content across the global change community.

The IGBP is developing a new activity – RAGC (Regional Aspects of Global Change) – designed to address the scientific integration of regional studies and also the issue of scaling up from local through regional to global levels. The DIS Steering Group discussed, expressed a strong interest in, and endorsed a proposal to support collaboration with the RAGC initiative through appropriate joint data related activities.

3. Data Information System

The Group noted that the responsibility for the Data Integration Project (Information System) activities were being transferred from the previous IGBP-DIS Office to the IGBP Secretariat in Stockholm. This system has two major components: a search engine, for which some technical support will continue to be provided through the new DIS Office in Potsdam, and the information itself which populates the system. IGBP has identified internal communication as a high priority area for improvement in 2000 and will devote a 3-day meeting of International Project Office staff in early 2000 to internal communication issues.

4. Outreach Activities

Two areas of outreach activities were considered: (i) outreach towards partner organisations involved in data aspects of global change research (including Space Agencies, World Data Centers, G3OS) and (ii) outreach towards other IGBP Programme Elements. Responsibility for outreach should be broadened beyond the DIS Office staff and the Steering Group itself to other scientists involved in IGBP networks. The Group agreed that it should make a particular effort to involve more scientists with remote sensing experience within the IGBP system, as well as helping build capacity in the use of remotely sensed data by IGBP scientists.

Several specific activities are to be included in a coordinated strategy:

- Maintain and enhance links with data providers, such as Space Agencies and World Data Centers
- Periodic updates on data issues in the IGBP Newsletter.
- Briefings by the IGBP-DIS Executive Officer at Core Project SSC meetings.
- Training activities, such as a proposed series of training sessions in the use of radar data, being offered by ESA (the European Space Agency) at its facility in Frescati, Italy.

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Biogeosciences at AGU

The American Geophysical Union is a major organization of Earth scientists, spanning a range of disciplines from deep earth structure to space physics. In recent years, AGU has included publications (e.g. Global Biogeochemical Cycles) and meeting sessions centered on issues of global change, and now has a major new "theme" on Biogeosciences for the recent Fall and upcoming Spring meetings. This will provide a valuable forum and outlet for all aspects of global change research, with a particular focus on the biologic aspects of concern to IGBP. The Spring meeting will have an additional aspect of policy-relevance, being held in Washington DC.

We now have the opportunity to send abstracts to the AGU meeting (Abstract deadline, March 9, 2000) indicating "B theme". Abstracts can be submitted on any topic related to biology and its interaction with any or all of the Earth System.

In addition, a few sessions have been identified already for the Fall Meeting. These are listed in the adjacent text box. Abstract submission can be done on the web at http://www.agu.org

Submission of Abstracts

Authors are encouraged to submit abstracts electronically via the Interactive Web Form on the AGU Web site. Abstracts submitted by postal/express mail must be received at AGU Headquarters by September 2, 1999. Abstracts submitted by the Interactive Web Form must be received at AGU by September 9, 1999. (These deadlines are firm and no exceptions will be granted.)

Abstract submission instructions are available at http://www.agu.org

Abstract Submission Deadlines:

March 2nd, 2000 (Postal/Express Mail)

March 9th, 2000 (Interactive Web Form)

2000 Spring Meeting: May 30-June 3, 1999 (Tues-Sat)

A few Special Sessions have been formulated for the AGU Spring Meeting in the "Biogeosciences". A few of these are listed below. A full list of session descriptions is available at the AGU website. If you wish to propose an additional special session, please contact Dork Sahagian at gaim@unh.edu as soon as possible, but before Feb 15, 2000.

Example AGU Sessions in "B Theme"

Geobiology of Macroorganisms

Forest Biogeochemistry

Coastal ecosystems and sea level change

Biogeochemistry of C and N in soils

Response of coral ecosystems to changes in terrestrial and coastal environments

Biogeophysics of land cover change

Remote sensing of the biosphere

Kyoto protocol: modelling response

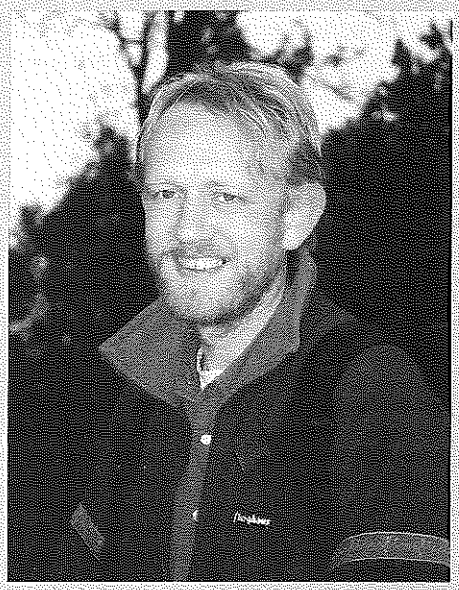
For More AGU Information, contact:

AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 USA

Tel: +1-800-966-2481 or +1-202-462-6900, Fax: +1-202-328-0566, E-mail: meetinginfo@agu.org (subject: 2000 Sping Meeting)

People and events

New Chair of IGBP-DIS

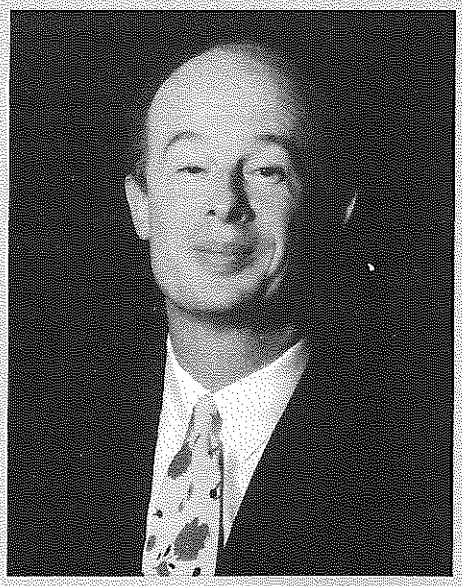


Wolfgang Cramer, a physical geographer and ecologist, currently head of the Department of "Global Change and Natural Systems" at the Potsdam Institute for Climate Impact Research, took over as chair of IGBP-DIS on January 1, 2000. Wolfgang was trained at the Universities of Gießen (Germany) and Uppsala (Sweden), completing a Ph.D. thesis on sea-shore vegetation dynamics in Sweden in 1986. While based at the Department of Geography at the University of Trondheim (Norway) from 1986 to 1992, he was a frequent visitor and guest scientist at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. In the IIASA Biosphere Project, he became involved in global biospheric modelling as well as the associated database developments - and also in GCTE, where he now is a focus leader and SCC member.

In 1992, he joined the newly founded Potsdam Institute for Climate Impact Research as leader of a department with around 25 scientists. His own research group within the department focuses on the further development of the "Lund-Potsdam-Jena Dynamic Global Vegetation Model". At the national and European level, he and his department carry out several collaborative research projects on different aspects of climate change impact assessment. Wolfgang has been involved as lead author in WGII of the Second Assessment of the IPCC, and now works as author for both the Third Assessment Report and for the Special Report on Land Use and Forestry. Apart from GCTE, he also is a member of GAIM, for which he co-ordinated the "Potsdam NPP Model Intercomparison Project" (recently published in a special issue of Global Change Biology).

Wolfgang is married and proud father of a two year old daughter.

New Chair of GAIM

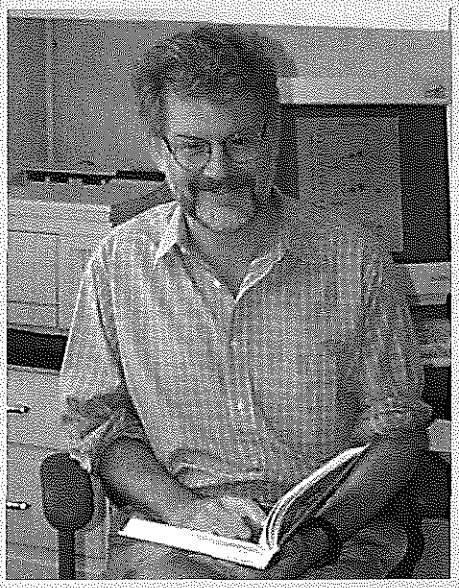


Born in 1950 in Ortenburg, Germany, Hans-Joachim Schellnhuber was trained in physics and mathematics through a scholarship for the highly gifted at the University of Regensburg. He received a doctorate in theoretical physics in 1980. Various periods of research abroad followed, in particular at several institutions of the University of California system (USA). Following his habilitation in 1985, John received a Heisenberg Fellowship, and in 1989 became Full Professor at the Interdisciplinary Centre for Marine and Environmental Sciences (ICBM) at the University of Oldenburg, later Director of the ICBM. In 1991 he was appointed as the Founding Director of the Potsdam Institute for Climate Impact Research (PIK), and from 1993 appointed to a Professorship for Theoretical Physics at the University of Potsdam as well.

John is a member of some dozen national and international panels for scientific strategies and policy advice regarding environment & development matters, such as Chairman of the German Advisory Council on Global Change (WBGU), Vice Chairman of the National Committee on Global Change of the German Science Foundation (DFG), German Representative of the International Geosphere-Biosphere Programme (IGBP), and Coordinating Lead Author of Chapter II.19 of the Third Assessment Report of IPCC.

He has written numerous publications on solid state physics, the theory of complex non-linear systems, coastal zone research, and regional and global environmental analysis. See, in particular, the recent book on "Earth System Analysis" (Springer, 1998), in which the effort is made to describe the conception of sustainable development in precise mathematical terms.

New Chair of JGOFS



Hugh Ducklow grew up in Wisconsin, USA and received his AB degree in the History of Science from Harvard College in 1972. He has a continuing interest in the history, philosophy and sociology of science. He received his PhD in Environmental Engineering from Harvard's Division of Applied Sciences in 1977 (Ralph Mitchell, advisor). His dissertation was on coral reef ecology. Following postdoctoral research on biological control of schistosomiasis, he went into biological oceanography and held research positions at Lamont-Doherty (Palisades, NY) and the University of Maryland Horn Point Lab before joining the faculty of The College of William and Mary, where he is Glucksman Professor of Marine Science.

Hugh's main research field is marine microbiology, and he specializes in the production and population dynamics of heterotrophic bacterioplankton. He has been active in JGOFS since 1988, and has participated in over 25 major oceanographic expeditions in all the major world oceans. He has trained 3 PhD and 3 MSc students and currently has students working on estuarine biogeochemistry, Antarctic bacteriology and ecological simulation modeling of the Black Sea. He was Chair of US JGOFS before accepting the Chair of the JGOFS SSC.

Hugh Ducklow is married with two children aged 11 and 16. His hobbies include reading, travel, hiking and running, and he is a dogged fan of the Boston Red Sox American baseball club.

Ducklow's website: http://www.vims.edu/bio/microbial/

Coordinator, Global Change Open Science Conference

Rowena Foster has recently joined the IGBP Secretariat as the Coordinator/Manager of the Global Change Open Science Conference, to be held in Amsterdam on 10-14 July 2001. Working out of a base in Canberra, Rowena will oversee, on behalf of IGBP, all logistical and organisational aspects of the Conference. She is one of the longest serving members of the IGBP family, having started with the GCTE IPO at its inception in November 1990. Rowena has become somewhat of a guru of big science conferences, having led the organisation and implementation of two GCTE science conferences, the first in Woods Hole, MA, USA in May 1994 and the second in Barcelona in March 1998. The latter, held in collaboration with the LUCC core project, attracted 851 participants and was the largest such event held to date within the IGBP community.

In addition to her technical expertise, Rowena brings a large number of personal skills to the task. Her warm and open personality and her ever-ready hospitality have welcomed many IGBP visitors and new residents to Canberra. She is renowned for her exceptional energy, often following a hard day of work at a big conference with an equally hard night at the pubs and salsa clubs! At home, Rowena is the proud mum of two delightful little girls, Sally (aged 4) and Meghan (aged 6 months).

We are absolutely delighted that Rowena's experience, boundless energy, drive, and bright personality will continue to benefit IGBP. Please feel free to contact Rowena on any aspect of Conference planning. She can be reached via email at:

Rowena.Foster@dwe.csiro.au

rowena@igbp.kva.se

Lisa Cronqvist leaves IGBP

For nearly a decade, Lisa Wanrooy Cronqvist has been a central character in the IGBP Secretariat, starting out as a secretary, and moving up to do technical editing of reports, engineering the database and producing the IGBP Directory. Always eager to learn, as computer technology improved, Lisa found ways of using it to improve the quality of IGBP publications and raise the level of graphic presentation. Lisa is something of a perfectionist about details, and this has always been displayed in her efforts - those of us who know her know how much she agonised over the errors that inevitably do appear now and then.

Lisa grew personally during her time in Sweden, as she was married here and both her children were born in Stockholm. A native of New Zealand, a part of Lisa always longed for home. The opportunity came earlier this year to move to NZ. Always adventurers, Lisa and Ronny, Beau and Sofia, quickly packed up, sold their house and moved to the land of Kiwis in March. She could not quite leave IGBP so easily though, and kept working for us on a part time basis whilst we were trying to find a new person (see article on John Bellamy). As our new graphics artist found his place in the Secretariat, finally, this October Lisa resigned even her part time work.

We are very pleased to report that Lisa quickly found a job in Auckland doing advertising sales and graphics for a real estate company.

Lisa will be sorely missed in Stockholm, not only for her fine work, but her enthusiastic spirit and her very special sense of humour. Things were never very dull around Lisa. We wish her the very best in her new ventures.

New faces at the IGBP Secretariat

John Bellamy works as the technical editor at the IGBP where his duties include layout and digital production of publications, image editing and production of graphic material.

Originally from Essex, England, John has lived and worked for six years in Sweden. He has previously studied two-dimensional visual communication at Portsmouth Polytechnic, England and also digital publishing and multi media in Stockholm.

In his free time John enjoys gardening, reading, good music and holds a genuine interest for typography and graphic design.

John replaced Lisa Cronqvist as technical editor at the IGBP secretariat in May of this year.

Charlotte Wilson comes from bonny Scotland and has been living in Sweden for almost 2 years now. She takes up the post as Administrative Assistant at IGBP where her duties include maintaining the database, managing the flow of paper in the Secretariat, responding to requests for publications and assisting with meetings. In her spare time Charlotte enjoys reading, Italian and Chinese food and listening to Irish and Scottish folk music. She is also studying Swedish and German and has now started taking accordion lessons.

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