ICSU
International Council for Science

strengthening international science for the benefit of society

Environment and its relation to sustainable development

Report of the CSPR Assessment Panel




About ICSU

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both national scientific bodies (101 members) and international scientific unions (27 members).

Through this international network, ICSU coordinates interdisciplinary research to address major issues of relevance to both science and society. In addition, the Council actively advocates for freedom in the conduct of science, promotes equitable access to scientific data and information, and facilitates science education and capacity building.

The Council acts as a focus for the exchange of ideas, the communication of scientific information and the development of scientific standards. ICSU's members organize scientific conferences, congresses and symposia all around the world—in excess of 600 per year—and also produce a wide range of newsletters, handbooks, learned journals and proceedings.

ICSU also helps create international and regional networks of scientists with similar interests and maintains close working relationships with a number of intergovernmental and non-governmental organizations, especially UNESCO and the Third World Academy of Sciences (TWAS).

Because of its broad contact with thousands of scientists worldwide, ICSU is increasingly called upon to speak on behalf of the global scientific community and to act as an advisor in matters ranging from ethics to the environment.

CSPR

The Committee on Scientific Planning and Review was established in 1998, to coordinate the development of proposals for major new scientific initiatives by ICSU and to advise the Executive Board on priorities for such initiatives. The Committee also reviews the activities carried out by ICSU's Interdisciplinary Bodies, advises the Executive Board on the future course of these activities, and oversees the ICSU Grants Programme. The CSPR's terms of reference can be found under Rule of Procedure 11.1a) at: www.icsu.org – infocentre/ICSU central.

ICSU

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Environment and its relation to sustainable development

Report of the CSPR Assessment Panel

by

Robert Watson (Chairman), Anne Buttimer, Angela Cropper, Istvan Lang, Gordon McBean, James McCarthy, Uri Shamir, Crispin Tickell, Shem Wandiga

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ICSU Priority Area Assessment on Environment and its Relation to Sustainable Development

ICSU has identified the environment and its relation to sustainable development as a priority area in developing its strategic plan for the coming years. In this regard, a Panel was appointed by the Committee on Scientific Planning and Review (CSPR) to perform a Priority Area Assessment (PAA); this strategic approach replaces the previous statutory requirements of the six-year periodic reviews of individual ICSU Interdisciplinary Bodies (IBs). The approach of the Panel was to first develop a mission statement and theoretical framework, and then to focus the assessment on the environmental activities of the relevant IBs and Joint Initiatives (JIs; in the future jointly referred to as IBs), while leaving a more detailed analysis of the areas of Data and Information and Capacity Building to subsequent PAAs. The conclusions and recommendations from this analysis of the IBs have been primarily considered within the larger framework of the activities of ICSU's National and Union Members and partner organizations.

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.

1. Introduction

1.1 DEVELOPMENT OF A STRATEGY FOR ICSU

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization representing a global membership that includes both National Members (101 members) and International Scientific Unions (27 members). In order to strengthen international science for the benefit of society, ICSU mobilizes the knowledge and resources of the international science community to:

- Identify and address major issues of importance to science and society;
- Facilitate interaction among scientists across all disciplines and from all countries;
- Promote the participation of all scientists—regardless of race, citizenship, language, political stance, or gender—in the international scientific endeavour; and
- Provide independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society, and the private sector.

Over the years, the ICSU General Assembly, comprised of National and Union Members, has decided to address interdisciplinary and international issues through the establishment of Scientific Interdisciplinary Bodies (IBs). In some instances, Joint Initiatives (JIs) have been established in collaboration with partners outside of ICSU. Such bodies (hereafter jointly referred to as IBs) focus on specific areas that are of interest to many or all ICSU Members that require multidisciplinary and international approaches wider than that which can be covered by the single disciplinary Scientific Unions or National Member.

In 1995-96, an independent Panel of experts was invited to conduct an assessment of ICSU. According to the Panel report[1], "ICSU and its members need to formulate an innovative process for determining future directions and for identifying new initiatives". As a consequence, the Committee on Scientific Planning and Review (CSPR) was established to advise the Executive Board and the General Assembly of ICSU. At the 27th General Assembly in 2002, it was decided to develop a strategic plan to cover the coming 5-10 years. The CSPR was charged with developing a process that will result in a strategy for discussion at the 28th General Assembly in 2005. Components of this process include:

- Identification of emerging issues;
- Priority Area Assessments (PAAs);
- Strengthening ICSU role in, and for developing countries;
- Development of specific initiatives such as science and technology for sustainable development, and energy and sustainable societies.

Section 12.1 of the ICSU Rules of Procedure (Annex 1) specifies that "Individually, or in the context of broader policy reviews, IBs will be reviewed by the ICSU Committee on Scientific Planning and Review for every second General Assembly of ICSU". In response to this requirement, the CSPR has initiated strategic assessments of ICSU's activities in selected "Priority Areas". The PAAs are designed to help ICSU develop a clear strategy for taking forward priority areas with full participation of the ICSU family – i.e. the Unions and National Members as well as the IBs. The process should in itself increase synergies and coordination among activities of these bodies.

Three priority areas were initially identified: Environment and its Relation to Sustainable Development, Scientific Data and Information, and Capacity Building. The CSPR has appointed an ad hoc Panel for each PAA. Membership of the PAA for environment and its relation to sustainable development is given in Annex 2 and the Background Information and ToR in Annex 3.

1.2 EVOLUTION OF ICSU'S ENVIRONMENT PORTFOLIO

International activity in the environmental area has a long history, including the First International Polar Year in 1882, the ICSU-sponsored International Geophysical Year in 1957-1958, and the Global Atmospheric Research Programme (GARP) in 1967-1980. In 1969, ICSU established the Scientific Committee on Problems of the Environment (SCOPE) to address environmental

issues – either global or shared by several nations – in urgent need of interdisciplinary synthesis, assessment and evaluation of information on natural and human-made environmental changes and their effect on people. The first SCOPE Report was commissioned by the Secretary-General of the 1972 UN Conference on the Human Environment.

In 1979, ICSU co-sponsored the first World Climate Conference, which led to the establishment in 1980 of the World Climate Research Programme (WCRP) by ICSU, the World Meteorological Organization (WMO), and the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). Based on the studies of SCOPE in the 1970s and early 1980s, ICSU initiated the planning of the International Geosphere-Biosphere Programme (IGBP) in 1986. In addition to IGBP and WCRP, which are Global Environmental Change (GEC) programmes, ICSU also co-sponsors the International Human Dimensions Programme on Global Environmental Change (IHDP), established in 1996 in collaboration with the International Social Science Council (ISSC), and DIVERSITAS, initially established in 1991 by the International Union of Biological Sciences (IUBS), SCOPE, and UNESCO. These four GEC programmes are currently coming together under the banner of the Earth System Science Partnership (ESSP) that promotes international and interdisciplinary research in special focal areas (carbon, food, and water). The GEC programmes and their joint ESSP projects form the core research programmes of ICSU in the environmental sector.

Since the UN Conference on Environment and Development (UNCED,1992), the UN has expanded its focus from the environment to embrace sustainable development issues, emphasising the integration of the environmental, social and economic pillars of sustainable development, as demonstrated by the World Summit on Sustainable Development (WSSD, Johannesburg 2002). ICSU and the World Federation of Engineering Organizations (WFEO) were invited by the UN to represent the Scientific and Technological community at WSSD. One of the challenges, highlighted by ICSU, is to promote research that integrates the three pillars of sustainable development. The Scientific and Technological community examined these challenges in publications prepared for the World Summit on Sustainable Development (WSSD).[2]

Over the past few decades, the scientific community has made remarkable progress in advancing scientific understanding of environmental problems through international collaboration. ICSU has often taken the lead and the results of these research programmes, complemented by a number of international assessments, have been essential for the development of multinational environmental agreements such as the Convention on Long-range Transboundary Air Pollution, the Vienna Convention for the Protection of the Ozone Layer, the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biodiversity (CBD), the United Nations Convention to Combat Desertification (UNCCD) and the UN's Forest Principles.

The Global Change System for Analysis, Research and Training (START), which is jointly sponsored by WCRP, IGBP, and IHDP, supports regional networks of researchers and institutions engaged in collaborative research on global change issues. One of the goals of START is to strengthen indigenous capacity and to address scientific and policy aspects of environmental changes in the regions.

In addition to the GEC programmes, other important activities in the environmental area that also contribute to the elucidation of the Earth system processes, are carried out by ICSU IBs, such as the Scientific Committee on Oceanic Research (SCOR) and the Scientific Committee on Antarctic Research (SCAR).

ICSU also sponsors three Global Observing Systems (GOS): the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), and the Global Terrestrial Observing System (GTOS), in collaboration with partner organizations such as the WMO, IOC, UNESCO, the Food and Agricultural Organization (FAO), and the United Nations Environment Programme (UNEP). The goal of the GOS is improved monitoring of the global Earth system. The

[1] *Final Report. ICSU Assessment Panel, October 1996.*
[2] *ICSU Series on Science for Sustainable Development, No. 1-11, 2002-2003.*

GOS are among 14 partner organizations of the Integrated Global Observation Strategy (IGOS) that seeks to unite the major satellite and surface-based systems for global environmental observations of the atmosphere, oceans, and land. The Panel on World Data Centres (WDC) and the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) also provide services for collection, validation and distribution of scientific data of environmental relevance. The Committee on Space Research (COSPAR) is facilitating international exchange of information on scientific research related to global environment monitoring from space.

Important activities of high relevance to the environmental sciences are also undertaken by ICSU Scientific Union Members. Some of the Unions are major sponsors of the above-mentioned ICSU programmes. The PAA has taken due note of the environmental activities of the Scientific Unions and evaluated the effectiveness of the collaboration between Unions and IBs. It should be noted that many environmental problems were first detected by basic single-disciplinary research, and thus the Unions have not only provided an early warning system for emerging problems; they have also assumed leading roles in their analysis.

National Members have also been very supportive of ICSU initiatives and programmes. Many IBs and Unions have national membership, and effective linkage between the national and international levels is crucial for the success of ICSU.

1.3 APPROACH OF THE PAA

The scope of this Assessment covers all IBs in so far as their programmes concern environmental issues. General data and capacity building issues will be the purview of subsequent PAAs.

The Panel worked in close collaboration with the ICSU family throughout the preparation of this report. While the ToR guided its work and the CSPR made suggestions during the Assessment process, the Panel had the autonomy to determine the best approach to be used to meet the goals of the PAA. Initially, the Panel was asked by the CSPR to perform an assessment of ICSU environmental activities. However, at its first meeting in November 2002, a strong consensus emerged to enlarge the scope of the PAA to consider ICSU environmental activities and their relation to sustainable development; this was agreed to by the CSPR.

It should be noted that ICSU, in collaboration with the Initiative on Science and Technology for Sustainability (ISTS) and the Third World Academy of Sciences (TWAS), has established a Consortium for Science and Technology for Sustainable Development and appointed an ad hoc Advisory Group for the purpose of defining an agenda for the Consortium. The Advisory Group started its work concurrent to this Assessment, and it is hoped that this Group can make use of some of the observations and recommendations in this report.

A mission statement to guide its work for this Assessment (Section 3) was drafted by the Panel. Feedback from the IBs and all Unions on this statement was sought by the Panel, and the responses were incorporated in the final version.

The most extensive consultation, which began with a web-based questionnaire (Annex 4), focused on the environmental activities of the IBs. A similar questionnaire was also sent to all Unions. Participation among the IBs and Union members was 100% and about 50%, respectively. A two-day meeting was organized by the Panel at which each IB involved in environmental activities was represented. This marked a first for ICSU by bringing together representatives from all its environmental IBs to engage in discussion.

Union Members were consulted via a web-based questionnaire (Annex 4) and specifically invited to suggest how they could better interact with IBs. To complete the Assessment process, a draft report was circulated to the ICSU family for comments.

While the primary audience of this report is the CSPR and the Executive Board, it is also intended for the larger ICSU family and for those interested in international science, in particular specialists in fields concerning environment and sustainable development.

2. Key environmental challenges for the scientific community

2.1 KEY ISSUES

There is little doubt that the Earth's environment is changing on all scales from local to global, in large measure due to human activities. The climate is warming at a rate faster than that at any time during the last 10,000 years, biodiversity is being lost at an unprecedented rate, fisheries are in decline in most of the world's oceans, air pollution is an increasing problem in many of the major cities in the world, large numbers of people live in water stressed areas, and extensive areas of land are being degraded. Much of this environmental degradation is due to the unsustainable production and use of energy, water, food, and other biological resources, and is already undermining efforts to alleviate poverty and stimulate sustainable development. Worse still, the future projected changes in the environment are likely to have even more severe consequences for sustainable development.

Two examples of projected changes in the environment that will undermine sustainable development are climate change and loss of biodiversity. The Earth's climate is projected to warm by between 1.4 and 5.80C over the next 100 years. These higher temperatures will be accompanied by changes in precipitation patterns, including an increase in heavy precipitation events, increases in sea level, and an increased incidence of extreme weather events, such as heat waves. Furthermore, projected changes in climate will, in many parts of the world, adversely affect water resources, human health, agriculture, forestry, fisheries, and ecological systems. Biodiversity, and the goods and services provided by ecosystems, are being degraded because of conversion and fragmentation of ecosystems, introduction of exotic species, and air and water pollution, in addition to the emerging threat of human-induced climate change. Ecosystem degradation can adversely affect: 1) the provisioning of food, fibre, and other goods; 2) the regulating services that control the quality of air and water, the likelihood of floods and climate change, and the spread of infectious diseases; and 3) cultural services, which bear on the quality of life and human well-being.

2.2 CHALLENGES FOR THE SCIENTIFIC COMMUNITY AND FOR ICSU

Such changes in the environment and their implications for humanity pose unprecedented challenges for science; treating them within the framework of sustainable development adds further complexity. Four distinct clusters of challenge are indicated. Firstly, there are conceptual/analytical challenges of integrating insights from social (including economics and humanities) and natural sciences. Secondly, there are practical concerns about how best to interact with those who are concerned with promoting sustainable development. Thirdly, there are challenges of promoting capacity building for integrated science as well as for influencing policy. Overriding these is a fourth challenge, arguably the most essential, i.e. ongoing assessments and critical reflections on states of knowledge about environment and sustainable development. All of these require conscious attention within the ICSU environment programme.

2.2.1 Conceptual/analytical challenges

Scientific analyses of the environment have pursued increasingly more specialized lines of enquiry into distinct aspects of environment, e.g. atmosphere, lithosphere, biosphere, anthroposphere, and even noosphere. While disciplinary specialization has yielded better results within particular areas of knowledge, the goals of reaching integrated understandings of environment, and of human interactions with it, have become more challenging. Several distinct types of research cultures have thus emerged within and among researchers in the natural and social sciences during the twentieth century. Prospects for mutual understanding and collaboration among scientists therefore remain difficult but vital. Today, harmonization of social, economic, and ecological values constitutes a common challenge.

2.2.2 Challenges of capacity

Today, considerable work in capacity building is found in all activities of the IBs, Scientific Unions, and National Members. This was confirmed by the Panel through a questionnaire, responses to which are analysed in Section 6 of this report. The Panel recommends that priority be given to the continuation of capacity building activities, recognizing that scientists in both developed and developing countries need opportunities for training in dialogue across disciplinary boundaries and geographical contexts, as outlined in Section 5.9 of this report.

2.2.3 Practical challenges of influencing policy-makers and communicating with the public

Scientists should play a major role in explaining scientific information, including what is known and indicating what is not known, and enter into public dialogue as appropriate. To transpose the results of scientific research into policy-relevant guidelines requires careful attention to cultural context. The communication strategy developed by the scientific community for the WSSD serves as a good example of communicating with a wide range of interested parties.

International policy formulation has benefited from integrated assessments such as the Intergovernmental Panel on Climate Change (IPCC), the Millennium Ecosystem Assessment (MA) and the Global International Waters Assessment (GIWA), and the UNEP Global Environment Outlook project. ICSU should become more closely identified with, and involved in supporting, assessments that integrate the various relevant domains of scientific knowledge, and present them in ways that could underpin the policy process.

ICSU has an important role in ensuring that relevant scientists are nominated as lead authors and peer-reviewers for international assessment processes, and that the latest scientific findings from ICSU programmes and projects are made available to them.

Such assessments need to be policy relevant, but not policy prescriptive, encompassing risk assessment, identifying areas of certainty, uncertainty, and controversy. Ownership and participation by experts in their individual capacity in the scoping, preparation, and peer-review is essential. Geographical representation and intellectual balance among the experts are critical to ownership and to address these complex issues. Ownership by all interested parties requires the assessment to be conducted in an open, transparent, representative, and legitimate process, with well-defined principles and procedures.

In addition to the above general guidelines, the Panel emphasizes the importance of integrated scientific assessments, such as those of the MA of which ICSU is a sponsor.

2.2.3.1 Integrated conceptual framework

Identification of needs and design of related scientific initiatives for the environment in the context of sustainable development require a conceptual framework which illuminates the relationship among the three pillars of sustainable development, as well as the cyclical relationship between human impacts on the environment and consequences for human well-being over time. The Panel considers that the approach of the MA provides a useful and relevant framework for illustrating how ICSU's environmental activities might strengthen science for the benefit of society (see Figure 1). This framework helps to illuminate the following challenges inherent in ICSU's environment programme in the context of sustainable development:

- Scientific research must become increasingly systemic, including consideration of forces that affect the environment, impacts on human well-being, and feedbacks over time and space through institutional, economic, technological, and behavioural responses.
- This requires conscious efforts to integrate across the physical, chemical and biological disciplines and across the natural and social sciences.
- Given environmental and human interactions (climate with forests, forests with water, water with human well-being, etc.), environmental science needs to be comprehensive in relation to issues of vulnerability, resilience, and sustainability.

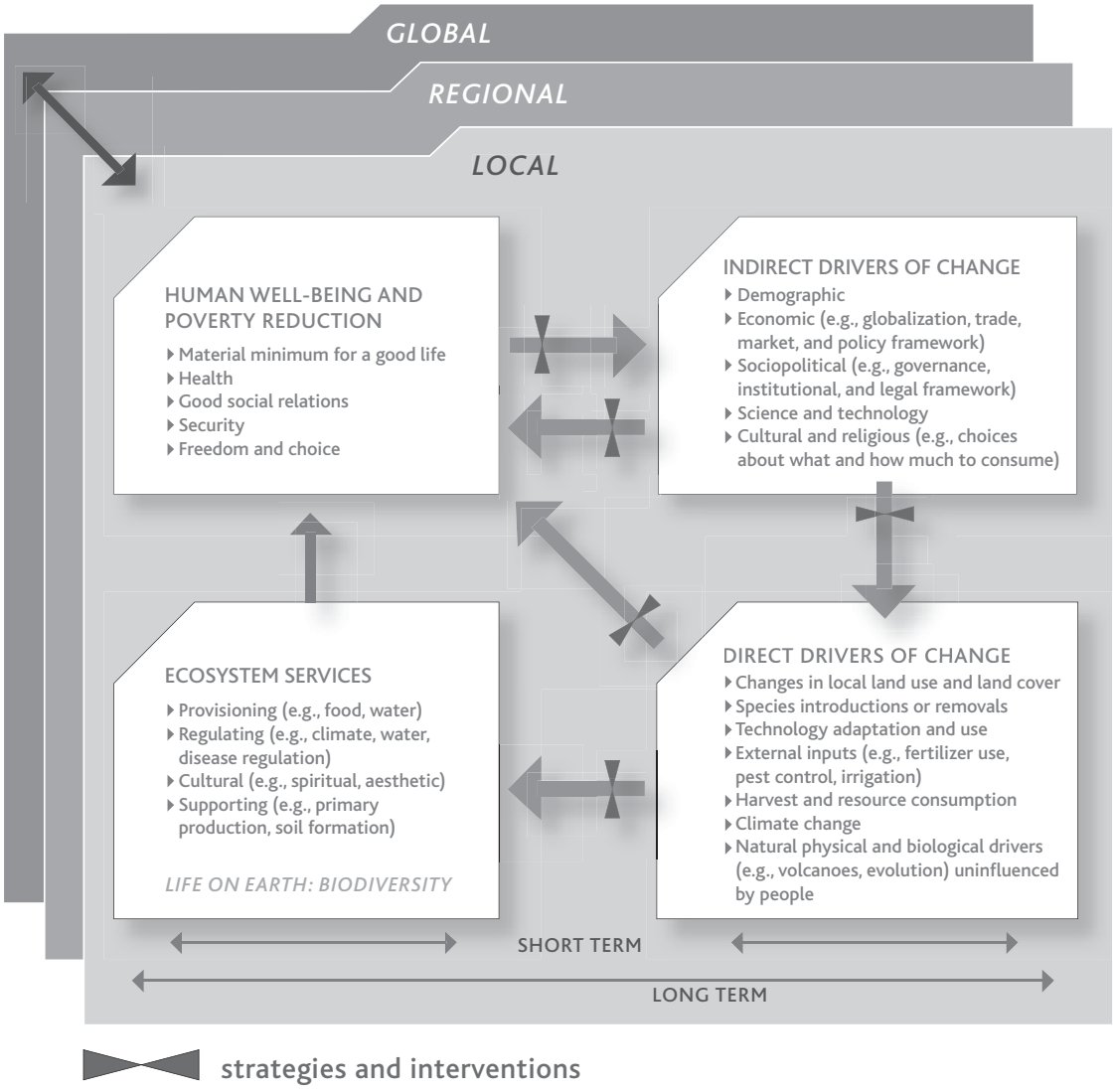

Figure 1. Conceptual framework of the Millennium Ecosystem Assessment (MA, 2002. Ecosystems and Human Well-being: A Framework for Assessment. Island Press, Washington, D.C. 245 pp.).

All societies depend on the provisioning, regulating, supporting, and cultural services of the Earth's environment. Yet, this relationship is not understood with confidence. ICSU's environmental programme might be oriented to:

- explain at different time and spatial scales, causality between driving forces, environmental changes, and consequences for development and human well-being;
- identify and forecast critical thresholds in environmental change processes so that irreversible changes might be avoided.

People are vulnerable to natural environmental phenomena over which they have no control. However, the degree of vulnerability varies among different groups, even at the same geographical scale, according to income level, health status, quality of shelter, etc., and is reflected in varying impacts on food security, economic losses, physical and social disruption, and loss of shelter and cultural services. ICSU's environment programme should consider:

- assessing levels and trends in vulnerability of different groups; and
- developing indicators and measuring impacts of environmental change on human well-being.

2.2.3.2 Importance of scale

In addressing the three pillars of sustainable development - economic, social and ecological - issues of scale are central. For each of these domains there are many optimal scales in space, time and function. The minimum thresholds of size and capacity required for efficiency in economic systems may be quite different from the minimum requirements of population and income levels needed for viable social communities. Associated with each spatial setting are multiple timescales - mostly invisible - and usually ignored. Each of the major pillars of sustainable development has its own characteristics in time, and choices made in one region bear implications for other regions at scales ranging from local to global.

It is necessary to have better understanding of the relationship between environment and human well-being at various geographical and temporal scales in order to contribute to appropriate responses. For some global concerns it is necessary to design multi-scale research activities to clarify the local-to-global continuum. Equally, national and local scale assessments are needed to complement global assessments in order to ensure that the information is at the appropriate scale for policy formulation. This is especially so for analysing the impacts of regional and global environmental changes.

The Panel recommends that ICSU should ensure that its environment programme reflects issues of scale by:

- focusing attention on those people and places where there is a marked deprivation of well-being;
- focusing attention on those resources that are under serious threat of decline; and
- analysing local-to-global linkages.

By developing better integrated frameworks of enquiry, and more sophisticated methods of observation and monitoring, the international scientific community has sought to study environmental issues at all geographical scales from local to global. Among the fruits of these developments is a commitment to place-based research that does not only integrate insights from both natural and social scientists, but also actively involves people on the ground.

2.2.3.3 Importance of recognizing various epistemologies

Activities at various scales would also facilitate direct participation of interest groups and other people on the ground who are connected to the issues being studied. Such participation would make it possible for ICSU to draw upon and integrate various ways of knowing by indigenous and local communities, and to consider environment-sustainable development linkages in a given cultural context. Integrated assessments should seek to:

- advance methodology for integrating epistemologies; and
- secure inputs from various groups that hold both academic and traditional knowledge.

3. ICSU's Mission and Role in the Area of Environment

ICSU's mission is to strengthen international science for the benefit of society. The Panel was asked to develop a mission statement for ICSU's environmental activities; this was the first task undertaken by the Panel. Its recommendation is as follows:

- 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.

4. The Advisory Committee on the Environment (ACE)

Historically, ICSU has had a very strong environmental portfolio (e.g. 16 of its 18 IBs have environmental foci), particularly in the natural sciences. Moreover, in the past 15 years, ICSU has diversified its base by co-sponsoring programmes with social science components such as IHDP, DIVERSITAS, and the MA.

ICSU has earned recognition for its work on environmental aspects of its mission ranging from the International Geophysical Year (IGY) in 1957-58 to the SCOPE assessments launched in the 1970s to the GEC programmes that began in the 1980s. With the emergence of the latter, it became apparent that the ICSU Executive Board could benefit from additional expert advice in addressing some of the problems that the environmental IBs were experiencing. Thus, in 1989, the Advisory Committee on the Environment (ACE) was established to advise the Executive Board on the environmental activities undertaken by ICSU itself or in partnerships with other organizations.

ACE was specifically configured to have membership with a broad range of experience from interdisciplinary and international environmental science programmes. It was asked to assist the Executive Board in promoting harmonious interaction among members of the ICSU family by providing a platform for discussion and exchange of information among relevant ICSU bodies and their external partners, and by setting up and maintaining an interface with external partners, such as UN bodies, and other international organizations including those in the social and technological sciences and industry.

The advice of ACE helped ICSU to play a significant role in preparation for, and following the 1992 UNCED in Rio de Janeiro, Brazil, and WSSD, held ten years later in Johannesburg, South Africa.

Since the creation of ACE, significant changes have occurred in the governance structure of ICSU (e.g. the establishment of the CSPR in 1998). Thus, in recent years questions have been raised about the form, function, and effectiveness of ACE and its relationship with the CSPR. There are two broad possibilities in addressing these questions. One is to merge the roles of ACE and the CSPR. This would require broadening the membership of the CSPR to include members with the necessary skills and experience. The other is to re-constitute a new ACE with provision for more emphasis on the social and health sciences. Whichever option is adopted, members of such an entity should have: 1) extensive knowledge of ICSU's environmental activities and their interactions with the research programmes of bodies outside ICSU; 2) experience with the application of the knowledge from environmental science to sustainable development; and 3) understanding of the linkages that connect environmental scientific knowledge to the policy process.

The following responsibilities need to be covered, and should be specified in the amended ToR for such an entity:

- provide the Executive Board with advice on the status and development of activities relating to the environment undertaken by ICSU IBs alone or in partnership with others;
- promote harmonious interaction on environmental issues among members of the ICSU family;
- provide a platform for discussion and exchange of information among relevant ICSU bodies and their external partners; and
- set up and provide a means for discussion with external partners, such as UN bodies, and other international organizations, including those in the social and technological sciences, and business and industry.

5. Analysis of ICSU Current Activities

5.1 INTRODUCTION

In place of the previous statutory requirements (Annex 1) of six-year periodic reviews of individual IBs, the CSPR initiated strategic assessment of ICSU's activities through the PAAs. For this Assessment, the IBs were divided into four categories: assessment bodies, thematic organizations, GEC programmes and monitoring/observation and data/information organizations. Each of these IBs is assessed in the context of the PAA mission statement and framework, and the following questions guided the assessment:

- When and why was this organization established?
- What have been its successes and failures?
- What does the Panel recommend for this organization?
- What does the Panel recommend for ICSU?

The analysis of the IBs is followed by a discussion of the Union activities, National Members, an analysis of collaborations among the bodies, and an overview of capacity building efforts.

5.2 ASSESSMENTS BODIES

5.2.1 Scientific Committee On Problems of the Environment (SCOPE)

SCOPE was established in 1969 to identify and critically assess the importance of emerging global or regional environmental issues, emphasizing those that need an interdisciplinary perspective. SCOPE has a wide range of partnerships, both within and outside of ICSU. Its projects range from studies of biodiversity and ecosystems, alien invasive species, biogeochemical cycles including the impact of human activities (carbon, nitrogen, phosphorus, sulphur, and silicon), chemicals and ecosystems, and human health and the environment.

Most studies deal with environmental issues that are directly relevant to sustainable development. Major outcomes during the last decade include the identification of a number of key emerging issues, e.g. SCOPE studies laid the foundation for the formation of the IPCC. Studies have also been among the first to explore the importance of biodiversity in ecosystem functioning and the consequences of biodiversity for ecosystem goods and services; how alterations in the carbon cycle interact with the climate system, and how the nitrogen and carbon cycles are interlinked with biodiversity and land-use changes; and an assessment of methodologies to assess chemical risks to ecosystems and human health.

The major challenge for SCOPE is to prioritize its activities among the numerous topics to be explored, and to find the appropriate balance between regional versus global, and between scientifically interesting versus policy relevant emerging environmental issues. During the last five years, SCOPE has placed greater focus on issues that have regional significance as well as global implications in Africa, Asia and Latin America. The Panel encourages continuation of these types of studies and recognizes that the audiences for studies include both policy-makers and the science community. SCOPE can be particularly helpful to both these audiences by identifying issues well before comprehensive international assessments are authorized by international Conventions or UN agencies. The Panel was pleased to note the recent decision to reduce the number of projects, since recent projects have not been particularly innovative or addressed "over the horizon" issues. SCOPE studies need to contribute more to the planning of other ICSU activities, and when policy relevant, to include the environmental, economic and social dimensions as appropriate.

5.2.2 Millennium Ecosystem Assessment (MA)

The specific proposal for the MA arose from the 'Pilot Analysis of Global Ecosystems' produced in 2000 by the World Resources Institute in collaboration with UNEP, and the World Bank. The MA is a four-year project that was launched by the UN Secretary-General in June 2001. ICSU is one of the international sponsors and is represented on the Executive Board.

The MA was designed to provide decision-makers with the latest scientific knowledge about the relationship between ecosystem change and human well-being, and to build capacity of scientists to conduct integrated ecosystem assessments. Among the primary target audiences of the assessment are the ecosystem-related conventions (Convention on Biological Diversity -CBD, Convention to Combat Desertification -CCD, Ramsar Convention on Wetlands, and Convention on Migratory Species), national governments, civil society and private sector. Through its conceptual framework (Fig. 1), the MA will bring attention to the linkages between humans and ecosystems, encompassing the entire range of ecosystem services. It is a multi-scale assessment, consisting of interlinked assessments at local, watershed, national, regional, and global scales. The major focus is on: 1) the current condition and historical trends in ecosystems and their contribution to human well-being; 2) response options for conserving ecosystems; and 3) future scenarios for change in ecosystems and human well-being.

A major outcome will be to facilitate integration of environment and sustainable development perspectives into mainstream development planning. One challenge the MA faces is to ensure that its findings will be used by decision-makers and other stakeholders at all levels. The MA is already establishing a firm foundation for adoption of its findings through extensive engagement and outreach activities with stakeholders at all levels. For example, through the ecosystem-related conventions, it has been endorsed by the governments of more than 180 countries.

An innovative approach is the multi-scale assessment with regional and sub-regional components. The MA should consider how these sub-global projects could be continued beyond the termination of the global assessment in early 2005. The methodologies used in these projects are highly relevant to address science and technology for sustainable development. The Panel suggests that a more long-term organizational structure be found for the existing and new sub-global assessments.

5.3 THEMATIC ORGANIZATIONS

5.3.1 Scientific Committee on Oceanic Research (SCOR)

SCOR was founded in 1957 to further international scientific activity in all branches of oceanic research. It was one of the first IBs of ICSU, and every oceanographer is familiar with at least some of SCOR's impressive list of accomplishments. This organization has a rich history of successes with working groups that have vetted methods of sample collection and analysis, and brainstormed topics for future research. Well known is the reputation of SCOR for its extensive outreach to scientists, laboratories, and research organizations in the developing world. Over the last 45 years, many developed country oceanographers made their first contacts with developing country scientists through SCOR meetings and reports. Prior to its first major programmatic accomplishment - the Indian Ocean Expedition in the early 1960s - major oceanographic expeditions were largely the works of individual nations or individual laboratories. SCOR, more than any other organization, is responsible for the widespread international cooperation that is characteristic of modern ocean science.

In view of the successes of the GEC programmes (e.g. IGBP and WCRP) in the 1990s, the advent of the Internet and virtual meetings, one could ask "does SCOR still have a role to play?" SCOR sponsorship remains still the best way to bring oceanographers of all disciplines to the table. The development of ocean projects within the GEC programmes was considerably facilitated by the work of SCOR. The roots of the international underpinnings of Tropical Ocean and Global Atmosphere (TOGA), World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux Study (JGOFS), and Global Ocean Ecosystem Dynamics (GLOBEC) can be traced to SCOR initiatives. Similarly, SCOR is currently a partner in the development of potential new projects like Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB), Surface Ocean Lower Atmosphere Study (SOLAS), and Integrated Marine Biogeochemistry and Ecosystem Research (IMBER).

In conclusion, 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 significantly diminished without the scientific integrity and experience of SCOR. Ocean science is inherently global, and SCOR is the instrument by which good local ideas in this field become global. Also in this regard, the Panel finds the successes of SCOR in capacity building to be highly meritorious.

SCOR should 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 GEC programmes. The Panel encourages SCOR to explore prospects for joint capacity building initiatives with START.

5.3.2 Scientific Committee on Antarctic Research (SCAR)

SCAR was established in1958, in the wake of the IGY of 1957-58, which included a major Antarctic component. The Panel notes that ICSU has recently appointed an ad hoc Planning Group for the 4th International Polar Year, which is to be held in 2007-08, and that other "International Year" activities will also have Antarctic components.

The primary role of SCAR is to coordinate national research programmes in the Antarctic, identify international strategic priorities, and provide independent scientific advice to the Antarctic Treaty system. It has 26 full and four associate member countries, and works with a wide variety of partner organizations, both within and outside of ICSU, ranging from such bodies as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to the WMO and UNEP. SCAR's remit covers issues of climate change, biodiversity, data and information systems, pollution, and all impacts of human activity in the Antarctic.

The importance of SCAR has increased over the years with greater understanding of the pivotal role of the Antarctic in the Earth system and its numerous connections with other physical and biological elements including space weather and Sun-Earth interactions. Antarctic science therefore has global relevance, whether in tracking the history of the atmosphere through ice-core analysis over the last half-million years, in determining levels of pollution (e.g. heavy metals, organic compounds) and their impacts, and ultimately in exploring life forms in subglacial Lake Vostok.

With the establishment of a new structure within SCAR, three Standing Science Committees have been set up to cover physical sciences, life sciences, and geosciences. There will also be an Executive Director, to help drive SCAR science forward in ways not always possible in the past. These reforms should lead to better cooperation with other groups and institutions, particularly those within the ICSU family.

While some concerns have been raised about the efficacy of SCAR, 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 noted relatively weak interactions between SCAR and the rest of the ICSU family, and SCAR should endeavour to work more closely with other IBs and Unions.

5.3.3 Committee On SPAce Research (COSPAR)

COSPAR was established in 1958 as an IB concerned with the advancement of scientific investigations carried out with space vehicles, rockets, and balloons. The COSPAR Scientific Assemblies are important in bringing together the space science community. In its first submission to the PAA, COSPAR indicated that three primary results presented by scientists at the 35th Scientific Assembly, were contributions to: 1) forecasting of extreme weather events and the creation of an integrated global atmosphere observing system; 2) El Niño prediction and the creation of a tropical Pacific Ocean and global atmosphere observing system; and 3) observations of trends in global concentrations of greenhouse gases. COSPAR considers the major challenge in relation to this PAA to be efforts for an increased integration of atmosphere, land, and ocean sciences from an experimental and modelling point of view.

While COSPAR Scientific Assemblies are major events for the space community, COSPAR has not been a major player in space-based aspects of ICSU's GEC programmes, and it does not appear to be involved in the development of the GOS. Since much of the present and future of global environmental research involves remote sensing, the relevant COSPAR commissions should develop plans that clearly articulate how COSPAR could contribute more to ICSU activities in environmental science and the added benefit of COSPAR to the wider environmental science community. In looking to future needs in this area, the Earth sciences will be well served by enhanced complementarity and prioritization of Earth remote sensing missions. To this end, COSPAR should especially consider how it could contribute to the development of a truly integrated Earth Observation System.

5.3.4 Committee on Disaster Reduction (CDR)

CDR was created in 1999 as successor to the Special Committee for the International Decade for Natural Disaster Reduction (SC-IDNDR). CDR was established to coordinate research and applications to reduce the impacts of natural hazards and related environmental and technological hazards. CDR indicated no interaction with other ICSU bodies (see Fig. 2, section 5.8), although it has collaborated with the International Union of Geodesy and Geophysics (IUGG) to prepare a position paper on "Safer Sustainable Communities: Making Better Decisions about Risk" (April 2002). The CDR sees its customers as the UN system (i.e. WMO, UNESCO, and UNEP) and other international and regional agencies.

Environment-human interactions are often considered in a unidirectional manner, i.e. the impacts of humans on the natural environment (e.g. land-use changes, urbanization, and emission of greenhouse gases). However, changes in the natural environment also have many impacts on humans whose activities in turn continue to intensify the stressors on the environment and sustainable development. The increasing vulnerability of human populations to natural disasters is of great concern globally. Nevertheless, there is little interaction between the CDR and the GEC programmes although the increase in the strength and frequency of natural disasters, for example, floods, droughts and severe storms, is clearly associated with a changing global climate. In addition, the IHDP project on Global Environmental Change and Human Security (GECHS) and the IGBP-IHDP Land-Use Cover and Change (LUCC) are also concerned with natural hazards.

With the emergence of science for sustainable development, including management of risks, it is essential that the mitigation of, and adaptation to, natural hazards be part of the research agenda, with links between the natural, technological, social and health sciences, and civil defence (emergency management organizations), and the private sector (especially insurance companies). Coordination and integration of the various initiatives on hazards and their mitigation should be considered. The Panel concluded that the existing CDR was insufficiently active, and that it is important for this high priority area to have a new start. Furthermore, the Panel concluded that ICSU's environmental science activities would be strengthened with the addition of a research programme on natural and human-caused hazards that focuses both on abrupt hazards (e.g. wind storms, floods, droughts, fires, earthquakes) and on prevention strategies to reduce their impacts. This should be done in collaboration with the UN International Strategy for Disaster Reduction (ISDR).

The current CDR committee should be disbanded and ICSU should initiate a planning process involving all relevant Unions and IBs to plan for a new programme in this very important area.

5.3.5 Scientific Committee on the Lithosphere (SCL)

SCL was established in 1980, as an IUGG-IUGS Inter-Union committee. In 1999, SCL was established as an ICSU IB. It was established to undertake an international programme of interdisciplinary research for an improved understanding of the Earth, especially those aspects on which human well-being depends.

SCL operates the International Lithosphere Programme (ILP), which seeks to elucidate the nature, dynamics,

origin, and evolution of the lithosphere, with special attention to the continents and their margins, and their interactions with society. It has established international, multidisciplinary working groups and coordinating committees, and encourages active participation of scientists from developing countries. SCL has many national committees that participate actively in ILP projects.

The Panel notes that SCL/ILP has for many years been very active and regularly produced highly relevant and valuable outputs. Recently, however, the level of activity seems to have declined. IUGG and IUGS, the Unions that proposed its establishment, have requested that SCL conduct a self-evaluation; this process is ongoing. While the study of the lithosphere is a very interesting scientific domain, SCL should be under the responsibility of IUGS and IUGG.

5.3.6 Scientific Committee On Solar-TErrestrial Physics (SCOSTEP)

SCOSTEP was established in 1966 to promote international interdisciplinary programmes in solar-terrestrial physics. While the overall scientific work of SCOSTEP is excellent, its programmes have limited importance in understanding issues of environmental concern. It currently cooperates with WCRP, to study in part, how the Earth's climate is influenced by solar-terrestrial processes (e.g. changes in solar output) and changes in the composition and dynamics of the upper atmosphere (i.e. above 50 km). The Panel notes the new SCOSTEP initiative on Climate and Weather of the Sun-Earth System (CAWSES) whose purposes is to address the role of natural solar variability on climate.

5.4 GLOBAL ENVIRONMENTAL CHANGE PROGRAMMES

5.4.1 International Geosphere-Biosphere Programme (IGBP)

IGBP was established in 1986 to understand the interactive physical, chemical and biological processes that regulate the Earth systems and how they are influenced by human actions. Strong partnerships have evolved during the past decade with the other GEC programmes, culminating in the recently initiated ESSP. IGBP core projects range from understanding paleo-climatic changes; terrestrial and oceanic ecosystem dynamics, including the impact of elevated carbon dioxide on terrestrial systems; the exchange of gases between terrestrial and oceanic ecosystems (including coastal zones) and the atmosphere; and biospheric aspects of the hydrological cycle, to modelling atmospheric, terrestrial and oceanic processes, emphasizing biogeochemical processes. The Panel commends the IGBP for its first two decades of acting as an integrating framework among the physical, chemical, and biological science communities.

Major outcomes during the last decade include an improved understanding of the important role that biology plays in controlling the Earth's environment and the strong interactions among biological, physical, and chemical processes; that the Earth system is characterized by critical thresholds and abrupt changes that can be inadvertently triggered by human activities; and that the Earth system has recently moved well outside of the range of natural variability, with the magnitude and rates of change being unprecedented.

The improved understanding of Earth system processes gained from IGBP core projects is critically important in understanding how human activities are affecting the Earth at regional and global scales, thus contributing to the issue of sustainable development. The IGBP core projects that explicitly include a strong social science component, e.g. LUCC and new ESSP projects, are the most relevant to understanding the impact of human activities and thus identifying potential policies and practices to reduce these impacts.

One of the challenges for IGBP is to improve our understanding of biogeochemical processes in order to develop transient ecological models of sufficient complexity to capture the dominant processes of the core elemental cycles that can be coupled to transient global change models (e.g. to address simultaneous changes in regional air quality and climate). This is in order to understand the interactions, feedbacks, and thresholds within the Earth system. Also required is an

increased emphasis on understanding the impact of regional and global environmental changes on both managed and unmanaged ecosystems.

The new structure of IGBP, which is centred on the three major Earth system compartments - ocean, land and atmosphere- and the interactions among them, would appear at first sight to be a step backwards in the quest for integration. However, the planned core projects have all been designed to increase sub-system understanding that is needed for larger- scale integration of ecosystem and biogeochemical processes. A major challenge is to ensure inclusion of the human dimension when appropriate, especially in the proposed new land project

5.4.2 International Human Dimensions Programme on Global Environmental Change (IHDP)

IHDP, established in 1996 with ISSC and ICSU as co-sponsors, is an interdisciplinary research programme addressing the coupled human-natural system in the context of global environmental change. The lack of a human dimension in ICSU's GEC programmes was of considerable concern 15 years ago. It was anticipated that the IHDP would be a complementary social science endeavour to the natural science projects.

IHDP's most visible success to date is the LUCC project undertaken jointly with IGBP. Its design is a good example of an approach to integrating the natural and social sciences. Other core projects are Institutional Dimensions of Global Environmental Change (IDGEC), GECHS, and Industrial Transformation (IT).

The presentation of the IHDP programme in the questionnaire reveals a range of elements that indicates its multi-disciplinary purpose and intent. But it is not possible from the documentation or discussion to date to judge the extent to which these activities are integrating the biophysical and the socio-economic issues, or their orientation to enable decision-makers to operate at the nexus of environment and development issues.

The emergence of the ESSP is a step in the right direction in unifying existing GEC programmes. The participation of IHDP in the ESSP is a welcome contribution both to the synergy of ICSU programmes in global environmental change and to their potential for substantive input to policy-making processes.

The Panel acknowledges the difficulty of integrating the natural and social dimensions in environmental science, but suggests that IHDP has a great responsibility in providing leadership in this regard. It encourages IHDP to strengthen the involvement of economists in its projects. For this purpose, IHDP would benefit from a more active and effective ISSC.

The Panel notes the various attempts to develop the ISSC, that a well-functioning ISSC is critical to the success of many of the ICSU programmes, and that to date this relationship is not fully satisfactory. However, the Panel is encouraged that the ISSC appears to now be getting on track, and recommends that ICSU take a pro-active approach to further develop ISSC and achieve a close integrative working relationship within its programmes.

5.4.3 World Climate Research Programme (WCRP)

WCRP was established in 1980 under the sponsorship of ICSU, WMO, and IOC to understand and provide the basis for prediction of the Earth's physical climate system. Strong partnerships have slowly evolved during the last decade with the IGBP, IHDP, and DIVERSITAS, culminating in ESSP. Other partnerships include the three GOS (GCOS, GTOS, and GOOS). WCRP aims to understand climate variability and predictability, and human-induced climate change, regionally and globally, by studying physical and dynamical processes in the atmosphere-ocean-land surface-cryosphere system at a wide range of temporal scales, i.e. seasonal-interannual-decadal-centennial. This is accomplished by studying global ocean circulation, global hydrological and energy budgets, cryosphere (including Arctic sea ice) and stratospheric processes, as well as developing comprehensive global models of the full climate system.

Major outcomes during the last decade include establishing the physical basis for understanding and predicting El Niño events, as well as improved climate models through improved understanding of key climate

processes, comprehensive field measurements, and the development of regional and global observational climatic data sets.

The improved understanding and predictability of natural climate variability and human-induced climate change at the regional and global scales, gained from WCRP, is central to the issue of sustainable development given the sensitivity of socio-economic sectors (e.g. water resources and agriculture), ecological systems, and human health to weather and climate. The WCRP contribution to the recently initiated ESSP projects will be even more directly relevant to understanding the impact of natural climate variability and human activities on issues central to poverty alleviation and development, and thus to identifying potential policies and practices to reduce adverse effects.

Major challenges for the WCRP include reducing the uncertainty in the climate sensitivity factor (i.e. the projected change in temperature at equilibrium when the atmospheric concentration of carbon dioxide is doubled), and improving the predictability of natural climate variability and human-induced climate change, including extreme events, at the local and regional scales. This will require an improved understanding of radiative, dynamical, and physical processes in order to develop improved transient fully coupled atmosphere-ocean-land general circulation models that incorporate biogeochemical feedbacks. It is also important to be able to identify thresholds and non-linearities in the system.

5.4.4 DIVERSITAS

The roots of DIVERSITAS date back to 1991, when it was launched by UNESCO, IUBS, and SCOPE. In 2001, the five sponsors of DIVERSITAS, which now include ICSU and the International Union of Microbiological Societies (IUMS), asked the scientific community to organize an integrative programme dedicated to the science of biodiversity, building up on the earlier activities carried out during the first phase of DIVERSITAS (1991-1998). The overall goals of DIVERSITAS are to: 1) promote integrative biodiversity science, linking biological, ecological, and social disciplines in an effort to produce new, socially-relevant knowledge; and 2) provide a scientific basis for the conservation and sustainable use of biodiversity.

A science plan was published in 2002, and calls for the establishment of three core projects:

- discovering biodiversity and predicting its changes;
- assessing impacts of biodiversity changes
- developing the science of the conservation and sustainable use of biodiversity.

In addition to these three thematic core projects, cross-cutting initiatives are being created around particular topics or ecosystems. Two such networks already exist: Global Invasive Species Programme (GISP) and Global Mountain Biodiversity Assessment (GMBA). A new cross-cutting network "greening agriculture" is under preparation. The Panel also notes the success of the International Biodiversity Observation Year (IBOY, 2001-2002), an initiative of DIVERSITAS.

DIVERSITAS is stimulating the establishment of national committees. It has attracted leading scientists to develop a science plan, an implementation plan, and planning groups for the core projects. There is renewed vigour in planning and coordination, which should be strengthened by establishing strong links with national biodiversity programmes.

DIVERSITAS has been a full programme of ESSP since its establishment, and is currently involved in the development of the Global Water System Project (GWSP) activities and leading, on behalf of ESSP, the exploration phase of the fourth joint project on global environmental change and human health. In 1997, DIVERSITAS signed a Memorandum of Cooperation with the Secretariat of the CBD. Scientists involved in DIVERSITAS have been requested to contribute to the work of this Convention and its Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA).

The Plan of Implementation of WSSD includes several recommendations for the conservation of the Earth's biological diversity, and the DIVERSITAS science plan is consistent with WSSD expectations regarding biodiversity protection. The DIVERSITAS programme

meets the demands of the most relevant international documents in relation to the conservation of natural diversity. The organization and management of the programme are progressing well, and the visibility of DIVERSITAS has increased over time.

It is important that DIVERSITAS remains mindful of the need to stay focused in order to use the limited resources effectively. The Panel notes the complex structure with five sponsoring organizations. As SCOPE, IUBS, and IUMS are ICSU bodies, they should support DIVERSITAS through collaborative activities without being formal sponsors. The Panel also notes the weak involvement of UNESCO in the development of DIVERSITAS. UNESCO should consider concrete steps for providing substantive inputs to the further development of DIVERSITAS. If this does not materialize, the Panel suggests that ICSU remain the sole sponsor of DIVERSITAS.

5.4.5 Earth System Science Partnership (ESSP)

In recognition of the growing need for collaborations, in 2001 the four GEC programmes (IGBP, IHDP, WCRP, and DIVERSITAS) established the ESSP for the integrated study of the Earth system, the changes that are occurring to it, and the implications of these changes for global sustainability. ESSP activities currently include three joint projects that are at different stages of development, and a possible fourth joint project that is currently being scoped. The ESSP partnership has also initiated for Integrated Regional Studies and it includes also START.

The science that is performed under ESSP is anchored in the projects of the four sponsoring GEC programmes that have activities relating to the environment that do not come under ESSP. The following relates only to those activities that come under the joint ESSP framework.

The Panel has considered the individual ESSP initiatives, as it considers these initiatives to be of special importance in addressing environment in relation to sustainable development. Thus, of the four currently planned projects, three address the WEHAB (Water, Energy, Health, Agriculture and Biodiversity) priorities. Thus, water, health and agriculture are considered by ESSP, while energy is the topic of a separate ICSU task force review and biodiversity is covered by DIVERSITAS. In addition, these initiatives also address areas, where ICSU has recently terminated IBs (Committee on Science for Food Security, CSFS, and Scientific Committee on Water Research, SCOWAR, were both closed down by the 27th General Assembly in 2002).

5.4.5.1 Global Carbon Project (GCP)

Over the past decade research under the auspices of four IGBP Projects - Global Change and Terrestrial Ecosystems (GCTE), International Global Atmospheric Chemistry (IGAC), Past Global Changes (PAGES), and JGOFS - have contributed substantially to understanding of the past, present, and future of the carbon cycle. The successes of these projects along with contributions from other projects under the auspices of WCRP (especially WOCE) and IHDP (especially the joint IHDP-IGBP project LUCC), have demonstrated the potential for important new understanding from focused integrated research on the global carbon cycle. Such an effort is now being proposed as the Global Carbon Project (GCP).

The development of new foci on spatial and temporal distributions of major sinks and fluxes for carbon, feedbacks in the dynamics of the human-environment aspects of the carbon cycle, and scenarios for future behaviour of this system are all suitable and timely research activities. Questions that form the research elements of this endeavour are only partly new, but without the underpinning provided by the last decade of research, none of the objectives of this new project would be realistic.

Improved understanding of how future human activities relating to land use and energy production will affect climate has to be a central objective of research at the interface of environment and sustainable development. Any new activity in this area will also have future sustainability and policy relevance. In all likelihood, accords will soon come into force that will alter national and international policies relating to the carbon base of residential, industrial, and transportation energy requirements. The IPCC response to a request of the

UNFCCC to examine opportunities and limitations related to terrestrial ecosystem carbon sequestration (IPCC Special Report on Land-Use Change and Forestry) is an excellent example of the convergence of current carbon cycle science and policy. The high likelihood that markets will soon emerge for carbon emission credits points to the urgency of better understanding of the near-surface and deep terrestrial and ocean potential for enhanced carbon sequestration.

By adopting projects such as those proposed for ESSP, the GEC programmes raise high expectations. The type of synthesis and integration required among hitherto mainly separate research programmes is largely untested. ICSU should be especially watchful during early formative stages of the GCP to ensure that disciplinary fragmentation does not confound well-laid plans for the execution of this research project.

5.4.5.2 Global Environmental Change and Food Systems (GECAFS)

The goal of the GECAFS programme is to assess how global environmental changes will affect food provision and vulnerability in different regions and among different social groups, provide the scientific understanding needed to determine strategies to adapt, and evaluate the environmental and socio-economic consequences of different adaptation strategies. Initially, there will be four regionally-based projects in the Indo-Gangetic Plain, Caribbean, Southern Africa, and Eastern Pacific Coastal Fisheries.

The two basic questions are: 1) whether the approach of focusing only on regional case studies is appropriate or whether it should be combined with a series of more generic studies of the response of different agricultural crops to environmental changes and the development of improved crop traits (e.g. temperature, drought, pest, and salinity resistant), and 2) whether the most appropriate regional case studies were chosen. The initiative needs a science plan or at least a framework with well-defined criteria for the selection of the case studies; the criteria should be broader than who is willing to fund them.

The major challenge of the GECAFS project will be to fully integrate the physical, biological, and social science aspects of its projects, ensuring that they are fully participatory, involving all relevant decision-makers in planning and implementation. An accurate assessment of plausible futures based on a realistic assessment of future changes in direct and indirect drivers of environmental change will be critical to the success of this project, as will ensuring that the emphasis is not on production alone but on "field to fork", integrating the food chain.

GECAFS should consider linkages with WMO through Climate Prediction and Agriculture (CLIMAG), a joint programme of WCRP, IGBP, IHDP and START.

5.4.5.3 Global Water System Project (GWSP)

GWSP is still in its formative stage, and its project structure is not yet finalized. The following evaluation is based on draft documents, the last of which is "Global Water System Project of the Global Environmental Change Programmes", dated September 2003. It states that "An overarching scientific question guides GWSP: How are human actions changing the global water system and what are the environmental and socio-economic feedbacks arising from the anthropogenic changes in the global water system."

The proposed project plan envisages five cross-cutting activities: 1) building a data base (years 1-2); 2) methods for bridging gaps between biogeophysical, biological, and social dimensions and approaches to global water science - a joint lexicon of terminology (full project duration); 3) scaling from region-to-globe and globe-to-region (full project duration); 4) integrative GWSP models, process-based understanding to quantify and state future feedbacks to the Earth system (years 3-10); and 5) informing policy and management (years 5-10).

The Panel views this "linear" progression of activities to be inappropriate. A modelling structure for which the data are assembled must be designed before, and adjusted during, the data collection phase. Models to test possible responses should be planned at the same time, even if they are to be implemented at a later stage, after experience has been gained. A GWSP meeting was

held in New Hampshire in October 2003, but at the time of this writing there was still no additional information on whether the parent bodies are in agreement on how to proceed.

The Panel is concerned that there is no indication of how GWSP depends on and links with ongoing water research conducted within the ICSU family and by others. The Panel urges GWSP to collaborate with ongoing water efforts of major and global impact, such as UNESCO's International Hydrological Programme (IHP), especially Hydrology for the Environment, Life, and Policy (HELP) and the World Water Assessment Programme (WWAP), with Union programmes, such as Prediction in Ungaged Basins (PUBs) of the International Association of Hydrological Sciences (IAHS), and with the Global Energy and Water Cycle Experiment (GEWEX) of WCRP, to promote and strengthen linkages with these programmes and to avoid duplication of effort. ICSU should closely track the development and execution of the GWSP programmes and projects to ensure that this recommendation is followed.

5.4.5.4 Global Environmental Change and Human Health (GECHH)

This initiative is only in the early stages of planning. The major goals of the GECHH initiative are to assess past, current, and future health impacts of global environmental change; elucidate the particular health-related upstream drivers of global environmental change; harmonize mitigation and adaptation; and develop and use new methodologies to explore the tension between particular pathways of economic development, environmental change, and human health. The potential activities include promoting scientific knowledge on global environmental change and health; promoting collection of data for scientific and surveillance purposes; capacity building; and developing links with policy fora.

While there is not enough information available in the draft documentation to critically evaluate the initial plans, the overarching questions being considered are very appropriate. The Panel strongly endorses the need for such a project, and recommends that it be linked with WHO.

5.4.6 Funding of Global Environmental Change Programmes

Understanding both natural and social processes requires an international scientific research effort of unprecedented collaboration and interdisciplinarity. In response to this challenge, the international scientific community has developed an approach, based on adding value to existing national and regional research through a suite of integration activities. The key element in this approach is the small amount of funding, sometime called "glue money", required to maintain an adequate coordinating infrastructure and to initiate and implement the integration activities. Three types of structure are involved in scientific integration: 1) the central offices and secretariats of the four GEC programmes; 2) their respective International Project Offices (IPOs); and 3) important but small-scale integrating activities conducted under the umbrella of the programmes.

Examples of integrating activities include defining common experimental protocols, data standardization, model inter-comparison, and synthesis and integration of results. Without the aid of an international framework, national, bilateral, and regional efforts cannot be meshed in a coherent way to give understanding at the global scale (e.g. global carbon cycle). An effective international programme can also help provide an unbiased, common base of knowledge on which all can agree, and on the basis of which various policy options can be evaluated and debated.

The efficiency of the GEC programmes is based on:

- Focusing on value adding – 1) priority setting, and development of a coherent research agenda; 2) efficient allocation of scarce scientific resources; 3) scientific network building; 4) common methodologies and experimental protocols; 5) model inter-comparisons and validation with common datasets; 6) synthesis papers and executive summaries for the policy and resource management sectors; and
- Being resource-efficient by building on the large body of global change research conducted at national and regional levels. Development of mutually agreed synergistic research agendas and priorities among

countries greatly enhances the interaction of national researchers and projects with the broader international community.

Overall, current funding of global change research programme planning and coordination amounts to only 0.5% of the total research budget (the global level of funding for global change research has remained stable around US$2bn[3]). Based on estimates by the GEC programmes, there is a significant gap between the current and required funding for integrative activities; this gap has increased between 1999 and 2003. Even this small amount is insecure and difficult to obtain. Much of the success achieved in the past is attributable to the work of a few persons on both sides (funding agencies/IGFA and programmes). There is not yet the long-term, stable, institutionally-based support for the integrative functions of the central offices and IPOs that would be required. This is also the most difficult to obtain through existing funding mechanisms. The lack of stable funding is leading to diversion of scarce staff time from scientific integration to fund-raising, an inability to plan appropriately, and loss of morale within the international programmes.

IGFA has provided an important platform for dialogue between the GEC programmes and some important funding agencies. Although not a funding mechanism, IGFA has ensured continued interest among the funding agencies and also helped secure funding for DIVERSITAS during a critical period of its development. IGFA has recently expanded its interest through, for example, participation in IGOS-P and the Earth Observation Summit (EOS)/ Group on Earth Observations GEO.

IGFA is still an informal network and if it wishes to become a more active player in the policy arena, its legitimacy as a body needs to be ascertained. IGFA can play an increasingly important role if it expands its membership to include consistent participation in its efforts of a larger number of national funding agencies. In addition, such agencies must represent more than the natural sciences in general, and geosciences in particular. The involvement of bodies funding relevant social sciences research is highly recommended.

5.5 MONITORING/OBSERVATIONS, DATA/INFORMATION

5.5.1 Global Observing Systems (GOS)

ICSU is a sponsor of the three GOS: the Global Climate Observing System (GCOS); the Global Ocean Observing System (GOOS); the Global Terrestrial Observing System (GTOS); and a partner of the Integrated Global Observing Strategy (IGOS). In each case ICSU is but one of several partners of which the others are intergovernmental organizations. In the following, a brief description of each observing system is given and a common section follows on analysis, conclusions, and recommendations.

5.5.1.1 Global Ocean Observing System (GOOS)

GOOS was established in 1991, with sponsorship by IOC (UNESCO), WMO, UNEP, and ICSU. The GOOS Secretariat is located in IOC. GOOS is meant to address the need for a global network of systematic and sustained observations that will meet the needs of a wide user community, including the scientific research community. GOOS is not operational but quasi-operational and serves a dual purpose, meeting the needs of both the operational and the research community. Most of its programmatic focus to date seems to be aligned with various UN projects. GOOS is now being designed through two panels, the Ocean Observations Panel for Climate (OOPC), which is jointly sponsored by GOOS, GCOS, and the WCRP, and the Coastal Ocean Observations Panel (COOP), which is jointly sponsored by GOOS, FAO, UNEP, and IGBP. The climate panel of GOOS (OOPC) is the ocean panel of GCOS.

Although GOOS has been a successful convener of discussions about future ocean observations, from the point of view of ICSU sponsorship, linkages with the marine global change projects have been weak. Home pages for WOCE, JGOFS, GLOBEC, and the Land-Ocean Interactions in the Coastal Zone (LOICZ) indicate no more than courtesy affiliation, at best, with GOOS.

[3] *IGFA Resource Assessment 1995.*

5.5.1.2 Global Climate Observing System (GCOS)

GCOS was established in 1992, with sponsorship by WMO, IOC, UNEP, and ICSU. The GCOS Secretariat is located in WMO. GCOS's main goal is "to assist in ensuring availability and quality of climate observations for a range of users". GCOS prepared two Adequacy Reports (in 1998 and 2003), in response to UNFCCC decision to assess how well current and planned observing systems meet scientific requirements, observing principles, and UNFCCC needs. GCOS also initiated a capacity-building Regional Workshop Programme in mid-2000 and completed five regional workshops, with Regional Action Plans now being prepared. GCOS recognizes that the UNFCCC has now become a major driver for improving the GOS, but stresses the importance of the observing needs of the GEC programmes.

Within WMO, GCOS has close working relationship with the Global Atmosphere Watch (GAW), World Weather Watch (WWW), Hydrology and Water Resources (HWR). GCOS partners within ICSU include WCRP, and IGBP. For example, GCOS works in partnership with IGBP, with IGOS on the carbon and water cycles, and collaborates with IGBP's IGAC Core Project and WCRP Stratospheric Processes and their Role in Climate project (SPARC). It would be of benefit if IGBP would co-sponsor the Terrestrial Observing Panel for Climate of GTOS and GCOS.

Based on the Adequacy Reports and other analyses, there has been a significant general decrease in capacity and coverage of the global climate observing systems over the past decade. It is difficult to assess how the efforts of GCOS have mitigated this decline.

5.5.1.3 Global Terrestrial Observing System (GTOS)

GTOS was established in 1996, with sponsorship by FAO, UNEP, UNESCO, WMO, and ICSU. The GTOS Secretariat is located in FAO. GTOS was mandated to provide appropriate data for scientists and policy-makers on issues of sustainable development and terrestrial ecosystems. Progress has varied on its five original foci: land quality, freshwater resources, biodiversity, climate change, and pollution and toxicity.

Translation of global terrestrial observations into the final products that most countries and sponsors require is still inadequate. Products of GTOS such as the "Dynamic Maps" on South African agricultural patterns are difficult to access via software that is generally available, especially in developing countries. GTOS envisages its future role as a key contributor to advancing knowledge about global changes and their effects on terrestrial ecosystems.

It appears that in many instances, GTOS focuses on the collection of regional and sub-regional data sets, although its emphasis should be on the development of a terrestrial component of the GOS. It is important that FAO put GTOS higher on its agenda in order to be a credible major sponsor and host of the Secretariat.

5.5.2 Integrated Global Observing Strategy (IGOS)

IGOS is a partnership of 14 agencies (IGOS-P), including ICSU, WCRP, IGBP, and the three GOS. IGOS has been developing plans for focused observing systems in thematic areas (including water, carbon, geohazards, etc.). The science community, but not necessarily the ESSP community, has been important partners in determining the IGOS Themes.

The EOS (July 2003) was an important initiative by the political community towards implementation of a Global Observing System or Systems. The purpose of the EOS is to identify a group of countries committed to developing and maintaining an IGOS that is international, comprehensive, and sustainable. The summit established an ad hoc GEO, of which ICSU is an institutional member, to prepare a 10-year implementation plan for presentation at a ministerial meeting in late 2004/early 2005. At present, it is not possible to ascertain how successful this strategy will be. It is important that the activities build on past achievements of GOS and IGOS-P and do not duplicate what has already been done.

5.5.3 Global Observing Systems: Analysis and Conclusions

The Panel notes the separation of the agendas of the observing systems and the GEC programmes. To some

degree, the sketchy nature of these relationships is due to the fact that the GEC programmes were well underway with considerable momentum while GCOS, GTOS, and GOOS were developing their missions. The Panel considers that the value of the GOS to the GEC programmes has not been demonstrated. The lack of reciprocity in the collaboration matrix (Fig. 2) is remarkable.

The relationship between the GOS, the IGOS Themes, and the science community, especially ESSP, needs to be clarified and strong collaborative ties must be developed. For example, the Panel noted that none of IGBP, WCRP, or SCOR is a sponsor of the ocean theme of IGOS. In consideration of the terrestrial observations, critical reflection on progress to date reveals the persisting tensions between two major "observation" agendas, i.e. those of atmospheric and marine scientists on the one hand, and those of terrestrial scientists on the other.

The sponsorship of the GOS is three UN agencies (four for GTOS) plus ICSU. The difficulties in dialogue among these parties and the GEC programmes may reflect that the operational nature of the GOS missions is more consistent with the modus operandi of their UN sponsors. In addition, there is a need for a strong bridge to the scientific activities of ICSU in order to fulfil the GOS missions.

Each of the IGOS Themes will have a socio-economic component, and the Panel noted that ICSU has been charged with convening a group of experts that can address the generic issues related to spatially-referenced, global socio-economic data sets. In this regard, IHDP should apply for membership in IGOS-P.

Close working relations between the GOS and the GEC programmes will provide the best forward-looking judgment on what variables should be monitored and how to best develop new efficiencies in methods of global atmospheric, ocean, and terrestrial observations, and data analysis, synthesis, and distribution. Generally, much good could come of closer interaction among the ICSU GEC programmes and GOOS, GCOS, and GTOS. The onus should be on the observing programmes to work sufficiently closely with the GEC programmes to ensure that GOS plans are on the right track.

GOS and IGOS should set their priorities based on the global requirements of the science community, especially of the GEC programmes, as well as the policy community. ICSU should strengthen its involvement in IGOS-P to ensure that the science community has a concrete impact on the development of the themes and its involvement in the three GOS and IGOS to build better connections with the ESSP.

5.5.4 Panel on World Data Centres (WDC)

The Panel on WDC (Geophysical, Solar, and Environmental) was established in 1968 to advise ICSU on the management of the World Data Centres and to carry out related activities. Today the Panel oversees about 40 World Data Centres, which are maintained by their host countries and are responsible for collecting, archiving, and distributing a wide range of data.

It is unclear how the set of WDC relates to an overarching strategy for development and implementation of an archive and retrieval system for globally relevant international scientific data sets. Furthermore, the strategy for the deposition of GOS data (how much, when, with what standards, etc.) in the WDC is not clear. There is no evidence of strong links between the WDC and the ICSU Unions and IBs. The relationship between the WDC and FAGS (see section 5.5.8) is also unclear and there is concern about possible duplication of effort. The commercialization of data is a threat to an open data exchange system. The Panel notes that the WDC could, if properly managed, become the depository for GOS data. The assessment by the Panel of the WDC in this report is limited to their contribution to environmental science.

The WDC Panel should prepare a vision and strategy for its future through working with the GEC programmes, the Scientific Unions, and the GOS. The strategy and resulting plan should ensure that their data are freely available in a timely manner to the global science community. ICSU should analyse the WDC strategy to guide its further involvement.

5.5.5 Federation of Astronomical and Geophysical Data Analysis Services (FAGS)

FAGS was established in 1956 and now has 12 permanent Services. The cost of data services is considerable, given that they manage extensive data collection, analysis, and storage systems, and require a large staff. FAGS provides an advisory function and a link with the Scientific Unions. The ICSU umbrella strengthens the position of the data services with the national and international programmes, and helps to justify the expense. The assessment of FAGS in this report is limited to their contribution to environmental science.

While the rich historical data record is a major accomplishment of FAGS, it is seen as being disconnected from the environmental science community. Today, FAGS finds itself in a relatively weak position, as there is doubt whether it is fulfilling the role for which it was designed. It has been suggested that FAGS is an unnecessary middle layer between the scientific associations and the data services. The International Association of Geodesy (IAG) within IUGG has already taken several steps in addressing this, and in certain cases has assumed the role originally assigned to FAGS. The value-added nature of ICSU sponsorship of FAGS is questioned and IAU, IUGG, and Union Radio Scientifique Internationale (URSI) should take responsibility for its future. Thus, FAGS should no longer be an ICSU IB.

5.6 INTERNATIONAL SCIENTIFIC UNIONS

5.6.1 Retrospect and prospect

The IBs that have been reviewed by the Panel were created by the ICSU General Assembly, namely by the National Members and Scientific Unions. At the time when many of these Unions were established, issues of environment were not yet on the horizon, and their agenda was primarily scientific. Yet, in many cases, there was an implicit aim to provide society with the knowledge needed for the improvement of human existence.

With few exceptions, such as the International Union of Anthropological and Ethnological Sciences (IUAES) and the International Geographical Union (IGU), Unions did not initially regard interactions between humanity and planet Earth as the primary focus of their science. With time, however, this has changed. Many of the current Unions, their Associations and Working Groups (henceforth simply referred to as "Unions") now direct more specific attention to issues of the environment and its relation to sustainable development, acknowledging their responsibility to convey relevant scientific findings to decision-making processes. Issues such as stratospheric ozone depletion, climate change, negative effects of biomass burning, water pollution, natural hazards, and ways of coping with risk were addressed. Much of this harvest has benefited the IBs.

The Panel's assessment relies on the responses from the Unions to a questionnaire (Annex 4). Among responses received, none of the listed topics ("keywords"; see section 6) were neglected, and additional topics were mentioned, such as human settlements and megacities, coasts, fresh water supply, food safety, non-renewable raw materials, soils and monitoring. When asked about their primary results/outcomes, some specified analytical/methodological advances such as weather and climate models, geoindicators, analyses of biophysical processes, integrated place-based comparative case studies, and interactions of social and natural systems. Others pointed to substantive domains such as tropical biomes, medical geology, green chemistry, and hazardous effects of chemicals. Still others highlighted practical outcomes, such as the development of early warning systems, natural disaster prevention/mitigation, and natural elements that may be deficient or overabundant in particular places. Only some of these topics have been transformed into IB programmes.

The Unions collaborate with not only other Unions, but also with international and regional professional associations and international agencies and programmes, such as UNESCO, UNEP, and other UN agencies. They are a fertile ground for germination of scientific ideas and approaches, through seed projects, workshops and scientific meetings which emphasize inter-disciplinary collaboration. They also help to provide

resources to science and scientists in those parts of the world where local conditions do not permit the development of scientific capacity or do not allow full expression of the existing scientific cadre in national and international research, thereby making a major contribution to capacity building.

5.6.2 The role of the Unions within ICSU

ICSU should aim to achieve a better orchestration of scientific effort among the Union programmes and those of the IBs, avoiding unnecessary duplication. It is recognized that a major IB requires staff and resources beyond that which the Unions can normally mobilize. A balanced approach between using existing structures and creating new ones, with some of the new activities organized, initially at least, as inter-Union collaborative proposals, is therefore called for.

Indeed, ICSU is seen by many Unions as a means of strengthening each of them while also affording a potential voice for policy implications of science globally. ICSU has also already demonstrated its potential role as "host" for inter-Union encounters, as "harvester" of Union research results, and an important source of financial support for Union activities. One valuable outcome of inter-Union encounters, such as ICSU has facilitated on a few occasions since 2000, was the opportunity for Union Presidents and Secretaries General to meet and exchange views on potential collaboration. Some of the recent developments include:

- A discussion during the Unions meeting at ICSU (February 2001) led to a very fruitful "scoping workshop" on food security that contributed important insights for the GECAFS project that is now part of ESSP;
- A meeting of Union representatives during the ICSU General Assembly (September 2002) allowed newly-elected Union executive members to share views on ways in which inter-Union collaboration could be fostered; and
- Following upon this, an IUBS initiative assembled representatives of 12 Unions to explore themes around which inter-Union collaboration could be developed. This was followed by a meeting (February 2003) that fleshed out a research programme around the general theme of "Science for health and well-being". Three specific lines of enquiry, each with specific Union leads, are currently underway: 1) "Living environments" (led by IGU); 2) "Connections between water and health" (led by IUGG and the International Society for Photogrammetry and Remote Sensing, ISPRS), and 3) "Impacts of technology on health and well-being", led by the International Union of Psychological Science (IUPsyS) and the International Union of Physiological Sciences (IUPS).

Other inter-Union encounters are currently planned. Following the highly successful "Year of the Mountains", led by IGU, there are now plans among the geo-unions (IGU, IUGS, IUGG, and the International Union of Soil Sciences - IUSS) for an International Year of Planet Earth (2006). In addition, IUGG has taken the lead to plan for an IGY +50. ICSU is coordinating these activities, together with the Fourth International Polar Year, to all coincide in 2007/2008, with the objective of creating a similar international attention as did the successful IGY in 1957.

On ICSU itself, Union respondents emphasized the role of the grants programme and the authority that ICSU affords, for example, in the support that its "stamp" offers in applications for external funding. Many Unions also welcomed ICSU's role in expressing a universal voice on policy issues, such as pollution, climate change, and ozone depletion. All Unions expressed gratitude for the positive help received from ICSU in the past, and offered views on ways in which they could contribute in the future. There were complaints, however, about ICSU procedures that were perceived by some as excessively bureaucratic.

5.6.3 Core issues

Several core concerns emerge from this consultation with ICSU's member Scientific Unions. First, a philosophical issue arises with respect to relationships between the descriptive/explanatory aims of functionally-specialized scientific research on the one hand, and the "policy relevant" implications of results from such research within the sectorally-specialized domains of policy formulation on the other. However,

some Unions have grappled with these issues and have come forward with suggestions about science and contextually-appropriate policy implications.

A second issue regarding cooperation between the natural and social/human sciences arises. This touches upon the relationships between ICSU and ISSC, a relationship that has apparently been less than satisfactory in the past. Since issues of environment and sustainable development have now become a priority within ISSC, possibilities for more mutually beneficial interactions could be explored. One suggestion is that the three international Scientific Unions - IUAES, IGU, the and IUPsyS - which are members of both umbrella organizations, might be encouraged to facilitate such efforts. Attitudes toward this interdisciplinary dialogue vary. To transcend such impasses may involve more than epistemological argument; it may also be facilitated by fresh approaches to empirical enquiry into issues of sustainable development.

A third major issue concerns scale in problem definition and research approach. The value of conducting case studies within specific places, and then tracing the wider resonances of locally-based events and processes to wider horizons should be recognized. Expansion from local through regional to global scales expresses itself in two ways: 1) Local problems that are duplicated in many locations, e.g. water shortage and contamination, solid waste, and congestion in transportation systems; and 2) Problems at the global scale that are created by local behaviour around the world, e.g. use of chlorofluorocarbons (CFCs) that deplete stratospheric ozone, air pollution in one location that carries to other locations, HIV/AIDS (Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome), and SARS (Severe Acute Respiratory Syndrome). Environmental changes such as water, land and air quality, land slides, floods and droughts, are viewed first at the local and regional scales and later at the global scale (e.g. ozone depletion, climate change). People respond to local issues more readily than they do to global ones.

A fourth issue relates to science and scientists in less developed countries. Capacity building is often construed as transfer of currently practised scientific and technological knowledge from developed to less developed countries. There is virtually no explicit acknowledgement of the new knowledge and alternative technologies - on environment and sustainable development - that could be acquired, nurtured or developed through partnering with colleagues in developing countries. It is hoped that the ICSU Regional Offices will help to re-orient thinking to promote this approach.

Finally, despite several decades of specialized scientific research, generous national funding for environmental research, and improved efficacy of electronic media in reporting both environmental conditions and scientific results, environmental problems have increased in intensity, and global inequalities have increased. It would be a worthwhile objective for ICSU to uncover some of the sources of such contradictions, as it seeks to provide a forum for debate/dialogue over science and public policy.

5.7 NATIONAL MEMBERS

Science is increasingly an international endeavour. In areas such as environmental studies, the coordination of mutually agreed synergistic research agendas and priorities among countries greatly enhances the interaction of national researchers and projects within the broader international community. ICSU interacts with national scientific institutions and scientists through its 73 National Scientific Members, 15 National Scientific Associates, and 13 National Scientific Observers. These national institutions are usually the principal scientific academy or the main research council. To promote integrative approaches to science, the Panel considers that there are substantial benefits to be gained by National Members encouraging the teaching of interdisciplinary approaches to research. In addition to scientific encouragement, the Panel recognizes that the financial support for coordinated international programmes is made possible by contributions from primarily national funding sources. The Panel also encourages national funding bodies to develop their national programmes with a view to contributing to relevant international programmes and to enabling their national scientists to reap the benefits from involvement in international research endeavours.

To build upon their scientific and financial investments, the Panel suggests that National Members should provide links to relevant national policy-makers and ensure that results from international programmes are made available at the national level.

5.8 COLLABORATION WITHIN ICSU AND WITH EXTERNAL BODIES

Cooperation within the ICSU family and with other organizations is critical to ensuring that projects do not duplicate efforts and that scientific progress and capacity of each organization is optimally used by the rest of the scientific community. The questionnaire circulated by the PAA included the question "Which are your major partner organizations within and outside of ICSU?"

For the responses on collaboration among the IBs (Fig. 2), only about a quarter of potential collaborative links were identified, with the GEC programmes showing the greatest number of acknowledged collaborations among the IBs. The establishment of the ESSP by the four programmes will result in even more intensified collaboration in the future.

SCOPE has strong collaborative links, which is to be expected due to its mandate. It should be noted that there seems to be good collaboration between SCOPE and the ESSP partners, which is an excellent development. In the early stages of some GEC programmes, there was concern that there would be competition, overlap, and duplication. The complementary and important role of SCOPE has evidently been realized by the GEC programmes. SCOR is another body with several strong partnerships, while CDR and SCL have not mentioned any collaboration and they are not mentioned by any of the other bodies. FAGS is only mentioned by WDC, but it does not list partnership with any of the IBs.

The mandate of WDC is to oversee a system of centres that collect, archive, and distribute a wide range of data. It is noteworthy that whereas WDC mentioned collaboration with six other IBs, none of them acknowledged collaboration with the WDC. This includes all three GOS (GCOS, GOOS, and GTOS), as none of them mentioned WDC.

Although the responses to the questions are interesting, one should not draw any far-reaching conclusions, as each question might have been interpreted differently by the various respondents.

Collaboration between ICSU's IBs and Unions seems to be very weak (Figure 3). The two IBs (SCOPE and COSPAR) quoting the greatest number of Unions mentioned only five each. In addition, SCOPE was mentioned by four Unions, and COSPAR by three. More than half of the IBs (11) did not claim to work with any of the Unions.

From the perspective of the Unions, IUGG collaborates with six IBs and IGU with three. However, IGU is a special case - it claims to work with an additional nine IBs, but IGU was not mutually listed as a partner by these IBs. Many Unions have only limited activities in the environmental field, and thus did not respond to the questionnaire. Except for IAU (three partners) and IUMS (one), the thirteen non-responding Unions were not mentioned as partners by any IB.

Many bodies external to ICSU have major activities of relevance to the ICSU environment portfolio. Figure 4 shows those bodies that the IBs mentioned as partners. It is natural that assessment bodies such as the MA have many partners outside ICSU, and the same goes for the GEC programmes (Group 3 of Fig. 4). The observational programmes (group 4) also have many partners, and ICSU is only one of several sponsors of these programmes. The thematic IBs have considerably fewer external partners and WDC, which should serve the wider science community, only cites one body with which it collaborates.

The organization with which there is most collaboration is UNESCO, which is to be expected as it is the UN Specialized Agency responsible for science, and since ICSU and UNESCO have a very special relationship. UNEP is also a key partner as responsible for environment within the UN system. In addition, UNFCCC, WMO, IPCC, and IOC (which is a component of UNESCO) are also involved in many collaborative partnerships with ICSU IBs.

		MA	SCOPE	CDR	COSPAR	FAGS	SCAR	SCL	SCOR	SCOSTEP	WDC	DIVERSITAS	ESSP	IGBP	IHDP	START	WCRP	GCOS	GOOS	GTOS	IGOS	*Full Collab.*	*Cited by*	*Cites*
1	MA		◥									◥	◥	■	◥							1	4	0
	SCOPE	◣							■			■	◥	■	■					◥		5	2	1
2	CDR																					0	0	0
	COSPAR								◣	◥							■					1	1	1
	FAGS										◥											0	1	0
	SCAR								■	◥				◣			■					2	1	1
	SCL																					0	0	0
	SCOR		■		◥		■							■		◥	◥		■			4	3	0
	SCOSTEP				◣		◣										■					1	0	2
	WDC					◣								◣		◥	◣	◣	◣	◣		0	1	6
3	DIVERSITAS	◣	■										■	■	■	■	■					6	0	1
	ESSP	◣	◣									■		■	■	■	■					5	0	2
	IGBP	■	■				◥		■		◥	■	■		■	■	■	◥	◥	◥	■	9	5	0
	IHDP	◣	■									■	■	■		■	■					6	0	1
	START		■						◣		◣	■	■	■	■		■			◣		6	0	3
	WCRP				■		■		◣	■	◥	■	■	■	■	■		■	◣	◣	■	10	1	3
4	GCOS										◥			◣			■		◣	◣	■	2	1	3
	GOOS								■		◥			◣			◥	◥			■	2	3	1
	GTOS		◣								◥			◣		◥	◥	◥			◥	0	5	2
	IGOS													■			■	■	■	◣		4	0	1

A ■ B 'Full Collaboration' A and B cite each other as partners

A ◥ B A cites B

A ◣ B A is cited by B

Figure 2. Collaboration among IBs as stated in the responses to the PAA questionnaire.

	Unions	IBRO	IGU	IMU	ISPRS	IUBS	IUFoST	IUGG	IUGS	IUPAC	IUPAP	IUSS	IUTAM	IUTOX	URSI	IAU	IUAES	IUBMB	IUCr	IUHPS	IUIS	IUMS	IUNS	IUPAB	IUPESM	IUPHAR	IUPS	IUPsyS	*Full Collab.*	*Cited by*	*Cites*
	Int Bodies																												■	◥	◣
1	MA																												0	0	0
	SCOPE		■			■		■	◣	■		◥																	4	1	1
2	CDR		◥																										0	1	0
	COSPAR				◣	◥		■	◣						■	✓													2	1	2
	FAGS							■							◣	✓													1	0	1
	SCAR					◥		◥							◥														0	3	0
	SCL							■	◣																				1	0	1
	SCOR					◥		■		■					◥														2	2	0
	SCOSTEP							■			◣				■	✓													2	0	1
	WDC																												0	0	0
3	DIVERSITAS		◥		◥	■																✓							1	2	0
	ESSP		◥																										0	1	0
	IGBP		◥		◥			◥				◥																	0	4	0
	IHDP		■																										1	0	0
	START		■						◣																				1	0	1
	WCRP		◥					◥																					0	2	0
4	GCOS		◥																										0	1	0
	GOOS		◥																										0	1	0
	GTOS		◥																										0	1	0
	IGOS		◥																										0	1	0
	Full Collab.	0	3	0	0	2	0	6	0	2	0	0	0	0	2	These Unions dis not answer the PAA Questionnaire																
	Cited by	0	0	0	1	0	0	0	4	0	1	0	0	0	1																
	Cites	0	9	0	2	3	0	3	0	0	0	2	0	0	2																

A / B ■ 'Full Collaboration'
A and B cite each other as partners

A / B ✓ TICK: IB cites a non-responding union
(A cites B, no data from B)

A / B ◣ A cites B (reading horizontally)
B is cited by A (reading vertically)

A / B ◥ A is cited by B (reading horizontally)
B cites A (reading vertically)

Figure 3. Collaboration between IBs and Scientific Unions as stated in the responses to the PAA questionnaire. Please note that the matrix should be read by rows for IBs and by columns for Unions, as indicated by the summary of totals. The non-shaded areas represent Unions not having responded to the questionnaire.

		FAO	IOC	UN	UNEP	UNESCO	WHO	WMO		CBD/SBSTTA	IPCC	UNCCD	UNFCCC/SBSTA		IUCN	TWAS		APN	CEOS	IAI	IFS	TOTAL
1	MA	X		X	X	X	X			X		X	X		X	X						10
	SCOPE		X		X	X	X								X							5
2	CDR			X		X																2
	COSPAR			X		X		X								X						4
	FAGS					X																1
	SCAR				X			X							X							3
	SCL																					0
	SCOR		X	X		X					X											4
	SCOSTEP				X			X														2
	WDC																		X			1
3	DIVERSITAS					X				X	X		X					X		X	X	7
	ESSP										X		X									2
	START		X		X			X			X					X		X		X	X	8
	IGBP		X	X							X	X	X			X		X		X		8
	IHDP				X						X		X					X		X	X	6
	WCRP		X			X		X			X		X			X		X	X	X		9
4	GTOS	X			X	X		X					X						X			6
	GCOS	X	X		X	X		X					X						X			7
	GOOS	X	X		X	X		X											X			6
	IGOS	X	X		X	X		X			X		X						X			8
	TOTAL	5	8	5	10	12	2	9		2	8	2	9		3	5		5	6	5	3	99

Figure 4. Summary of IBs partnerships with organizations outside ICSU. Only those organizations quoted at least twice are included (for explanations, see list of acronyms). Organizations which are primarily funding bodies have not been included.

5.9 CAPACITY BUILDING

5.9.1 Capacity building for research on environment and sustainable development

Capacity building, both individual and institutional, is a central component in any effort to address the science of environment and its relation to sustainable development. It is necessary to educate a new generation of scientists who can contribute to the understanding of the causes of environmental problems, and who can outline pathways to their solution. It is also essential to train researchers who are competent and confident in addressing environmental issues using approaches that integrate the natural and social sciences.

Capacity building is currently carried out by the ICSU family in three main areas: training programmes, institution and infrastructure strengthening, and cooperation and exchange of people. Specific activities include promotion of science and mathematics at primary level. Other areas include improvement of public awareness and understanding of science and science policy, grants for laboratory equipment, and specialized staff training at their local institutions. Travel grants for participation at conferences and workshops have been widely used as a vehicle for exchange of scientists.

In the environmental area, there is need for formal training at all levels, with more emphasis at master's and doctorate levels, of young people who can then undertake national, regional, and global research. In doing so more emphasis should be placed on multidisciplinary research. In order to do this it is necessary to change the conservative nature of universities that tend to fragment environmental issues into traditional disciplinary approaches through its departments and faculties/schools. Considerable capacity building activities are carried out by the four GEC programmes through their international networks.

These efforts have had mixed outcomes in different places. Countries with strong science-based institutions and stable governance structures have benefited enormously, while countries with weak science and poor governance structures have seen their expensively trained citizens leave for better prospects in industrialized countries. To reduce the exodus of trained people, training in developing countries should be conducted in local universities (where possible) with opportunities for short-term visits to advanced countries. Trained people need support with acquiring research equipment, purchase of information and communication facilities, research proposal writing, training in the peer-review process and publication of research results in peer-reviewed journals, as well as dissemination of research results to society.

In order to further strengthen human resources development, the Panel recommends that outreach and curriculum material for primary and secondary education should be in local languages. National Members have a special role to play in this regard.

Four areas of capacity building requiring concerted efforts in the next decade have been identified. The first, which is of high priority, is formal education, which includes curriculum change to lower the barrier to collaboration between natural and social sciences. Young scientists must have the opportunity to obtain training in working across disciplines and geographical scales.

The second area relates to improvement of the policy-making process. In many developing countries, most research topics are donor-driven and fall within the applied science fields, with little fundamental research. Linkages between scientists and policy-makers are weak everywhere, and communication of scientific research results to policy-makers is always difficult. Bridging the communication gap between scientists and policy-makers is a joint learning experience that requires new initiatives. ICSU should consider the best way to address the need for training courses for scientists and policy-makers in this respect.

The third area of capacity building relates to the application of research results to develop national policies and in socio-economic planning and development projects. Improving human living conditions remains a primary objective of all UN programmes, and ICSU is equally committed to this goal.

The fourth area of capacity building is related to changing attitudes of different scientists and scientific communities. Active participation of social, technological, and health scientists in programmes and projects generally need to be increased.

5.9.2 Global Change SysTem for Analysis, Research and Training (START)

The GEC programmes have, from their establishment, ranked capacity building activities high on their agendas. START was established by IGBP in 1992 to support and foster regional networks and collaboration among scientists and institutions in developing countries. To this end, START has achieved its objectives in establishing infrastructure and cooperation in regional research development and mobilizing resources for capacity building. Within ESSP, it does this directly with regional centres and with its co-sponsoring programmes: IGBP, WCRP and IHDP. It has also cooperated with many other organizations within the ICSU family. Outside the ICSU family, primary partners are the Asia-Pacific Network for Global Change Research (APN), the Inter-American Institute for Global Change Research (IAI), and the European Network for Research in Global Change (ENRICH). Despite this noble beginning, ENRICH, which was started by the European Union to assist the African region, has not taken off. Furthermore, there has been infrequent interaction between START and IAI. On the other hand, interaction between START and APN has been very fruitful.

START has been able to obtain some research funds to support global environmental change research in Africa. Unlike other regions, Africa has had difficulties in attracting funds for global change research. In addition, coordination between policy-makers and individual research activities undertaken in Africa has been weak. Furthermore, the weak resource base in Africa has made long-term research planning and execution in that continent problematic. The character of environmental research must depend on local circumstances.

6. Areas of Emphasis

6.1 AREAS CURRENTLY COVERED

All IBs and Union Members were asked to identify, by defined keywords (Table 1), which area they address in the current or planned activities. The choice of keywords reflected priorities in the UN Millennium Development Goals as well as discussions held during WSSD. Although the choice was somewhat arbitrary, it was considered important to collect information on how various bodies relate to major priority areas to identify potential overlaps as well as areas where additional initiatives may be warranted.

Capacity building and climate change were the most highly ranked areas while energy and poverty alleviation the lowest by both IBs and Unions (Table 1). Some bodies can be considered as addressing very broad mandates (more than 80% of the keywords selected by ESSP, MA, COSPAR, IHDP, IGBP, IGU, and IUBS; Figure 5), while GOOS, the International Mathematical Union (IMU), and the International Union of Food Science and Technology (IUFoST) considered less than 20% of the keywords to be relevant to their ongoing or planned activities. Overall, ICSU bodies address topics that are central to environment and its relation to sustainable development. However, very large domains such as energy, technology, and health were low on the list. This probably reflects the imbalance in the scientific domains covered by ICSU Scientific Unions with very little coverage of, for example, technological and health sciences.

Table 1
Ranking of the keywords by percentage of respondents.

Rank	Keyword	IBs	Unions	Total
1	Capacity building	85	92	91
2	Climate change	85	77	82
3	Data and information	75	69	76
4	Water	75	62	70
5	Biodiversity	70	46	61
6	Agriculture and food security	65	46	58
7	Natural disasters	55	38	52
8	Chemical pollution	45	54	48
9	Health	45	46	45
10	Technology	40	46	45
11	Energy	40	38	39
12	Poverty alleviation	25	38	30

6.2 EMERGING ISSUES

One of ICSU's priorities is "to identify and address major issues of importance to science and society". The process of identifying such emerging issues is an important component in the development of a strategy for ICSU. In this regard, the CSPR commissioned a study of national foresight studies[4] by the Science and Technology Policy Research Unit (SPRU) at the University of Sussex, United Kingdom (UK). Subsequently, National Members were invited by the PAA Panel to submit any additional national foresight studies in relation to the environment not included in the results of the CSPR study.

The SPRU report identified key scientific areas in which ICSU could play a central role. In a list of 28 key scientific areas, environment and sustainable use of natural resources was the most important cluster; it included 12 of the 28 key scientific areas and related to three more from other clusters. The areas relating to environment and sustainable development were: biodiversity; resource management; soil science; bioremediation; air pollution; water recycling; water use saving/efficiency technologies; carbon sequestration; recycling; risk and disasters; and weather and climate modelling, simulation and long-range forecasting. Other areas highly relevant to the environment were: new/renewable, clean energy sources; environmental sensors; and genetic modification of food/crops.

[4] *ICSU, 2002. Identification of Key Emerging Issues in Science and Society: an International Perspective on National Foresight Studies. 28 pp.*

	Acronyms / *keywords*	poverty alleviation	water	energy	health	agriculture & food security	biodiversity	climate change	data & information	capacity building	technology	chemical polution	natural disasters	No. of keywords
IBs	CDR								X	X	X		X	4
	COSPAR		X	X	X	X	X	X	X	X	X	X	X	11
	DIVERSITAS		X		X	X	X			X				5
	ESSP	X	X	X	X	X	X	X	X	X	X	X	X	12
	FAGS		X		X	X		X	X	X			X	7
	GCOS		X	X		X	X	X	X	X	X			8
	GOOS							X		X				2
	GTOS	X	X			X	X	X	X	X		X		8
	IGBP		X	X	X	X	X	X	X	X		X	X	10
	IGOS	X	X			X	X	X	X	X		X	X	9
	IHDP	X	X	X	X	X	X	X	X	X	X		X	11
	MA	X	X	X	X	X	X	X	X	X	X	X	X	12
	SCAR						X	X	X			X		4
	SCL								X	X	X		X	4
	SCOPE		X		X	X	X	X				X		6
	SCOR		X			X	X	X		X		X		6
	SCOSTEP							X	X	X	X			4
	START		X	X	X	X	X	X	X	X			X	9
	WCRP		X					X	X	X			X	5
	WDC		X	X			X	X	X	X	X		X	8
Unions	IBRO								X	X	X			3
	IGU	X	X	X	X	X	X	X	X	X	X		X	11
	IMU							X		X				2
	ISPRS		X			X	X		X	X	X	X	X	8
	IUBS	X	X	X	X	X	X	X	X	X		X		10
	IUFoST		X											1
	IUGG		X					X	X	X	X	X	X	7
	IUGS		X	X	X		X	X		X			X	7
	IUSS	X	X		X	X	X	X	X	X		X		9
	IUPAC	X			X	X	X	X	X	X		X		8
	IUPAP			X				X	X	X	X			5
	IUTAM		X	X				X	X	X	X	X	X	8
	IUTOX	X			X	X		X		X		X		6
% Tot. Resps		30	70	39	45	58	61	82	76	91	45	48	52	
% IBs resp		25	75	40	45	65	70	85	75	85	40	45	55	
% Unions resp		38	62	38	46	46	46	77	69	92	46	54	38	

Figure 5. Environmental keywords selected by IBs and Unions in response to the PAA questionnaire.

The SPRU report was sent to National and Union members and IBs who were all asked to comment on the areas identified in the report and to identify major emerging issues in which they think ICSU could play a role. An initial analysis of the responses indicates that the ICSU family generally agrees with the list of issues identified in the SPRU report. However, some additional issues of relevance to environmental issues were identified and these are discussed below with the Panel's comments:

- Two areas, energy and biotechnology, genomics and proteomics are very broad and are not addressed within this report. Energy and sustainable societies is currently being considered by another ad hoc committee.
- Contributions to sustainable development, global change science and monitoring, and strengthened involvement of social science are key elements of all the activities discussed in this report.
- Land-use and the environment is a focus of the LUCC project of IGBP and IHDP
- Water is the focus of the GWSP of the ESSP.
- Environment and Health would be a main thrusts of a proposed new priority area - Environment and human health- described below.
- Natural and man-made hazards is the thrust of a proposed new priority, described below.
- Demography would be a thrust of a proposed new priority area - Human security (e.g. environmental refugees), described below.

As scientific research and knowledge development is crucial for addressing environmental issues, it is clear that ICSU must continue to develop its environmental portfolio. Many of the priority areas are already covered by major ICSU initiatives (i.e. global change research), whereas others (e.g. natural and man-made hazards) are partially covered by existing initiatives, but the Panel considers an increased effort to be warranted.

6.3 NEW PRIORITY AREAS

Based on considerations regarding current and planned activities, the Panel suggests that ICSU should consider initiating suitable planning processes for new initiatives in the following priority areas:

- Environment and human health;
- Natural and man-made hazards; and
- Human security (e.g. environmental refugees)
- Transgenic crops and their implications for the environment.

In development programmes in each of these priority areas, it is essential that two important approaches be included:

- Understanding of vulnerability/resilience to multiple stressors; and
- Scenario building.

Increasing evidence that many aspects of Earth's natural systems and our social and economic systems have been perturbed by changes in climate over the past several decades has stimulated new interest in assessing the vulnerability of key components of these systems[5]. Vulnerability is defined as the degree to which a system or component thereof is likely to experience harm due to exposure to a hazard, as either a perturbation or an altered stress/stressor.

Vulnerability analysis expands upon well-established practices in the risk-hazard field, largely by considering the degree to which the system is resilient or has the capacity to adapt in response to the perturbation or stress. This is a particularly important distinction when considering the vulnerability of coupled human-environment systems. Actions taken by humans can intentionally or unintentionally attenuate or amplify the impacts of the hazard.

Thus, while it is possible to conduct an analysis of vulnerability to a single stressor, e.g. climate change, the applicability of such analyses is inevitably constrained

[5] *ICSU 2002. ICSU Series on Science for Sustainable Development: Resilience and Sustainable Development No. 3. 37 pp.*

unless the likely effects of other key stressors are also included. For example, patterns of some emerging and resurgent infectious diseases are plausibly linked to regional and sub-regional climate changes that provide more favourable conditions for specific pathogens and vectors. However, the resilience of humans to this stress can vary dramatically on the two sides of a political boundary because two different governments have invested differently in public health measures and community design and development that either prevent the infection or deal effectively with its consequences. Similarly, with exceptional heat waves, the number of human deaths will be closely coupled with resilience and adaptive capacity of medical and public health response systems within a specific societal and cultural context.

Since the mid-1990s there has been an evolving use of qualitative and quantitative exploratory and anticipatory scenarios to assess the status of the environment, regionally and globally. Exploratory scenarios are descriptive and explore plausible futures using a self-consistent set of demographic, economic, socio-political, scientific and technological, cultural and religious, and biophysical drivers. Anticipatory scenarios start with a vision of the future and work backwards in time to evaluate how desirable futures might be achieved and undesirable futures avoided. Scenario analysis has been an important tool in several regional and international environmental and sustainability assessments. They have been used to assess future changes in the demand for energy, food and water, trace gas emissions, and the status of ecological systems and their goods and services. The policy community and the private sector have found this tool to play an invaluable role in public and private sector decision-making.

The proposed ICSU projects could be designed to include a component on scenario building, to develop a range of plausible storylines, quantitatively evaluate the direct and indirect drivers of environmental change with and without nationally and internationally coordinated policy interventions, and use a range of "models" to assess the future range of a number of environmental parameters and the resulting implications for sustainable development. These scenarios could be developed at a range of scales from local to national, continental and global. In each case, the power of the decision-maker (from the consumer to producer and local and national governments) to influence their future can be evaluated. The scenarios can also be used to assess the influence of national policies at the local level and the influence of local actions nationally.

6.3.1 Environment and human health

Promoting human health and well-being, which is highly relevant to ICSU's mission of "strengthening international science for the benefit of society", has been identified as a priority for future ICSU initiatives. Public health experts are increasingly coming to understand how human health can be influenced by local environmental conditions and socio-economic circumstances, as well as social, institutional, technological, and behavioural adaptations. Human health problems fall disproportionately upon developing countries, and upon the poorest sectors within all societies, thereby exacerbating existing social and economic inequities. Many of the most exciting new insights related to human health are taking place at the interface between the 'traditional' medical/health sciences and other fields such as climatology, ecology, and social sciences.

Human health lies at the nexus of many topics with which ICSU is concerned (e.g. climate change, water, energy, capacity building, vulnerability, and extreme natural events). Currently, there are two initiatives (one from ESSP and one from ICSU Unions) within the ICSU family that directly address the issue of human health and well-being.

Increasingly, human health concerns are taking on global dimensions (e.g. SARS, HIV/AIDS), and thus international partnerships (e.g. with organizations such WHO and Inter Academy Medical Panel -IAMP) are critical for addressing such concerns. At present, there is no coherent, long-term global research initiative focused on understanding the full array of environmental and social factors that impinge upon human health and well-being. ICSU, with its disciplinary-based International Unions, its 101 multi-disciplinary National Members, and its proven

ability to collaborate with a wide array of other international scientific bodies, is uniquely positioned to catalyze and sponsor new international initiatives on this critically important topic of environment and human health.

6.3.2 Natural and human-induced hazards

Natural disasters are already a serious threat around the world, and result in large losses of human lives and economic assets. The Munich Re 2002[6] review stated that in 2002, 11,000 lives were lost through natural catastrophes and economic losses totalled $US55bn, an increase from 2000 but below the record $US100bn in 1999. Windstorms and floods accounted for over two-thirds of the 700 events. A single sudden earthquake may cause over 1,000 deaths or injuries, resulting in wide-ranging impacts on society. In addition, millions of people are injured or displaced each year because of natural disasters, and property damage has been doubling about every seven years over the past 40 years. Concern about natural disasters, which is the focus of programmes such as the United Nation ISDR and the World Bank Disaster Management Facility, is now coupled with heightened awareness of society's vulnerability to terrorism and other anthropogenic hazards. Though hazards will continue to exist, it is the vulnerability established often through people's choices that turns hazards into disasters. In addition, the changing global climate adds major complexities. Globally, there is exceptional knowledge and research excellence on: the analysis and design of infrastructure and public health systems; mitigation and adaptive management; severe weather, earthquakes and other hazardous events; and public policy questions on the management of risk and interactions among different levels of government. However, in a field that is highly interdisciplinary, much of the research is conducted along single-disciplinary lines. Hazards have been considered independently and much of the analysis has had a retrospective, rather than futuristic view.

It is essential that this excellence be brought together with a shared vision and an integrated approach that only an ICSU-led programme, with the participation of international and national partners, can achieve. An ICSU-led Natural and Human-induced Hazards Programme would have coordinated research in at least the following areas: critical infrastructure; population health; hazards assessment; public policy; and international development. An integrated risk management approach would examine the intersection of vulnerabilities and hazards.

The planning would consider the past achievements of CDR and the SC-IDNDR. The Panel recommends that ICSU develop this programme by building on the basis of the disciplinary expertise of the Unions (such as IUGG and IUGS), the subject areas of the GEC programmes, with additional components on population health and critical infrastructure (through appropriate partners). The programme would be integrated through a scientific committee and a small number of integrating, trans-disciplinary projects. In this way, ICSU would build upon existing expertise and projects and have a programme that is more effectively and efficiently implemented. It is further recommended that a planning workshop be held early in 2004 to move forward on this issue.

6.3.3 Human security – Environmental refugees

A prime source of pressure on the Earth's environment is human population increase and demographic movements, especially the migration of people in uncontrolled circumstances. Increased human migration could occur both within countries and across frontiers. Such migrants or refugees fall into three broad categories: political refugees, economic migrants, and environmental refugees. It could be forecasted with very high level of probability that the total number of environmental refugees will increase both in relative and absolute quantity. This demographic process is associated with the more serious problems of resource depletion, pollution of land, sea and air, water shortages, desertification, climate change (including sea level rise) increasing number of natural hazards, and destruction of biodiversity. Around 40 small-island countries could be in danger due to sea level rise. Nearly one third of the

[6] *Munich re Group 2002. Topics Natural Catastrophes. 52 pp.*

total world's population live in coastal areas (not more then 100 km from the sea or oceans). In many inland countries the desertification process and drought, and in the arid zones, the shortage of water very often causes extreme difficulties for living. Environmental vulnerability is increasing in many countries of the world. Appearance of large numbers of environmental refugees could be one of the biggest problems for governments in the 21st century.

ICSU should initiate a new and comprehensive project on environmental refugees, elaborating the scientific issues, and natural and human causes, possible consequences, prevention and adaptive management, limits and possibilities of the local population's resilience, etc. But ICSU alone could not cope with this task, and needs partners for such a project, especially the ISSC, UNESCO, and other relevant UN agencies. Inside the ICSU family are also potential partners such as IGU, IGBP, IHDP (particularly its Global Environmental Change and Human Security core project), SCOPE, and others. The Panel recommends the creation of a Task Force that would undertake an analysis of the scientific aspects of the problem, with all its social implications, and make recommendations for action.

6.3.4 Transgenic crops and their implications for the environment

The role of science and new genetic technologies in food production is an area of considerable controversy and concern to many people across the world. It is an area in which there are strongly conflicting views and opinions, in which scientific progress and individual morals and beliefs are often opposed, and in which the science itself is sometimes uncertain and open to interpretation. However, food security is also one of the major challenges facing humanity (e.g., 850 million people lack access to sufficient nutritious food at affordable prices). There is potential for using gene technology for improving crop traits such as temperature tolerance, drought and pest resistance, and enhanced yields and improved nutritional value. In 2003 ICSU released **New Genetics, Food and Agriculture: Scientific Discoveries - Societal Dilemmas**, which synthesised more than 50 science-based reviews. This report was prepared by Gabrielle Persley, who is an acknowledged expert in this area, analysed the risks and benefits of applying new genetic discoveries to food and agriculture.

The Panel recognizes that there is significant controversy and uncertainties surrounding the environmental and human health implications in both the scientific and policy communities. The Panel recommends that ICSU pay urgent attention to this issue and consider how it could contribute to sound policy relevant science in this area.

7. Acknowledgements

The Panel gratefully acknowledges the participation of Professor Sir Partha Dasgupta and Professor Lourdes Arizpe. Both of them were initial members of the Panel and added considerable insight to the final report through their participation in the second meeting of the PAA. However, due to conflicting engagements, they were not able to review the final report, and thus, are not listed as members of the Panel.

Also, the Panel would like to thank the entire ICSU family (i.e. IBs, National and Union members) for its input and attention to this review. The Panel invited representatives from the IBs that were assessed in this Report to its meeting in February 2003, and wish to extend particular thanks for their informative presentations and their participation in a fruitful discussion of ICSU environmental portfolio.

Finally, the Panel expresses their appreciation to Sherry Heileman for her participation to the meetings and her professional editing of this report.

Annexes

ANNEX 1:
Article 12 of ICSU's Rules of Procedure

12. TERMS OF REFERENCE FOR SCIENTIFIC INTERDISCIPLINARY BODIES

12.1. By virtue of Article 18. e) of the Statutes of ICSU, Scientific Committees and Programmes may be created by the General Assembly to facilitate the planning and coordination of interdisciplinary scientific research and related activities on an international basis, such as necessitates the cooperation of two or more Members.* These Bodies are set up for a specified period, renewable by decision of the General Assembly.

12.2. a) A Scientific Committee shall normally focus on a well-defined interdisciplinary theme.

b) A Programme shall normally focus on a set of interlinking interdisciplinary themes undertaken by ICSU alone or in partnership with others.

12.3. Each Interdisciplinary Body shall function under a constitution, approved by the Executive Board, which is appropriate to its specific task.

12.4. The adherents to an Interdisciplinary Body may be Members and Associates of ICSU, other ICSU interdisciplinary Bodies or other appropriate regional or international scientific or technological organizations.

12.5. Interdisciplinary Bodies shall have the obligation to submit to the Officers of ICSU, and to their own adherents, the agenda of all meetings and subsequently a full and proper record of their proceedings.

12.6. Each Interdisciplinary Body shall ensure the maintenance of an ongoing record of its activities and of projects it has launched, and, where appropriate, of their scientific results.

12.7. Each Interdisciplinary Body shall submit to ICSU an annual report on its work, the budget for the ensuing year and the audited financial statement for the preceding year. If the body is in arrears financially, the budget for the new year has to be approved by the Treasurer of ICSU.

12.8. Interdisciplinary Bodies must acquire, in addition to basic funding, adequate funds for planning and administration.

12.9 Individually, or in the context of broader policy reviews, Scientific Interdisciplinary Bodies will be reviewed by the ICSU Committee on Scientific Planning and Review for every second General Assembly of ICSU.

* *Bodies which were formerly referred to as Inter-Union Commissions may become Scientific Committees.*

ANNEX 2:
Members of the CSPR Priority Assessment Panel on Environment and its Relation to Sustainable Development

Robert Watson, Chairman
Senior Advisor for Environment
Environment Dept.,
World Bank, 1818 H Street, N.W.
Washington D.C. 20433, USA
Tel.: (1 202) 473-6965
Fax: (1 202) 477-0565
E-mail: rwatson@worldbank.org

Anne Buttimer
Department of Geography
University College Dublin
Belfield, Dublin 4, Ireland
Tel.: (353 1) 706 8174
Fax: (353 1) 269 5597
E-mail: anne.buttimer@ucd.ie

Angela Cropper
2, Mt. Anne Drive
Second Avenue Cascade
Port of Spain, Trinidad and Tobago
Tel.: (1 868) 625 4071
Fax: (1 868) 625 2531
E-mail: acropper@thecropperfoundation.org

Istvan Lang
Hungarian Academy of Sciences
Roosevelt tér 9, 1051 Budapest, Hungary
Tel.: (36 1) 269 26 56
Fax: (36 1) 269 26 55
E-mail : ilang@office.mta.hu

Gordon McBean
Institute for Catastrophic Loss Reduction
The University of Western Ontario
1389 Western Road
London, ON N6A 5B, Canada
Tel.: (1 519) 661 4274
Fax: (1 519) 661 4273
E-mail: gmcbean@uwo.ca

James McCarthy
Museum of Comparative Zoology
Harvard University, 26 Oxford Street
Cambridge, MA 02138, USA
Tel.: (1 617) 495 2330
Fax: (1 617) 495 0506
E-mail : jmccarthy@oeb.harvard.edu

Uri Shamir
Water Res. Institute Technion
Israel Institute of Technology
Haifa 32000, Israel
Tel.: (972 4) 829 2239
Fax: (972 4) 822 4246
E-mail: shamir@tx.technion.ac.il

Sir Crispin Tickell
Ablington Old Barn
Ablington, Cirencester
Glos. GL7 5NU, UK
Tel.: (44 1285) 740569
Fax: (44 1285) 740671
Home tel: (44 1285) 740566
E-mail : ct@crispintickell.net

Shem Wandiga
Kenya National Academy of Sciences
PO Box 39450, Nairobi, Kenya
Tel. : (254 2) 311714
Fax : (254 2) 311715
E-mail: sowandiga@iconnect.co.ke

ANNEX 3:
Background Information and Terms of Reference for the ICSU Panel on Priority Area Assessment on Environment and its Relation to Sustainable Development

Introduction

The goal of the Priority Area Assessments (PAA) process is to strengthen ICSU's overall capability in addressing priority scientific issues that are of emerging importance to science and society at large. The PAA is a mechanism to develop ICSU's strategies for selected priority scientific areas. It is designed to help ICSU develop a programme structure reflecting its priorities; to ensure synergies in the activities of the ICSU family; and to enable an appropriate allocation of limited resources. In order to be effective, the PAA process must involve relevant members of the ICSU family – i.e. Union and National Members, interdisciplinary Bodies, and joint initiatives. It should also consider ICSU's priorities in the context of relevant activities outside of ICSU.

The immediate outcome of a PAA is a report containing key recommendations that will be published and widely disseminated by ICSU. This report will form the basis for future actions by ICSU and ICSU members, including the development of new programmes, policy initiatives and definition of new priorities for the ICSU grants programme. Some of the recommendations may require the establishments of new partnerships with Bodies outside the ICSU family or may be more appropriately taken forward by other organizations, in which case, the necessary dialogue(s) will be initiated.

Context for the PAA on Environment

On the international scene, the environment has been in focus since the first UN Conference on the Human Environment in 1972 in Stockholm. As a result, the United Nations Environment Programme (UNEP) was established, which further testifies to the importance of the environmental area. Over the past three decades the UN has expanded its view from the environment to also embrace developmental and sustainable development issues with the Conference on Environment and Development (UNCED, Rio de Janeiro 1992) and the World Summit on Sustainable Development (WSSD, Johannesburg 2002). For the WSSD, the UN invited ICSU and WFEO (who subsequently invited TWAS, ISSC, IAP) to represent the Scientific and Technological community. The challenge is now to develop research that integrates the environmental, social and economic pillars of sustainable development.

Over the past few decades, the scientific community has made remarkable progress in advancing scientific understanding of environmental problems through international collaboration. ICSU has often taken the lead and collaborated with other intergovernmental (UNESCO, WMO, UNEP) and non-governmental (IUCN, WWF, etc.) organizations in the establishment of these programmes. International environmental research efforts/programmes have traditionally focused on global problems and the results of such research, complemented by a number of international assessments, have been essential for the development of international agreements such as the Montreal Protocol (and its subsequent Amendments), the Framework Convention on Climate Change, the Conventions on Biodiversity and Desertification and the UN's Forest Principles.

However, many other problems have been identified at the local and regional scale (e.g. air, soil and water pollution) and in some cases regional environmental agreements (e.g. for acid rain) have been achieved. These problems, which have immediate impacts at the local and regional level, are often also a shared concern of the global community. Given the proven and vital importance of scientific expertise at these varying scales of expertise, it is therefore necessary to further strengthen international research.

The UNEP Global Environment Outlook (GEO-3), which was published in preparation for the WSSD, emphasizes that the next 30 years will be as crucial as the past 30 for shaping the future of the environment. It is now necessary to take stock of ICSU's activities in the area of the environment to assess how it is suited to address emerging problems and to provide the basis of good science for good governance.

Major ICSU Activities in relation to Environment

SCOPE, since its establishment in 1969, has provided synthesis, assessments and evaluation of information on natural and anthropogenic environmental changes and the effects of these changes on society. SCOPE championed the study of human impact on the global biogeochemical cycles. These studies later led to the realisation that humans were affecting the global environment and, in particular, the climate system and its subsequent impact on ecosystems. SCOPE (together with WHO) has also led in the development of ecotoxicology, which studies biological invasions as a threat to ecosystems.

Based on the studies of SCOPE in the 1970s and early 1980s ICSU started the planning of the International Geosphere-Biosphere Programme (IGBP). In addition, ICSU also co-sponsors the World Climate Research Programme (WCRP, together with WMO and IOC), the International Human Dimensions Programme (IHDP, together with ISSC) and DIVERSITAS (together with UNESCO, IUMS, IUBS and SCOPE). The four Global Environmental Change Programmes – WCRP (established 1980), IGBP (1986), DIVERSITAS (1991) and IHDP (1996) – are currently coming together under the banner of the Earth System Science Partnership (ESSP). ESSP and its joint projects form the core research programmes of ICSU in the environmental sector; it promotes international and interdisciplinary research in special focused areas (carbon, food, water). This is often done in cooperation with international partner organizations.

START, which is jointly sponsored by WCRP, IGBP, IHDP and DIVERSITAS, supports regional networks of researchers and institutions engaged in collaborative research on global change issues in order to strengthen indigenous capacity and to address scientific and policy aspects of environmental changes.

In addition to the Global Change Programmes, other important activities in the environmental area, which also contribute to the elucidation of earth system processes, are carried out by ICSU interdisciplinary committees, such as SCOR, SCAR, SCOSTEP, IGCP, CDR and SCL.

ICSU Scientific Union Members also carry out important activities with high relevance to the environmental sciences. Some of the Unions are major sponsors of the above mentioned ICSU programmes. It is necessary that the PAA take due note of the environmental activities of the Scientific Unions and how effective the collaboration is between Unions and Interdisciplinary programmes. It should be noted that many environmental problems have first been detected by basic disciplinary research, and the Unions may thus provide an early warning system for emerging problems.

National Members have been extremely supportive of ICSU initiatives and programmes. Any recommendations from this PAA should also take into account on-going National efforts.

ICSU also sponsors three Global Observing Systems (GOS), GOOS, GCOS and GTOS, in collaboration with partner organizations such as the WMO, IOC-UNESCO, UNESCO, FAO and UNEP. The goal of the GOS is better monitoring of the earth system as a whole. The GOS are among 14 partnership organizations of the Integrated Global Observation Strategy (IGOS), which seeks to unite the major satellite and surface-based systems for global environmental observations of the atmosphere, oceans and land. WDC and FAGS also provide services concerning collection, validation and distribution of scientific data of environmental relevance. COSPAR is facilitating international exchange of information on scientific research related to global environment monitoring from space.

Scope of the PAA on Environment

To have an overview of ICSU activities in the environment sector as a whole, the scope of this assessment should cover all the interdisciplinary Bodies and joint initiatives mentioned in the previous section (partially when only a part of their programme concerns environmental research). The assessment of WDC and FAGS should be limited to their contribution to environmental research and relationship with the GOS.

Data management and policy issues should be primarily the purview of the PAA on Data and Information, which will take place in parallel to this assessment. Likewise, START will be examined in terms of its inter-linkages and collaboration with ESSP as part of this Assessment, but a review of its activities in capacity building should primarily be left to the PAA on Capacity Building.

One of the major goals of the PAA on Environment is to review the environmental activities in the ICSU family and to address whether further collaborations could be stimulated. In particular, strengthening linkages of ICSU environment programmes with other ICSU Bodies, the international scientific Unions and National Members, should be explored. The links to other partners, such as UNESCO, should also be considered.

The success of ESSP, as well as START, is dependent on the funding of scientific projects and secretariats. The Assessment should take note of resolution # 10 from the recent ICSU General Assembly: "ICSU should assist ESSP and START by taking appropriate action to create a dialogue between the ICSU National Members, the funding Bodies responsible for the contributions to the ESSP and START programmes, and the broader global change funding community in order to provide long-term, stable, core funding".

Assessments are of vital importance in linking scientific research to policy development. Within ICSU, SCOPE has a long track-record of synthesizing scientific results and making assessment in key priority areas. In many cases, there are also links between the ICSU programmes and the international assessments on climate, biodiversity, water resources, state of the world's ecosystems, etc. This PAA should consider whether ICSU has played and should play an important role in the establishment and conduct of such assessments and in facilitating the communication of these results to decision makers. As ICSU has identified more policy- relevant science as a priority, the role of assessments should be evaluated in this context.

As a follow-up to the WSSD, the 27th General Assembly of ICSU decided to initiate discussions of the development of a science plan for sustainable development. After extensive consultations during the next few months, the ICSU Executive Board, at its meeting in early February 2003 is expected to establish an ad hoc planning committee in consultation with appropriate partners for a new programme on science (and technology) for sustainable development. Planning will focus on place-based research using participatory approaches and how such studies should be integrated at the local and regional level. Any new programme would thus be complementary to the ESSP, which is currently strengthening its focus on the links from the global to the regional level while in many cases building on local studies and how local processes affect the global system. The PAA should address how the current ICSU activities are relevant to sustainable development taking note of the fact that it should not concern itself with the planning of any new programmes, which will be left to the new ad hoc committee. It is expected that the results of this PAA will provide valuable input to the new planning process.

The General Assembly also closed two ICSU interdisciplinary Bodies, the Scientific Committee on Water Research (SCOWAR) and the Committee on Science for Food Security (CSFS), which were working specifically on water and food issues. It is important to note the necessity for ICSU to develop innovative and integrative approaches to these two high-priority scientific issues.

The Assessment Process

The ICSU Committee on Scientific Planning and Review (CSPR) is responsible for all Priority Area Assessments and will appoint an ad hoc PAA Panel for each major priority scientific area. Membership of the PAA for the environment area is given in Annex 1.

Terms of Reference

The Panel will:

- Define an overarching "mission" and the role of ICSU in the area of the environment taking note of its relationship to sustainable development and taking into account relevant activities outside of ICSU;
- Propose a strategic framework for ICSU to take this area forward for the next 5-10 years;
- Examine current activities within the ICSU family, identify gaps, overlaps and synergies among existing activities and possibly propose new responsibilities for individual Bodies;
- Propose modalities for promoting collaboration and coordination within the ICSU family and when necessary and propose potential partnerships with Bodies outside ICSU;
- Examine and propose, if appropriate, changes either in the future direction of individual Bodies and/or their activities, including relationships with other Bodies/organizations.

An additional ToR for this specific review on the environment:

- Identify potential inputs from the ICSU environment programmes to a science plan for a possible programme on science for sustainable development, the planning of which may be initiated during the course of this assessment;
- Review the contributions of the ICSU Scientific Unions to the environment programmes and propose, if necessary, modalities for strengthening interaction between interdisciplinary Bodies, joint initiatives and Scientific Unions in the area of the environment; and
- Consider in view of the establishment of CSPR's for overall strategic planning and review of the ICSU programme, consider the potential future role of the Advisory Committee on the Environment (ACE).

Work plan

The Panel will prepare a report to the CSPR, which will include an overarching mission statement and strategic framework for ICSU and recommendations on roles of new and/or existing interdisciplinary Bodies and joint initiatives in the area. This report will be published.

Resources

ICSU will provide financial resources to carry out the review, including travel and accommodation costs for the Panel members to participate in the necessary meetings. The ICSU Secretariat will provide administrative support to the Panel, including assistance with communication among the members and organizations of meetings. The final report will be the responsibility of the Panel, although the ICSU secretariat will assist in its preparation as necessary.

ANNEX 4:
Questionnaire sent to ICSU IBs and Scientific Unions

(Two slightly different questionnaires were posted for IBs versus Scientific Unions (see the notes in questions 8, 9 and 13.)

Question 1:
What keywords apply to your scientific activities?

☐ Poverty alleviation	☐ Climate change
☐ Water	☐ Data and information
☐ Energy	☐ Capacity building
☐ Health	☐ Technology
☐ Agriculture & food security	☐ Chemical pollution
☐ Biodiversity	☐ Natural disasters
☐ Other	☐ Other

Question 2:
Describe your three primary results/key outcomes and actions taken to achieve them? (For research GEC programmes and ESSP, relevant information should be provided for all major projects)

Question 3:
What are new directions/emerging issues of your organization / Union?

Question 4:
What are your policy relevant "deliverables"? (e.g. contributions to scientific assessments, international agreements, etc.)

Question 5:
Do you address sustainable development? If so, describe how.

Question 6:
Which are your major partner organizations within and outside of ICSU?

Question 7:
How does your association with ICSU help and/or hinder your organization?

Question 8(For ICSU bodies):
With which countries do you have scientific collaboration? For Unions: Do you wish to explore the possibility of collaborating with ICSU's Joint Initiatives/IBs? If so, why?

Question 9 (For ICSU bodies):
What are the major funding sources for your organization/projects? Please differentiate between direct and 'in-kind' funding.

Question 10:
What do you see as the major environmental issues that ICSU should address over the coming 5-10 years?

Question 11:
Do you have any specific recommendations on how ICSU can improve its performance in the environment area?

Question 12:
Do you have specific changes to suggest for the Mission statement? If so, please enter them below.

Question 13 (only for Unions):
Does your Union see areas where collaboration between specific Unions, Joint Initiatives and IBs would lead to mutually beneficial interactions? Please specify the organization(s), and the particular area(s) of possible collaboration.

ANNEX 5:
Project Timeline

Date	Event	Action/Notes
9-10 November 2002	1st PAA Meeting	ToR reviewed, mission statement drafted and strategy discussed. Online Questionnaire sent out (Unions and IBs)
19 November 2002	IBs notified of the PAA process	IBs asked to comment on mission statement and informed of February meeting
3 December 2002	Unions and National Members notified	Members Asked to comment on mission statement
11 December 2002	First Panel Teleconference	Questionnaire, report outline and February meeting agenda discussed
16 December 2002	Invites to IBs for the Feb. meeting and questions for the online forum sent out	
14 January 2003	Online password-protected questionnaire activated	Questions for IBs and Unions posted
5-6 February	5th CSPR Meeting	Anne Buttimer gave a PAA update
10 February 2003	Deadline for online responses	Given a first deadline: 31 December 2002
14 February 2003	Second Panel Teleconference	
21-24 February 2003	2nd PAA Meeting	Analysis of questionnaire (presentations from IBs and outline drafted); Panel members all assigned writing tasks
11 April 2003	Unions invited again to respond	Given a second deadline: 25 May 2003
6 June 2003	GECs questioned about "glue money"	Responses received in mid-July
9-10 June 2003	6th CSPR meeting	Anne Buttimer gave a PAA update
20 June 2003	Deadline for Panel for report submissions	N.B. Conclusions had not yet been discussed
28-30 July 2003	3rd PAA Meeting	Draft conclusions prepared
05 September 2003	Report circulated to IBs, Union and National Members for comments	
30 September 2003	Deadline for comments on report	
14 October 2003	Report and consolidated list of comments sent to Panel	
22-24 October 2003	4th PAA Meeting	Review of the Comments and drafting of the Executive Summary. Remaining modifications assigned to Panel Members
3-10 November 2003	Draft report assembled by secretariat and editorial revision carried by science writer.	Draft sent to Panel on 10 November 2003.
17 November 2003	Comments on draft received at secretariat. Penultimate report prepared.	Penultimate report sent to Panel on 17 November 2003
18 November 2003	Third Teleconference	Report modified and then Panel agreed to send the Final report to CSPR
21 November 2003	Final report made available to CSPR through ICSU website.	
3-4 December 2003	7th CSPR meeting	Report sent for publication and CPRP's recommendations forwarded to the ICSU Executive Board

ANNEX 6 :
List of Acronyms and Abbreviations

ACE	Advisory Committee on the Environment
AIDS	Acquired Immune Deficiency Syndrome
APN	Asia-Pacific Network for Global Change Research
CAWSES	Climate and Weather of the Sun Earth System
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCD	Convention to Combat Desertification
CDR	Committee on Disaster Reduction
CEOS	Committee on Earth Observation Satellites
CFC	chlorofluorocarbons
CLIMAG	Climate Prediction and Agriculture
CLIVAR	Climate Variability and Predictability project
COOP	Coastal Ocean Observations Panel
COSPAR	Committee on Space Research
CSFS	Committee on Science for Food Security
CSPR	Committee on Scientific Planning and Review
DIVERSITAS	an international programme of biodiversity science
EMI	Earthquakes and Megacities Initiative
ENRICH	European Network for Research in Global Change
EOS	Earth Observation Summit
ESSP	Earth System Science Partnership
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
FAO	Food and Agricultural Organization
GARP	Global Atmospheric Research Programme
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GCTE	Global Change and Terrestrial Ecosystems
GEC	Global Environmental Change
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GECHS	Global Environmental Change and Human Security
GEO	Group on Earth Observations
GEOHAB	Global Ecology and Oceanography of Harmful Algal Blooms
GEWEX	Global Energy and Water Cycle Experiment
GISP	Global Invasive Species Programme
GIWA	Global International Waters Assessment
GLOBEC	Global Ocean Ecosystem Dynamics
GMBA	Global Mountain Biodiversity Assessment
GOOS	Global Ocean Observing System
GOS	Global Observing Systems (GCOS, GOOS, GTOS)
GSHAP	Global Seismic Hazard Assessment Programme
GTOS	Global Terrestrial Observing System
GWSP	Global Water System Project
HELP	Hydrology for the Environment, Life and Policy
HIV	Human Immunodeficiency Virus
HWR	Hydrology and Water Resources programme
IAG	International Association of Geodesy
IAHS	International Association of Hydrological Sciences
IAI	Inter-American Institute for Global Change Research
IAMP	InterAcademy Medical Panel
IAP	InterAcademy Panel on International Issues
IAU	International Astronomical Union
IBOY	International Biodiversity Observation Year
IBRO	International Brain Research Organization
IBs	Interdisciplinary Bodies
ICSU	International Council for Science
IDGEC	Institutional Dimensions of Global Environmental Change
IDNDR	International Decade for Natural Disaster Reduction
IFS	International Foundation for Science

IGAC	International Global Atmospheric Chemistry project
IGBP	International Geosphere Biosphere Programme
IGCP	International Geoscience Programme (formally, International Geological Correlation Programme)
IGFA	International Group of Funding Agencies
IGOS	Integrated Global Observing Strategy
IGOS-P	Integrated Global Observing Strategy Partnership
IGS	International GPS Service for Geodynamics
IGU	International Geographical Union
IGY	International Geophysical Year
IHDP	International Human Dimensions Programme on Global Environmental Change
IHP	International Hydrological Programme
ILP	International Lithosphere Programme
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research
IMU	International Mathematical Union
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPO	International Project Offices
ISDR	International Strategy for Disaster Reduction
ISPRS	International Society for Photogrammetry and Remote Sensing
ISSC	International Social Science Council
ISTS	Initiative on Science and Technology for Sustainability
IT	Industrial Transformation
IUAES	International Union of Anthropological and Ethnological Sciences
IUBS	International Union of Biological Sciences
IUCN	World Conservation Union
IUFoST	International Union of Food Science and Technology
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUHPS	International Union of History and Philosophy of Science
IUMS	International Union of Microbiological Societies
IUPAC	International Union of Pure and Applied Chemistry
IUPAP	International Union of Pure and Applied Physics
IUPS	International Union of Physiological Sciences
IUPsyS	International Union of Psychological Sciences
IUSS	International Union of Soil Sciences
IUTAM	International Union of Theoretical and Applied Mechanics
IUTOX	International Union of Toxicology
JGOFS	Joint Global Ocean Flux Study
JI	Joint Initiatives
LOICZ	Land-Ocean Interactions in the Coastal Zone
LUCC	Land Use Cover and Change
MA	Millennium Ecosystem Assessment
OOPC	Observations Panel for Climate
PAA	Priority Area Assessment
PAGES	Past Global Changes
PUB	Prediction in Ungaged Basins
SARS	Severe Acute Respiratory Syndrome
SBSTA	Subsidiary Body on Scientific and Technological Advice of the UNFCCC
SBSTTA	Subsidiary Body for Scientific Technical and Technological Advice of the UN CBD or CCD
SCAR	Scientific Committee on Antarctic Research
SCL	Scientific Committee on the Lithosphere
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SCOSTEP	Scientific Committee on Solar-Terrestrial Physics
SCOWAR	Scientific Committee on Water Research
SOLAS	Surface Ocean Lower Atmosphere Study
SPARC	Stratospheric Processes And their Role in Climate
SPRU	Science and Technology Policy Research

START	SysTem for Analysis Research and Training
TOGA	Tropical Ocean and Global Atmosphere
ToR	Terms of Reference
TWAS	Third World Academy of Sciences
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
URSI	Union Radio Scientifique Internationale
WCRP	World Climate Research Programme
WDC	World Data Centres
WFEO	World Federation of Engineering Organizations
WHO	World Health Organization
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WSSD	World Summit on Sustainable Development
WWAP	World Water Assessment Programme
WWF	World Wide Fund For Nature
WWW	World Weather Watch

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- Identify and address major issues of importance to science and society.
- Facilitate interaction amongst scientists across all disciplines and from all countries.
- Promote the participation of all scientists–regardless of race, citizenship, language, political stance, or gender–in the international scientific endeavour.
- Provide independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society, and the private sector.

51, boulevard de Montmorency
75016 Paris, France
Tel: +33 (0) 1 45 25 03 29
Fax: +33 (0) 1 42 88 94 31
Email: secretariat@icsu.org
www.icsu.org