

Executive Summary

The Earth's environment is changing due to human activities, and is undermining sustainable development. There is little doubt that the Earth's environment is changing on all scales from local (e.g. air, soil, and water pollution), to regional (e.g. acid deposition and land degradation) to global (e.g. climate change and loss of biodiversity). These changes are to a large measure due to human activities, and undermine efforts to alleviate poverty and adversely affect water resources, human health, agriculture, forestry, fisheries, and ecosystems. Worse, future projected changes in the environment are likely to have even more severe consequences for sustainable development.

The Panel notes that the role of ICSU is to strengthen international science for the benefit of society. Within this overarching mission, ICSU's objectives with respect to environment and its relation to sustainable development should be the following:

- Identify emerging issues, including potential problems and solutions, where scientific knowledge and research can make a difference;
- Catalyze and coordinate scientific research in the domain of the environment that:
 - expands understanding of the interactions between biogeochemical and physical processes and their social causes and impacts, and
 - underpins environmental protection and conservation, and addresses the need for economic and social development;
- Contribute to the development of monitoring activities that are essential for documenting the state of the global system and its components;
- Ensure that the social sciences are fully integrated into ICSU's programmes as appropriate;
- Stimulate collaboration with stakeholders in developing research agendas and communicating results from research of relevance to the development of appropriate policies;
- Contribute to environmental assessments;
- Develop mechanisms to ensure that results from policy-relevant research benefits the governmental and private sectors as well as civil society;
- Catalyze new types of effective collaborations/partnerships within the ICSU family and with others; and
- Promote the synthesis and communication of the policy-relevant work conducted by ICSU's Scientific Unions, National Members, and IBs.

The Panel commends ICSU's efforts to support international and interdisciplinary collaboration in environmental research. Over the past few decades the scientific community has made remarkable progress in advancing

scientific understanding of environmental problems through international collaboration, including through the numerous scientific activities launched and sponsored by ICSU. The results of these research programmes, complemented by a number of international assessments, have been essential for the development of multinational regional and global environmental agreements, e.g. the Convention on Long-range Transboundary Air Pollution, the Vienna Convention for the Protection of the Ozone Layer, and the United Nations (UN) Framework Convention on Climate Change.

Many of ICSU's current activities are policy relevant and salient to sustainable development. However, ICSU must increase its efforts to ensure that the results are communicated more effectively. The Panel recommends that ICSU Union and National Members, as well as individual scientists, become more active in explaining the current state of scientific information to policy-makers, including both robust findings and key uncertainties, and in turn, are responsive to the information needs of the policy communities.

The Panel endorses an expanded focus on the environmental programmes emphasizing the integration of the environmental, social, and economic pillars of sustainable development. The information needed by decision-makers requires continuing research and an evolution in scientific understanding. In order to inform decision-makers and influence the institutional, technological, and behavioural responses to environmental-development issues, scientific research must become increasingly policy relevant; participatory; address a variety of geographic scales; integrate various epistemologies; and be holistic and systemic. This requires integrating the natural, social, technological and health science domains so that the relationships among driving forces, changes in the environment, and poverty alleviation and human well-being can be better understood.

The Panel encourages the development of new multidisciplinary projects that fully incorporate the social science dimensions. The social sciences, including economics and the humanities, are essential components in addressing environmental problems in a holistic way. However, the Panel is disappointed in the weak interactions with the International Social Science Council (ISSC). If the ISSC is unable to take a stronger responsibility for programme development, then the Panel recommends that ICSU make alternative arrangements.

The conceptual framework of the Millennium Ecosystem Assessment (MA) provides a useful and timely model within which ICSU's environmental programmes might be considered. The MA conceptual framework links the direct and indirect human-induced drivers of change (e.g. demographic, economic, socio-political, technological, behavioural, and land-use) and natural drivers of change (e.g. solar activity and volcanic eruptions) to changes in the environment (e.g. climate change, air pollution, and degradation of ecosystems and their services) to human well-being and poverty alleviation (e.g. health and environmental, cultural, and economic security).

The Advisory Committee for the Environment (ACE)

ACE has helped to ensure that environmental issues have remained high on the ICSU agenda, but an evolution in ICSU's governance structure suggests that a careful re-examination of the role of ACE is required.

In recent years questions have been raised about the form, function, and effectiveness of ACE and its relationship with the CSPR. The following are the findings and recommendations of the Panel:

- The Panel unanimously acknowledges that there is a need for a continued, strong focus on environmental issues within ICSU's activities;
- The Panel recommends that some ICSU entity is designated with responsibility for providing ICSU with advice as needed on the status and development of ICSU activities relating to the environment;
- Members of this entity must have: 1) extensive knowledge of ICSU and non-ICSU environmental activities; 2) experience with the application of knowledge from the environmental sciences to sustainable development; and 3) understanding of the mechanisms that connect environmental scientific knowledge to policy processes; and
- ICSU could obtain the required advice by either merging the roles of ACE and the CSPR, or reconstituting ACE with an increased emphasis on social, technological and health sciences, and revised terms of reference (ToR). If the former option is chosen, the skills and experience mix of the CSPR members would need to be broadened.

Analysis of ICSU's Current Activities

The Panel stresses the importance of the complementary nature of assessment bodies, thematic organizations, global environmental change programmes, monitoring, observation and data systems, as well as the dissemination and communication of scientific information. The Panel recommends that ICSU use this ensemble structure to elaborate its environmental portfolio.

The Panel agrees with the ICSU Executive Board that ad-hoc groups, with finite lifetimes, should address specific issues and the establishment of new IBs should be restricted. The Panel recommends that IBs establish an independent assessment of their programmes/projects early in their development. Depending on their nature, the Panel recommends that certain ICSU activities be designed with a sunset clause.

The Panel recognizes that there is an urgent need for increased information exchanges within the ICSU family. Successful collaborative efforts result only when it is recognized that there is a shared responsibility across the ICSU family for developing linkages and coordinating activities.

Assessment bodies and activities

ICSU's assessment activities provide an essential bridge between the scientific and policy communities:

- The Scientific Committee on Problems of the Environment (SCOPE) plays a critical role in identifying and assessing the importance of emerging regional and global environmental issues, and is central to stimulating new scientific programmes and providing an important link between the scientific and policy communities. The major challenges for SCOPE are to be more focused (i.e. fewer studies), innovative (i.e. looking over the horizon for issues that are not already well-established on the scientific and political agenda), balanced (i.e. between regional and global studies), scientifically challenging and policy relevant, and feed more into the planning of other ICSU activities;
- The Panel commends ICSU's sponsorship of the MA, which has adopted an innovative multidisciplinary and multi-scaled approach to ecosystem assessments; and
- Scientists involved in ICSU's activities, and operating in their personal capacity, should whenever possible, participate in national and international assessments (e.g. the Intergovernmental Panel on Climate Change and the MA) to ensure that the results from ICSU's research activities are used to inform the policy process. The Panel recommends that ICSU offer advice to assessment bodies as new international assessment activities are planned, and ensure that relevant scientists are nominated as lead authors and peer-reviewers of the assessments.

Thematic Organizations

The range of ICSU thematic organizations is as varied as the scientific domains covered. In most cases, these organizations should increase their level of collaboration with the other IBs and ICSU members to ensure their relevance:

- The Scientific Committee on Oceanic Research (SCOR) has demonstrated flexibility in its focus as ocean science has evolved, and the success of future ICSU projects and activities related to the ocean would be diminished without the scientific integrity and experience of SCOR. The Panel recommends that SCOR continue in its efforts to enhance the development of international science within the oceanographic community, and to bring the strongest possible representation into ongoing and future projects of the Global Environmental Change (GEC) programmes and the relevant Global Observing Systems (GOS);
- The importance of the Scientific Committee on Antarctic Research (SCAR) has increased over the years with the greater understanding of the pivotal role of the Antarctic in the Earth system. While there have been some concerns raised about the efficacy of this committee, the Panel realizes that a process of change is in place. SCAR is encouraged to focus

primarily on promoting strong Antarctic science while retaining its role in relation to the Antarctic Treaty. The Panel notes the relatively weak interaction with the rest of the ICSU family and recommends that SCAR interact more efficiently with other IBs and Unions in order to further strengthen Antarctic science;

- While the Committee on Space Research (COSPAR) scientific assemblies are major events for the space community, the impact of COSPAR on the development of Earth System Science is weak, especially the GEC programmes. Furthermore, COSPAR does not appear to play any significant role in the international efforts to develop the GOS. The Panel recommends that relevant COSPAR commissions develop plans that clearly articulate the added benefit of COSPAR to the wider ICSU environmental science community;
- The Committee on Disaster Reduction (CDR) was established to coordinate research and applications to reduce the impacts of natural hazards and related environmental and technological hazards. However, there is little interaction between the CDR and the GEC programmes, although the increase in the strength and frequency of natural disasters is clearly associated with a changing global climate. The Panel recommends that the current CDR committee be disbanded and that ICSU initiate a planning process involving all relevant Unions and IBs to develop a new programme that focuses on predicting and reducing the impacts of natural and human-induced hazards;
- The Scientific Committee on the Lithosphere (SCL) operates the International Lithosphere Programme (ILP) that seeks to elucidate the nature, dynamics, origin, and evolution of the lithosphere, with special attention to the continents and their margins, and to examine the implications for society. The Panel notes that, while the SCL/ILP was for many years very active and regularly produced highly relevant and valuable output, recently the level of activity seems to have declined and SCL does not appear to be collaborating with any of the other IBs. The Panel recommends that the International Union of Geodesy and Geophysics (IUGG) and the International Union of Geological Sciences (IUGS) take responsibility for the SCL, rather than have it exist as an independent ICSU IB
- The Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) was established to promote international interdisciplinary programmes in solar-terrestrial physics. However, its programmes have limited importance in understanding issues of environmental concern. The Panel recommends that SCOSTEP address the effect of natural solar variability on climate, and thus encourages the new Climate and Weather of the Sun-Earth System (CAWSES) initiative.

Global Environmental Change Programmes

The four GEC programmes, i.e. the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), the International Human Dimensions Programme on Global Environmental

Change (IHDP), and DIVERSITAS have, to different degrees, made excellent progress and are producing knowledge that is policy relevant. In addition, the coordination and collaboration among the GEC programmes has successfully evolved over time:

- The Panel applauds the IGBP for success with its interdisciplinary core projects that have improved the understanding of Earth system processes, and especially how human activities are affecting the Earth at regional and global scales. The Panel endorses the planned holistic programme structure and planned core projects on ocean, land, atmosphere interactions. A primary challenge for the IGBP is to improve the understanding of biogeochemical processes in order to develop transient ecological models of sufficient complexity to capture the dominant processes of core elemental cycles that can be coupled to transient global change models (e.g. climate change);
- The Panel commends the progress made through the WCRP in establishing the physical basis for understanding and predicting El Niño events, and the improved understanding and predictability of natural climate variability and human-induced climate change at the regional and global scales. One of the major challenges for the WCRP is to develop improved transient, fully coupled atmosphere-ocean-land general circulation models that incorporate biogeochemical feedbacks;
- The Panel endorses the need for a vibrant, interdisciplinary IHDP that addresses the coupled human-natural system in the context of global environmental change, and recognizes its essential role in the Earth System Science Partnership (ESSP). The most visible success to date has been the Land Use and Cover Change (LUCC) project. The Panel encourages IHDP to broaden its range of social science disciplines, especially economics, and establish stronger links with appropriate ISSC activities and commissions. If ISSC is unable to take a stronger responsibility for programme development then the Panel recommends that ICSU consider an alternative arrangement; and.
- DIVERSITAS has developed a focussed and scientifically challenging science plan that calls for the establishment of three core projects. The Panel recommends that DIVERSITAS set appropriate priorities to make best use of available resources. The Panel notes the complex structure with five sponsoring organizations and recommends that SCOPE, the International Union of Biological Sciences (IUBS) and the International Union of Microbiological Societies (IUMS) continue to support DIVERSITAS through collaborative activities without being formal sponsors. The Panel also recommends that ICSU become the sole sponsor of DIVERSITAS unless the United Nations Educational Scientific and Cultural Organization (UNESCO) takes concrete steps for providing substantive support for this programme.

The development of the ESSP is an important new development, and the joint projects under ESSP are expected to provide significant results of high relevance to the science for sustainable development. However, it is important

to recognize that the science underpinning these joint ESSP programmes will come primarily from research conducted within the programmes of IGBP, WCRP, IHDP, and DIVERSITAS. The Panel notes that by adopting projects such as those proposed for ESSP, the GEC programmes raise high expectations. Prospects for success with the type of synthesis and integration required among hitherto separate research programmes is largely untested. The Panel recommends that ICSU be especially watchful during early formative stages of the ESSP projects to ensure that disciplinary fragmentation does not confound well-laid plans for the achievement of this integration.

- Given the centrality of the carbon cycle to the climate debate, the Panel endorses the Global Carbon Project, which is highly policy relevant and timely;
- With regard to the Global Environmental Change and Food Systems project, the Panel questions 1) whether the approach of focusing only on regional case studies is appropriate or whether there should also be a series of more generic studies of the response of different agricultural crops to environmental changes and the development of improved crop traits and 2) whether the most important regional case studies were chosen. The Panel recommends that the initiative needs a “science plan” or at least a “framework” with well-defined criteria for the selection of case studies;
- The Global Water System Project is still in a formative stage. The Panel recommends that the project link with existing water research programmes within ICSU and other international programmes to increase synergies and avoid duplication, and that ICSU track the cooperative development of this initiative; and
- There is not enough information available in the draft documentation to critically evaluate the initial plans of the Global Environmental Change and Human Health project. However, the overarching questions being considered are very appropriate and the Panel endorses the need for such a project.

To further promote international and interdisciplinary research more resources are required through national funding mechanisms, especially for the full participation of social scientists:

- The estimated annual research budget, as estimated by the International Group of Funding Agencies for Global Change Research (IGFA) for the GEC research programmes, is about US\$2 bn, excluding funding for satellite programmes; this is primarily through national contributions. The Panel recommends that support for programme/core project planning and coordination should be increased from about 0.5% to 1% of the total research budget;
- Given the important role that IGFA plays in providing a platform for communication between the GEC programmes and several key funding agencies, the Panel urges IGFA to broaden its membership and disciplinary representation consistent with the breadth of ICSU activities;

- The Panel notes that ICSU National Members and National Committees provide essential support for the GEC programmes and recommends the establishment of national focal points where they do not exist. In the future GEC National Committees should be formed to encompass IGBP, WCRP, IHDP and DIVERSITAS;
- National Members should take due note of the importance of including social, technological and health sciences in research on environment and its relationship to sustainable development; and
- The Panel recognizes the importance of mobilizing funds to support research and capacity building in developing countries, especially Africa.

Monitoring/observations, data and information

Global observations are critically important in support of policy relevant science, but the Panel concludes that the current GOS and the Integrated Global Observing Strategy Partnership (IGOS-P) are not adequately addressing the needs of the scientific communities:

The Panel would like to see a greater demonstration of the value of the GOS to the GEC programmes:

- The Global Ocean Observing System (GOOS) has been a successful convenor of discussions on the topic of future ocean observations. From the point of view of ICSU sponsorship, however, linkages with the marine global change projects have been weak.
- The Panel notes that there has been a general decrease in capacity and coverage of the climate observing capabilities worldwide over the past decade. While it is difficult to assess how the efforts of the Global Climate Observing System (GCOS) have mitigated this decline, the recently prepared “adequacy reports” have identified the issues.
- The emphasis of the Global Terrestrial Observing System (GTOS) should be on the development of the terrestrial component of the GOS, rather than on the collection of regional and sub-regional data sets;

The Panel recommends that there should be better integration and collaboration among the GOS, and that GOS and IGOS set their priorities based on the global requirements of the science community, especially the GEC programmes, as well as the policy community. Many ICSU IBs have been involved in defining IGOS themes. The Panel notes, however, that there is no ICSU research body with ocean expertise listed with membership on the ocean theme;

- ICSU should strengthen its involvement in the three GOS and IGOS-P to ensure that the ICSU science community has a significant impact on the development of the themes to build better connections with the ESSP;

There is a need to strengthen the public domain and to ensure full, open and equitable access to scientific data for research and education;

- The Panel recommends that the Panel on World Data Centres (WDC) prepare a vision statement and strategy document for its future development and interactions with the ICSU family, including the GEC

programmes, the GOS and the Unions. The strategy and resulting implementation plan should aim to ensure that environmental data are freely available in a timely manner to the global science community. ICSU should review the WDC plan for future activities and be prepared to monitor its implementation; and

- The value-added nature of ICSU sponsorship of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) is questioned, and the International Astronomical Union (IAU), IUGG, and Union Radio Scientifique Internationale (URSI) should take responsibility for its future. FAGS should no longer be an ICSU IB.

International Scientific Unions

The Panel recognizes the important role of the Unions in generating knowledge, organizing scientific meetings, and promoting inter-Union collaborative activities, which are key to identifying environmental problems and contributing to solutions for addressing them:

- The Panel notes that many Unions have significant activities of high relevance to environment and its relationship to sustainable development;
- Unions should be encouraged to continue their attention to these issues and to examine, coordinate, and integrate their activities with the IBs, which they have collectively established together with the National Members. The IBs should be encouraged to integrate Union activities into their work to avoid duplication of effort; and
- Unions should take note of the importance of the social sciences in developing policy relevant research. Unions, which belong to both ISSC and ICSU, should work to facilitate more effective collaboration around specific problem areas.

National Members

National members are vital to the success of ICSU activities:

- The Panel notes that most research associated with coordinated international programmes is primarily funded at the national level.
- National funding bodies are encouraged to develop their national programmes with a view to contributing to relevant international programmes and to enabling their national scientists to reap the benefit from involvement in international research endeavours.
- National members should provide links to relevant national policy-makers and ensure that results from international programmes are made available at the national level.
- National members should be strong advocates for encouraging the teaching of interdisciplinary approaches to environmental research.

Collaborative links

Research collaboration within the ICSU family and with other organizations on questions related to environment and its relation to sustainable development is critical.

- The Panel notes extensive cooperation among GEC programmes, but their links to other IBs, with the exception of SCOPE, is limited;
- Collaboration between IBs and Unions is weak and while some Unions claim joint activities with IBs, these are not always acknowledged by the latter;
- The Panel strongly encourages IBs and Unions to improve information exchange and collaborate more closely to avoid duplication and create strategic partnerships; and
- The Panel notes the many collaborative links with UNESCO, the UN Specialized Agency responsible for science.

Capacity Building

Capacity building, both individual and institutional, is a central component in any effort to address the environment and its relationship to sustainable development. This can be achieved through formal education, improved communication between the scientific community and decision-makers, and improved use of scientific information in policy formulation. The Panel:

- recommends that science and technology be a routine component of primary and secondary education;
- recognizes that current university structures are generally a hindrance for the development of trans-disciplinary curricula, and urges ICSU to work with the International Association of Universities (IAU) to address this issue;
- recognizes that scientists in both developed and developing countries need disciplinary expertise, but also recommends they are provided with opportunities for research training across disciplines as well as spatial and temporal scales;
- recognizes that bridging the communication gap between scientists and policy-makers is a joint learning experience, and recommends that ICSU consider the best way to address the need for training courses for scientists and policy-makers.

The Panel commends the capacity building efforts of the Unions and the IBs, and recommends a continued emphasis in this area:

- The Global Change System for Analysis, Research and Training (START) is an excellent example of an initiative that addresses the need for involvement of scientists from developing countries in the GEC programmes and fosters the development of capacity building through regional priority setting.

Possible new high priority areas

The Panel recommends that ICSU develop programmes in each of the following four areas that are widely recognized as important and consistent with its overall mission, and that each programme include components of understanding the vulnerability of systems to multiple stresses and developing plausible future scenarios:

- **Environment and human health.** Human health is a key determinant of human well-being. The environment is responsible for about 20% of the global disease burden (e.g. millions of people die annually in developing countries, especially children, from in-door air pollution, water pollution and vector-borne diseases), comparable to that of malnutrition. The Panel believes that there is an urgent need for an ICSU programme in this area and is encouraged by the current initiatives of the IUBS inter-Union collaborative endeavours and the ESSP to develop an integrated programme to address environment and human health issues. Collaboration should be sought with other organizations, particularly the World Health Organization (WHO).
- **Natural and human-induced hazards.** These are very costly to society, both economically and in terms of lives lost and human well-being. Human populations are becoming increasingly vulnerable to such hazards. As noted earlier, the Panel recommends that the current CDR committee be disbanded and that ICSU involve all relevant Unions and IBs in developing a new programme in this very important area.
- **Human security – environmental refugees.** The inter-relationships between demographic changes, including population increase, environmental degradation, and environmental refugees are a priority area for research. The Panel recommends that ICSU initiate, in collaboration with partners, a planning process for a project that identifies the scientific issues associated with these inter-relationships.
- **Transgenic crops and their implications for the environment.** The Panel recognizes that there is significant controversy and uncertainties surrounding the environmental and other implications in both the scientific and policy communities. The Panel recommends that ICSU pay attention to this issue and consider how it could contribute to sound policy through promoting relevant science and communicating results from scientific research in this area.