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Envisioning Earth System Science for Societal Needs

The development of Joint Projects and the Earth System Science Partnership (ESSP)

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The Earth System Science Partnership (ESSP¹) was launched at the Amsterdam Conference in 2001 and has brought together the four international global change research Programmes: DIVERSITAS, IGBP, IHDP and WCRP. As a precursor to ESSP (and before DIVERSITAS was re-launched in 2001), IGBP, IHDP and WCRP had already been collaborating more closely by co-sponsoring the design of a number of “Joint Projects”. These were envisioned as new initiatives aimed at helping to frame and develop innovative, interdisciplinary research that addressed issues of interest not only to science but also to society at large. This paper revisits the thinking that led to the Joint Projects and the launch of ESSP. It is intended to serve as a background for both the 2007 ESSP Review and for the incoming members of the new ESSP governance structure.

The 1990s had seen considerable and effective international research effort in a broad range of global environmental change topics, with coordination within major scientific areas being provided by the international global change research programmes IGBP, IHDP and WCRP. Science Plans had been published by most of the “Core Projects” (the main operational element of the Programmes) and scientists from around the world (although mainly from the “developed” countries) collaborated on common endeavours, often by establishing large networks of active researchers. Great scientific advances had been made and by the end of the 1990s many Core Projects in WCRP and IGBP had completed initial summaries – and in some instances (e.g. TOGA, IGAC, GCTE) fully comprehensive syntheses – of their research, while others less mature were rapidly gaining momentum. IHDP had been re-launched in 1996 and plans for a re-launch of DIVERSITAS in 2001 had been mapped out.

By design, research within Core Projects concentrated on their respective social or natural science focus. (This is largely still the case although some have more recently developed more of an inter-disciplinary agenda, e.g. LOICZ, GLP.) Core Project Science Plans were designed essentially by leading specialists with clear goals to advance science in critical areas. Progress was monitored and work guided by the Scientific Steering Committees of the Core

¹ Acronyms are explained at the end of this article.

Projects, who reported to the Scientific Committees of the Programmes, while the Chairs and Directors (Cs&Ds) of the Programmes met (starting in 1997) on an annual basis to review progress across the global change research community. In the main, the Core Projects were achieving their stated science goals.

The emergence of the “Joint Project” concept

In the late 1990s the Cs&Ds saw the need for an additional type of research structure more geared towards issues of greater interest to society at large. Rather than, for instance, research on climate, ecology or institutional analysis (as exemplified in the Programmes’ Core Projects), this novel global change research should address issues of energy, water resources and food security. Realising that input for such endeavours would need to come from a range of sciences, work would need joint inputs from all Programmes. The Cs&Ds therefore agreed to instigate the planning of a set of “Joint Projects” (JPs) on such topics and contacted members of the research community dealing most closely with these issues. There was no obvious group dealing with energy *per se*, but considerable climate, ecological and biogeochemical research across WCRP and IGBP on the dynamics of the carbon cycle was clearly very relevant, as was the work on governance and industrial transformation in IHDP. Similarly, no group was directly addressing agriculture as such, let alone food security, but agroecological research in GCTE was well advanced and had a clear contribution to make, while the GECHS project of IHDP was clearly focussed on the issues of vulnerability and human security. Water research was central to BAHC and GEWEX (and could also be addressed by the IHDP projects) and so a starting point for a joint water project was provided.

In 1999 a set of “Guiding Principles” for the JP on food security was drawn up, based on early discussions between researchers thus identified, the Cs&Ds and ICSU. These were the first attempts to establish some principles to help set the vision for JPs. The following principles, agreed upon by the Cs&Ds, were critical for the development of the food JP; the underlying philosophy in these also set the scene for the overall JP concept.

- (i) A major international effort is needed to understand and estimate the impacts of global change on food supply² and the environmental consequences of increasing production.

² As the food project planning advanced the more holistic notion of “food security” was adopted in place of “food supply”.

It requires effective links between biophysical and socioeconomic sciences in both design and implementation.

- (ii) Clear definitions of (a) overall goal, (b) scientific objectives, (c) scope (thematic, spatial and temporal), and (d) the global change dimension are essential.
- (iii) The project must have scientific “teeth” if it is to (a) achieve and maintain scientific credibility, and (b) deliver useful products.
- (iv) The relevance of the project’s science agenda to sustainable development needs must be clear.
- (v) The project’s comparative advantage over other international research bodies and UN agencies must be clear, and appropriate strategic alliances need to be established with them from an early stage. The project’s “niche” must be explicit.
- (vi) The project should be jointly sponsored by all three international global change Programmes: IHDP, WCRP and IGBP³. It should draw together and build on appropriate elements of each to address the scientific goals which will ensure strong links to their respective “core” sciences. It will not “replace” existing efforts at the core level, but rather will draw upon them, setting them in a broader canvas of societal concerns.
- (vii) The project’s international coordination must be underpinned by multi-national support (possibly a donor consortium) with sufficient resources for planning, coordination, integration and synthesis, and dissemination of results.

These points set the stage for enhanced interdisciplinarity and the adherence to quality science linked to the needs of the development agenda. They were a significant departure from the mandates of the Core Projects. Further, point (v) recognised that although the “combined” mandates of the three Programmes were already very broad, they were still insufficient to cover the full spectrum of issues that need to be considered, which span a “continuum” of social/natural science interdisciplinary requirements given the focus of the

³ Phase II of DIVERSITAS was not launched until 2001.

planned JPs. Strategic alliances therefore needed to be formed with a range of other international research and/or policy formulating bodies including UN agencies. The specific role that each community of collaborators plays in the continuum needed to be made clear, showing how collaboration would lead to more effective use of research findings. Point (vi) was particularly important in addition to ensuring that the JP's scientific framework had the endorsement of all three Programmes (i.e. it is thus underpinned by joint Programme sponsorship) as it sought to clearly differentiate the work of the Core Projects and JPs; the philosophy of the JPs was not to encompass the work of the Core Projects but to define new research that would build on Core Project outputs and other critical research elements outside the Core Projects' domains.

In summary, the JPs should capitalise on the comparative strengths of IGBP, IHDP and WCRP, and link these to other, national and international efforts relating to science, development and policy. The need for International Project Offices for the JPs was foreseen to coordinate planning, implementation and reporting, and probably funded by multi-donor support.

The establishment of the Earth System Science Partnership

About the time that the JPs were being formulated, the three global change research Programmes were thinking more generally about how they could collaborate around the theme of Earth System science, a concept which had grown in prominence through the 1990s to reflect the inherently inter-connected and systemic nature of the human and non-human parts of the planetary environment. The 2000 meeting of the Scientific Committee of the IGBP, held in Cuernavaca, Mexico, marked the beginning of the process that led to the ESSP. That meeting proposed a unified scientific effort that effectively brought together the three Programmes and outlined the ultimate outcomes of a collaborative international research effort on Earth System science:

- Answers to fundamental questions about the Earth System (e.g., how stable is the system in the face of major perturbations?)
- New approaches to designing research that integrates paradigms and questions from the beginning of the research effort.

- Innovative and integrative simulation tools of varying complexity that can tackle systemic questions.
- Harmonisation of social and biophysical information and data.
- Vigorous effort to communicate the work on Earth System science to a number of target audiences: broader scientific community, policymakers, resource/environment managers, public.
- Proactive measures to make scientifically based contributions to governance for the ‘sustainable management’ of our global environment.

Two major changes in IGBP activities helped deliver the inaugural (although informal) ESSP products. First, the IGBP synthesis project, which aimed to pull together a decade of research in the Programme, was broadened to include research from both WCRP and IHDP (in fact, the Executive Director of IHDP was a co-author of the resulting book). The aim became to synthesise current understanding of global change and the Earth System by drawing strongly on research from across the community. Second, the IGBP, which had never had a science conference at the Programme level, decided to broaden its first such effort (held in Amsterdam in July 2001) to include IHDP and WCRP as full and equal partners.

The 2001 Amsterdam Conference saw the strong endorsement of a new aspect of global change research more closely related to societal and policy interests, and sustainability. The Amsterdam Declaration (see Annex 1) effectively set the stage for the formalisation of the Partnership and the 2001 Cs&Ds meeting, held in Amsterdam at the time of the Conference, formally launched the ESSP. At this point DIVERSITAS formally became the fourth partner in the ESSP.

The ESSP set an ambitious research agenda. In addition to launching JPs on carbon, food and water (and later, health), it aimed to focus strongly on bridging the research divide between developed and developing countries. START, co-sponsored by IGBP, IHDP and WCRP, had already achieved much in this regard, and the ESSP set out to build on these successes through its JPs. ESSP subsequently expanded this effort by establishing a small set of

integrated regional studies (IRS) with LBA being the first activity that could serve as an example for an IRS (an activity started much earlier, in the early 1990s, with input from several IGBP and WCRP Core Projects); START was invited to help establish a companion study in Monsoon Asia (MAIRS).

The consolidation of Joint Projects within ESSP

By mid-2001, the JPs for carbon and food were in the advanced planning stage, and the outline of a JP on water was emerging. Immediately following the Amsterdam Conference the JPs on carbon (GCP) and food (GECAFS) were launched by the Cs&Ds as 10-year endeavours. The JPs on water (GWSP) and human health were launched early-2005 and late-2006, respectively.

Given the joint sponsorship by the Programmes, it was agreed by the Cs&Ds that JPs would report annually to the Cs&Ds, rather than to the Scientific Committees of the Programmes (see Annex 2). This was a crucial aspect as the envisioned innovative, interdisciplinary agendas of the JPs could be open to tensions from the natural or social science viewpoint of each of the different Programmes' Scientific Committees. This underlined a key philosophy of the JPs, *viz.* that they were not designed to be inclusive of Programmes' core science but rather to draw upon such science and set it in a broader analytical and societal context. While internal governance structures were established using slightly different models for each of the JPs, the basic governance relations with respect to the Cs&Ds has been common to all.

In the early 2000s each JP (with respective foci now on carbon, food systems and the global water system) was preparing to publish its own Science Plan and Implementation Strategy, and work was gathering momentum. New types of science product were emerging and formal partnerships were being established with a range of UN agencies and other bodies with whom collaboration had hitherto been on an *ad hoc* basis – if at all. This resulted in the JPs quickly outstripping the time available by the Cs&Ds to offer necessary governance for them individually, let alone coordination between them and/or the Core Projects of the Programmes; by the mid-2000s, although the JPs were *de facto* implementing the nascent ESSP, there was a poor governance structure struggling to help them move forward. Further, even collectively the JPs did not deliver ESSP as the integrated research endeavour

envisioned in the Amsterdam Declaration. ESSP is therefore now addressing the key issue of how to develop an intellectual identity and capability for itself, to complement the collation of JPs, IRSs and START. Such an identity would help position ESSP to address new, higher-order questions which are emerging and which need a more coordinated approach better linked to a wide range of stakeholders; the emerging ESSP governance structure is an important step. Meanwhile, the JPs have proven to be a considerable success, and have demonstrated that a more holistic, integrated approach to studying the Earth System is not only achievable, but that it is appropriate to help understand and analyse the human enterprise on the planet.

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Acronyms

BAHC	Biospheric Aspects of the Hydrological Cycle [IGBP Core Project]
Cs&Ds	Chairs and Directors [of DIVERSITAS, IGBP, IHDP & WCRP]
ESSP	Earth System Science Partnership [DIVERSITAS, IGBP, IHDP & WCRP]
GCP	Global Carbon Project [ESSP Joint Project]
GCTE	Global Change and Terrestrial Ecosystems [IGBP Core Project]
GECAFS	Global Environmental Change and Food Systems [ESSP Joint Project]
GECHS	Global Environmental Change and Human Security [IHDP Project]
GEWEX	Global Energy and Water Cycle Experiment [WCRP Core Project]
LOICZ	Land-Ocean Interactions in the Coastal Zone [IGBP + IHDP Core Project]
GWSP	Global Water Systems Project [ESSP Joint Project]
IGAC	International Global Atmospheric Chemistry [IGBP Core Project]
ICSU	International Council for Science
GLP	Global Land Project [IGBP + IHDP Core Project]
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme on Global Environmental Change
IRS	Integrated Regional Study [of ESSP]
JP	Joint Project [of ESSP]
LBA	Large-scale Biosphere-atmosphere Experiment in Amazonia
MAIRS	Monsoon Asia Integrated Regional Study [ESSP IRS]
START	SysTem for Analysis, Research and Training
TOGA	Tropical Ocean-Global Atmosphere [WCRP Core Project]
WCRP	World Climate Research Programme

Annex 1 The Amsterdam Declaration on Global Change

The scientific communities of four international global change research programmes - the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP) and the international biodiversity programme DIVERSITAS - recognise that, in addition to the threat of significant climate change, there is growing concern over the ever-increasing human modification of other aspects of the global environment and the consequent implications for human well-being. Basic goods and services supplied by the planetary life support system, such as food, water, clean air and an environment conducive to human health, are being affected increasingly by global change.

Research carried out over the past decade under the auspices of the four programmes to address these concerns has shown that:

- **The Earth System behaves as a single, self-regulating system comprised of physical, chemical, biological and human components.** The interactions and feedbacks between the component parts are complex and exhibit multi-scale temporal and spatial variability. The understanding of the natural dynamics of the Earth System has advanced greatly in recent years and provides a sound basis for evaluating the effects and consequences of human-driven change.
- **Human activities are significantly influencing Earth's environment in many ways in addition to greenhouse gas emissions and climate change.** Anthropogenic changes to Earth's land surface, oceans, coasts and atmosphere and to biological diversity, the water cycle and biogeochemical cycles are clearly identifiable beyond natural variability. They are equal to some of the great forces of nature in their extent and impact. Many are accelerating. Global change is real and is happening *now*.
- **Global change cannot be understood in terms of a simple cause-effect paradigm.** Human-driven changes cause multiple effects that cascade through the Earth System in complex ways. These effects interact with each other and with local- and regional-scale changes in multidimensional patterns that are difficult to understand and even more difficult to predict. Surprises abound.
- **Earth System dynamics are characterised by critical thresholds and abrupt changes. Human activities could inadvertently trigger such changes with severe consequences for Earth's environment and inhabitants.** The Earth System has operated in different states over the last half million years, with abrupt transitions (a decade or less) sometimes occurring between them. Human activities have the potential to switch the Earth System to alternative modes of operation that may prove irreversible and less hospitable to humans and other life. The probability of a human-driven abrupt change in Earth's environment has yet to be quantified but is not negligible.
- **In terms of some key environmental parameters, the Earth System has moved well outside the range of the natural variability exhibited over the last half million years at least.** The *nature* of changes now occurring *simultaneously* in the Earth System, their *magnitudes* and *rates of change* are unprecedented. *The Earth is currently operating in a no-analogue state.*

On this basis the international global change programmes urge governments, public and private institutions and people of the world to agree that:

- **An ethical framework for global stewardship and strategies for Earth System management are urgently needed.** The accelerating human transformation of the Earth's environment is not sustainable. Therefore, the *business-as-usual* way of dealing with the Earth System is *not* an option. It has to be replaced – as soon as possible – by deliberate strategies of good management that sustain the Earth's environment while meeting social and economic development objectives.
- **A new system of global environmental science is required.** This is beginning to evolve from complementary approaches of the international global change research programmes and needs strengthening and further development. It will draw strongly on the existing and expanding disciplinary base of global change science; integrate across disciplines, environment and development issues and the natural and social sciences; collaborate across national boundaries on the basis of shared and secure infrastructure; intensify efforts to enable the full involvement of developing country scientists; and employ the complementary strengths of nations and regions to build an efficient international system of global environmental science.

The global change programmes are committed to working closely with other sectors of society and across all nations and cultures to meet the challenge of a changing Earth. New partnerships are forming among university, industrial and governmental research institutions. Dialogues are increasing between the scientific community and policymakers at a number of levels. Action is required to formalise, consolidate and strengthen the initiatives being developed. The common goal must be to develop the essential knowledge base needed to respond effectively and quickly to the great challenge of global change.

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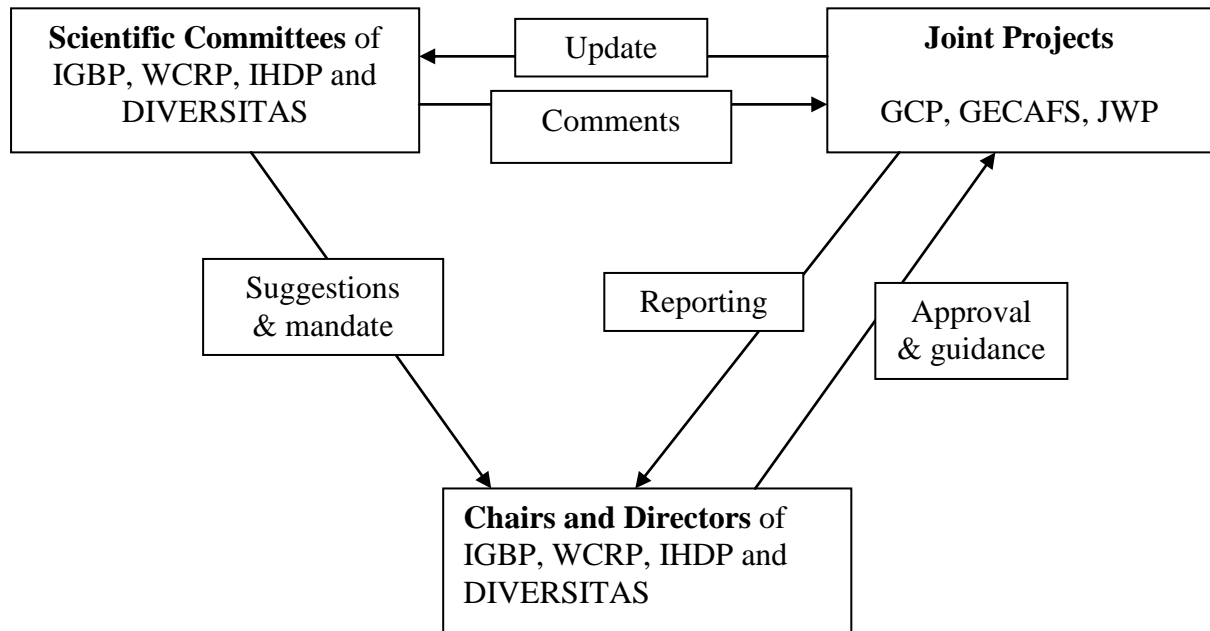
Arild Underdal
Chair, IHDP

Peter Lemke
Chair, WCRP

Michel Loreau
Co-Chair, DIVERSITAS

Challenges of a Changing Earth: Global Change Open Science Conference
Amsterdam, The Netherlands
13 July 2001

Annex 2 Reporting of the Joint Projects (as extracted from Minutes of the 2002 Cs&Ds Meeting in Bonn)



1. The Joint Projects (represented by an active SSC member, member of the Executive Committee or Executive Officer) each make a presentation at the SC meetings of IGBP, WCRP, IHDP and DIVERSITAS. (Note: Currently, DIVERSITAS only sponsors the Joint Water Project). The invitation will go to Joint Project Chairs (with a copy to the Executive Officer) asking them to decide who will attend. Participation of members of the SCs/JSC in the Joint Projects obviously would minimise some of the reporting duties.
2. The SCs provide feedback and comments.
3. The SSCs or Executive Committees consider the feedback and adjust work plan, if necessary and appropriate.
4. Joint Projects (represented by Chair and Executive Officer) report to the Chairs and Directors on their work plan.
5. Chairs and Directors need mandate from SCs to deal with issues arising from the consultations with the SSCs/ECs and unresolved questions.
6. Between SC meetings, questions on the Joint Projects should be addressed to the Executive Directors of the 4 Programmes, who will quickly decide among themselves how to deal with the issue at hand (in consultation with the Chairs, where necessary).