



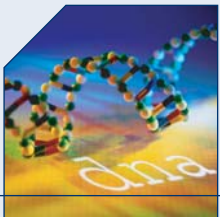
ICSU

International Council for Science

strengthening international science for the benefit of society

Foresight Analysis

Report of the CSPR



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.



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July 2004

The International Council for Science (ICSU) is a non-governmental organization representing a vast global network among the scientific community. It includes National Members, International Scientific Unions, and Interdisciplinary Bodies¹, as well as Joint Initiatives established in collaboration with partners outside of ICSU. 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.

In 1995-96, an independent Panel of experts was invited to conduct an assessment of ICSU. According to the Panel report, “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, and the CSPR was charged with developing this process.

It was further suggested that a central component of this planning process should be a broad-based, forward-looking assessment of issues that may be of growing importance to science and society in the coming decades, for which ICSU may have a unique, useful role to play in catalyzing the needed international, interdisciplinary linkages. The first step in this exercise was to commission a meta-analysis of national foresight studies that have been carried out by national governments around the world (*Identification of Key Emerging Issues in Science and Society: an International Perspective on National Foresight Studies*; ICSU, 2002). The next step was to seek the direct input of the ICSU membership. In November 2002, the CSPR Chair wrote to all ICSU National Members, Unions, and Interdisciplinary Bodies (herein referred to as ‘the ICSU family’) inviting responses to three questions:

1. What scientific developments do you see taking place in your field over the next 5-10 years that could have a major impact on other disciplines on the one hand and that could serve the need of society on the other?
2. What kind of collaboration or co-ordination (global or regional or across disciplines) are required at the international level in order to ensure these scientific advances are successfully implemented?
3. In the light of its mission, what is the unique role that ICSU can play in relation to these developments?

CSPR discussed the initial responses and subsequently developed a ‘synthesis memo’ that summarized the main themes raised in these responses. This preliminary synthesis was then circulated to the ICSU family in September 2003, with a request for additional and/or more detailed submissions. Through this iterative process, input was ultimately received from 27 National Members, 16 Unions, 7 Interdisciplinary Bodies, and 1 Associate Body. Annex 1 provides a brief summary list of all the topics that were raised by each responding body. The CSPR reviewed and discussed all of the

¹ ICSU’s *National Members* provide a national, multi-disciplinary perspective, and play an important role in facilitating links with National governments and science agencies. The majority of ICSU National Members are scientific academies. ICSU *Scientific Unions* provide expertise and input from an international, disciplinary perspective. They play a crucial role as representatives of the world-wide scientific community. ICSU’s *Interdisciplinary Bodies* focus on specific areas of international research that are of interest to all or many ICSU Members. Their roles vary depending on the area of science and the related needs of the international science community, but usually combine operational and policy/advisory functions.

responses, and decided upon a final list of topics to be recommended to the ICSU Executive Board as possible priorities for future ICSU action. These selections were based upon the criteria described below.

CSPR developed the following evaluation criteria to guide their decision-making in this exercise.

Scientific potential

- * Research areas where significant scientific advances are likely over the next 5 to 10 years and where the necessary resources are likely to be available to enable those scientific advances to take place.
- * Research that responds to scientific needs, generating advances that in turn open up possibilities for other scientific developments or fields.

Collaboration potential

- * Research that requires, or at least will greatly benefit from, international or global collaboration.
- * Research that offers new possibilities in terms of approaches to multi- or interdisciplinary cooperation, in particular to address complex problems with global ramifications.

Potential impact

- * Scientific developments that are likely to result in major benefits to society, whether in the form of wealth creation, improved quality of life, or protection of the environment.
- * Scientific developments that are linked with ethical issues.

Potential for developing countries

- * Areas where developing countries have some advantages in relation to scientific collaboration.
- * Research that offers opportunities for capacity building in key areas for developing countries.

This report provides a brief description of each topic that was selected, including examples of key scientific developments and future challenges for the research community, and an evaluation of the potential roles for ICSU² in addressing these challenges. These evaluations are based in large part upon the ideas suggested by the ICSU family. Some of the issues listed have not been previously addressed by ICSU, while others are already being addressed in ongoing programmes or scoping exercises. Table 1 provides a summary of the current ICSU activities that are relevant to each topic.

The issues are complex and have numerous dimensions of interest to the scientific community, and in many cases, are highly interrelated. The topics presented here are classified into the three broad categories, although some important linkages exist across these categories:

- i. 'Emerging' areas of science that are rapidly developing and promise to offer important opportunities for new understanding and application (*nanotechnology, molecular biosciences, natural and man-made hazards, complex systems science, cognitive neurosciences*).
- ii. Integrated studies of the interactions between human activity and the natural environment (*global change and sustainable development*), including several specific sectors of longstanding concern (*water, energy, health, agriculture, and biodiversity*).
- iii. Cross-cutting issues of interest to all fields of science (*data and information; capacity building and investment in basic science; science, ethics, and society*).

By design, the vast array of ideas that were originally suggested by the ICSU family have been narrowed down and thus are not all reflected in the final list of priorities. However, that all of the original submissions were viewed with great interest, as a valuable 'snapshot' of the ideas, concerns,

² This refers primarily to actions undertaken by ICSU's Executive Board, CSPR, and Secretariat; although in many cases, the broader ICSU family could be involved in the proposed actions.

and priorities that are foremost in the minds of the ICSU family (and by default, of the international science community). The input that was received will be used in a variety of ways, including:

- To identify focus areas for new initiatives, as part of ICSU's ongoing strategic planning process;
- To suggest ideas to ICSU Unions and other bodies for possible new interdisciplinary collaborations;
- To provide input to existing ICSU programmatic or scoping activities;
- To identify future priority themes for the ICSU Grants Programme.

Finally, it should be noted that a few respondents suggested that this type of exercise, aimed at evaluating opportunities and challenges associated with new scientific developments and their societal applications, should become a 'hallmark' ICSU activity, to be carried out on a regular basis and broadly disseminated to policy makers and general public.

I.) 'Emerging' Scientific Issues

NANOTECHNOLOGY

Nanotechnology, the ability to manipulate and control substances at the level of individual atoms and molecules, offers tremendous possibilities for creating new materials and devices, and is expected to have great importance for a wide array of future industries. Nanotechnology is a relatively new field of research, but there is already considerable evidence that further miniaturisation of devices is likely to bring great benefits to computing, communications, observation and intervention in biological systems, and the creation of new materials, to name just a few examples. Nanotechnology research initiatives in Europe, the United States, Japan, and elsewhere show high promise for pushing science towards several new areas of practical return. Some issues that are likely to provide central intellectual challenges to science in the coming years include observations at the level of single atoms and molecules, assembly mechanisms on surfaces, and nanoprobes for single living cells.

The potential roles for ICSU:

Nanotechnology is an interdisciplinary mosaic of diverse topics, and ICSU could contribute to future progress by creating platforms for interaction among the various relevant disciplines and identifying and fostering areas of 'enabling' science. This may include promoting social science analyses of public attitudes towards the various nanotechnology applications, drawing attention to any potential problems or dangers, and encouraging beneficial applications.

The UK Royal Society / Royal Academy of Engineering is currently undertaking a major assessment on the issue of nanotechnology (evaluating state of the science, gaps in knowledge, potential applications, social/ethical implications, etc.), which may provide useful input for future ICSU consideration of this issue.

MOLECULAR BIOSCIENCES

Biotechnology, genomics, and proteomics are now major driving forces in the biological sciences and are increasingly being applied in the study of environmental issues, medicine and pharmaceuticals, infectious diseases, and modifications of food crops. The field of biotechnology is extremely broad, and there are several areas that deserve a special attention:

- a) *The study of the microbial world at a genetic level.* Genomic sequences from bacteria, parasites and viruses are important for the study of evolution and epidemiology of human, animal, and plant diseases, virulence mechanisms, new diagnostic tools, vaccine production, and the development of 'DNA fingerprints' for organisms of economic, agricultural, and health importance.
- b) *Genetically modified organisms.* This issue continues to raise socio-ethical concerns among some segments of the population, but it seems clear that many regions of the world will increasingly rely on biotechnology for food security, an approach that should benefit from the rapid progress in plant and animal genetics and physiology. There is also likely to be continued development and utilization of genetically modified organisms for plantation tree crops, and for the production of pharmaceuticals and vaccines. (Note the recent ICSU report on this topic, *New Genetics, Food and Agriculture: Scientific Discoveries – Societal Dilemmas*).
- c) *Metabolic engineering.* Advances in metabolic engineering and genetic manipulation may lead to the production of intermediate molecules for production of polymers from carbohydrates and other renewable resources. This also may lead to the development of bacterial systems active in hydrogen generation, and thus could play an important role in the development of hydrogen as a fuel source.

d) *The biology and prospective utilization of human stem cells for regenerative medicine.* This constitutes a major challenge, given the hope placed in cell therapy (or combined cell and gene therapy) for treating certain human diseases, and the major advances in cell cultivation technologies that are required.

e) *Utilization of new 'microarray' biochips.* This is rapidly expanding field at the cross-cutting edge of nano-physics and biology, for the study and early diagnosis of human diseases, and for the screening of individually-tailored drugs.

f) *Systems biology.* Developments in the domain of genomics and proteomics, advances in informatics and complex modelling, and new developments in disciplines as far apart as mathematics, molecular genetics, physiology, and analytical chemistry need to be integrated to incorporate all processes of the living cell in a dynamic description, understanding how whole cells, tissues, organs, and organisms work in terms of parameters such as specific gene expression, macromolecular assemblies, and metabolic regulation. This could provide a basis for the true understanding of the complex network of processes that we call 'life'. Systems biology represents a long-term cross-disciplinary challenge that may revolutionize biological, biotechnological, medical, and pharmaceutical research.

The potential roles for ICSU:

ICSU's Advisory Committee on Genetic Engineering and Biotechnology was dissolved at the 27th General Assembly; although in so doing, the importance of this rapidly developing area of science was strongly acknowledged, and it was suggested that ICSU needs to carefully assess where it might best contribute in the future. A Priority Area Assessment (PAA³) scoping exercise supported by relevant ICSU Unions may be an important first step for defining priorities and focal areas. ICSU, working together with other relevant organizations, could facilitate advances in areas such as the following:

- Stimulating closer coordination among relevant disciplines for utilizing recent advances in molecular biology, genomics, and microbial culturing, to identify as exhaustively as possible the world's microbiota, and to establish databanks for specific groups of organisms;
- Organizing training courses, to familiarize scientists, physicians, and engineers from the developing world with the utilization of DNA biochips and with medically-oriented proteomics;
- Bringing together leaders in the various fields contributing to systems biology, to help develop a common language and to design a global research agenda that builds upon current efforts;
- Issuing authoritative statements on scientific progress and social implications in key, controversial issues in the molecular biosciences (such as the recent ICSU report on genetically modified organisms).

NATURAL AND MAN-MADE HAZARDS

Natural disasters pose a serious threat to populations around the world, each year causing thousands of lives lost, millions of people injured or displaced, and billions of dollars in damage. Concern about natural disasters is now coupled with heightened awareness of society's vulnerability to man-made hazards. There are numerous ways in which the scientific community may contribute to reducing society's vulnerability to such events, which can help prevent hazards from turning into disasters. Some examples of critical scientific and technical challenges include:

³ Priority Area Assessments (PAAs) are activities commissioned by CSPR as part of ICSU's strategic planning and review process. For each PAA, an independent panel is convened to evaluate relevant existing ICSU bodies and to provide guidance on future activities.

- Improving our ability to predict events such as droughts, floods, hurricanes, and landslides;
- Strengthening understanding of the basic physics underlying earthquake generation through the integration of new observational tools, and developing engineering responses to reduce the impacts of seismic activity;
- Assessing the potential for increased vulnerability of particular regions to natural disasters as a result of anthropogenically-driven changes in climate and land use.

The potential roles for ICSU:

The PAA report on Environment and Its Relation to Sustainable Development identified the issue of hazards as a priority for ICSU. The PAA Panel concluded that there exists a great deal of knowledge and research excellence on issues such as 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, much of the research is conducted along single-disciplinary lines, and has had a retrospective rather than futuristic view. Thus, they recommended the creation of a new ICSU-led programme on ‘Natural and Human-induced Hazards’ that addresses 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.

COMPLEX SYSTEMS SCIENCE

The development of science over the past century can largely be described as striving to reduce problems to their ultimate simplicity and to understand the fundamental components of a system under study (for example, the fundamental laws of physics, the basic building blocks of matter, the individual components of biological and environmental systems). There will undoubtedly continue to be great advances in observing and describing these ‘simple’ phenomena and structures; yet at the same time, there is growing interest in examining the complex phenomena and emergent properties that arise from the interactions of a system’s components.

Even the most complex systems can exhibit ‘universal’ features, and common themes often arise in studying the dynamics of non-linear systems. By examining the unity of these underlying concepts, investigators of complex, non-linear phenomena are beginning to understand (and in some cases, develop predictive capabilities for) problems once considered intractable. For instance, complex systems science is being increasingly applied to the study of climate dynamics, infectious disease transmission, systems biology, stock market fluctuations, traffic jams, etc.. A cross-cutting challenge for science in the coming years is to continue developing the observational tools and theory to help us probe, characterize, and visualize complex structures and properties.

Developments in complex systems science are being driven by rapidly increasing computational power, and by the convergence of mathematics, physics, chemistry, and biology, as well as fields such as engineering, social sciences, and ecology. An unprecedented level of interdisciplinary cooperation will be needed to catalyze further advances.

The potential roles for ICSU:

Of particular importance for ICSU’s mission will be promoting complex systems science applications that inform public policy, for instance, in understanding and predicting changes in global/regional climate, environmental conditions, social organization, economic developments; and perhaps most importantly, in understanding the relationships among these various issues. ICSU could invite grant proposals and foster multidisciplinary workshops and seminars that address these issues.

COGNITIVE NEUROSCIENCES

Whereas the last ten years of the previous century were dubbed "the Decade of the Brain", it would be equally appropriate to designate the first ten years of this century as "the Decade of the Mind". With the aid of new imaging technologies, the molecular, genetic, and cellular details of neural mechanisms are being unravelled in unprecedented detail and integrated into bigger pictures of the activity of the brain as a whole. Of particular importance is the growing convergence between different levels of analysis; for example, between direct intracranial recording techniques (including empirical data from single neuron recordings) and system-level approaches such as event-related potentials recording and functional neuroimaging.

Such developments may ultimately enhance our ability to account for personal experience in perceiving objects and events, evaluating possibilities and consequences, storing and recalling memories, etc.. Advances in schematic and computer models of cognitive and social psychology are building a broader framework within which we can work towards better understanding and appreciation of human mentality. The ultimate goal of understanding human consciousness in terms of mental machinery remains distant, but we do see beginnings of fruitful cross-fertilisation with realms as disparate as sociology, economics, and philosophy. This has vast relevance for understanding and treating mental illness and ageing-related degeneration, and for understanding of how cognitive functioning is influenced by an individual's physical and social environment. It also raises many questions for medical and societal ethics (note linkage to the topic of 'science, society, and ethics', discussed later).

The potential roles for ICSU:

Mainstream scientific research directions in this realm of inquiry probably need little help from ICSU. They will naturally gain momentum as academic and commercial incentives become ever more visible, and as multidisciplinary research centres continue to develop and exploit new laboratory technologies. ICSU's unique contributions could be to promote critical analysis and wide debate across the many cultures and disciplines with insights to offer; to stimulate conversations across the frontiers of the natural sciences and other branches of scholarship, in order to reconcile and integrate the biological and cultural perspectives on what makes us human; and to examine the implications of this new understanding for legal and ethical responsibilities.

II.) Human-Environment Interactions

GLOBAL CHANGE AND EARTH SYSTEM SCIENCE

The past two decades have seen rapidly expanding efforts by the scientific community to better understand the Earth system (i.e., the coupled atmosphere, ocean, land, biological, and cryosphere system): how it functions, how it is influenced by human action, and to what extent it can be 'managed' by preventative or remedial action. Ongoing improvements in modelling and observational capabilities have driven a breathtaking expansion in our understanding of the Earth system, and this will play a major role in many future scientific developments related to global change and sustainable development (for instance, in tracking diseases and epidemics, or in monitoring agriculture, natural disasters, pollution). Many critical processes, however, are not yet adequately understood. The following are some of the topics requiring continued and/or increased attention in the coming years.

- Characterizing patterns and impacts of land-use changes;
- Understanding interactions among the biosphere/geosphere/atmosphere;
- Understanding how world's ocean affect, and are affected by, a variety of global change processes and human-driven stresses;

- Evaluating the potential impacts of long-term climate change upon shorter-term climate variability, and the repercussions of such changes on food and water security;
- Ensuring that all nations benefit from our growing capabilities for forecasting severe weather and seasonal to interannual climate variations, and for making projections of long-term climate and environmental change;
- Exploring emerging topics such as the impacts of “electromagnetic pollution” on the environment and on environmental monitoring.

The potential roles for ICSU:

ICSU oversees an extensive international, interdisciplinary portfolio of activities related to global change and earth system science, including Assessment Bodies, Thematic Bodies, Monitoring and Observations Bodies, Data and Information Bodies, and Global Environmental Change Programmes⁴, which are jointly co-sponsoring the Earth System Science Partnership (ESSP). ESSP is currently developing new cross-cutting projects focused on the issues of water, food, carbon, and health. ICSU is also involved in two other major initiatives that will enhance our understanding of Earth System Science -- the International Polar Year and the Global Earth Observation System. A recent PAA on Environment and its Relationship to Sustainable Development concluded that these existing bodies are making substantial contributions in many of the research areas mentioned above. ICSU will continue to support such efforts, and will seek opportunities to enhance and expand the current portfolio of activities where needed.

SUSTAINABLE DEVELOPMENT

Sustainable development refers to the goal of integrating economic growth, social/cultural well-being, environmental protection, and values of intergenerational equity. Such integration can focus on scales ranging from local to global. The science of sustainable development seeks to understand the fundamental character of interactions between nature and society, and to use this knowledge to provide for basic human needs while protecting the Earth’s resources for future generations. It is inextricably coupled with global change science, but has a more explicit problem-solving and place-based orientation.

In preparation for the World Summit on Sustainable Development (WSSD) in 2002, UN Secretary-General Kofi Annan proposed that there are five aspects of sustainable development for which concrete results are both essential and achievable: Water and sanitation, Energy, Health, Agriculture, and Biodiversity and ecosystem management (commonly referred to as the 'WEHAB' framework). Not surprisingly, these issues all emerged as major themes in the recommendations from the ICSU family, and each is discussed later in this report.

The potential roles for ICSU:

ICSU, together with several partner organizations, played an active role at WSSD, promoting the contributions of science and technology to sustainable development. Delivering on the promises made at WSSD will be a central goal for ICSU in the coming years. To this end, ICSU has established a Consortium on Science and Technology for Sustainable Development, working together with the Initiative on Science and Technology for Sustainability (ISTS) and the Third World Academy of Sciences (TWAS). An ad hoc Advisory Group has been convened to advise the Consortium on priorities for future activities. This might include, for instance, creating new programmes for observation, research, and assessment; helping to build the capacity of all nations to contribute to S&T

⁴ Assessment Bodies include MA and SCOPE; Thematic Bodies include SCOR, SCAR, COSPAR, CDR, SCL, and SCOSTEP; Global Environmental Change Programmes include IGBP, WCRP, DIVERSITAS, and IHDP; Monitoring/Observations Bodies include GOOS, GTOS, GCOS, and IGOS-P; Data and Information Bodies include WDC and FAGS. Acronyms are defined in Annex 2.

for sustainable development; developing new mechanisms for translating research into 'real-world' policy and action; providing platforms for dialogue and information exchange among different disciplines and stakeholders; and assuring sound scientific input to international policy summits that address various elements of sustainable development.

WATER

Securing adequate and safe water resources is a central challenge facing mankind today, and in the coming decades the number of people living under 'severe water stress' is expected to nearly double. This complex topic encompasses issues ranging in scale from global hydrological cycling to local water resource use. Meeting the water resource needs of agriculture, drinking water and sanitation, industry, ecosystems, and other purposes, presents vast challenges that will likely grow increasingly difficult to address in the face of population growth, economic development, and changing climatic conditions. Some key challenges include:

- Promoting water conservation, water-use efficiency technologies and recycling, including energy-efficient technologies for treatment and re-use of waste water;
- Accelerating the development and application of efficient irrigation technologies;
- Strengthening our understanding of processes at the interfaces in the hydrological cycle (e.g., among atmosphere, soil and land-surface, surface-water, ground water, ocean);
- Understanding how water distribution, circulation, and availability is affected by human activities including land-use changes and consequences associated with global warming;
- Studying processes and use of deep groundwater reservoirs;
- Understanding the social and cultural factors that influence individual and institutional choices related to water resource use, adoption of conservation technologies, etc;
- Applying emerging climate-forecasting capabilities to water resources management.

The potential roles for ICSU:

Because of the highly interdisciplinary nature of this issue, ICSU should be well-suited to coordinate the expertise of various Unions and Interdisciplinary Bodies, to consider the myriad of scientific questions that need to be addressed for sound water resource management. However, ICSU has had problems for decades in trying to find a niche where it can really make a difference on water issues. The Earth System Science Partnership (ESSP) recently began a major new initiative aimed at improving the knowledge of and responsible interaction with all components of the Earth's hydrological systems. The 12th session of the UN Commission on Sustainable Development focused on water as a central priority, and ICSU coordinated the development of a discussion paper for this session. Any new ICSU activities on this topic must fill a unique niche that complements existing ICSU programmes, as well as the activities of other organizations such as the International Water Management Institute.

ENERGY

Energy is a fundamental necessity for almost all aspects of human activity and prosperity. Meeting the world's growing energy needs in an environmentally responsible manner is one of the central elements of sustainable development, and it involves several related challenges: satisfying the current needs of the hundreds of millions of people in the developing world who have little or no access to adequate energy services; meeting the future energy demands of the world's rapidly growing population; and simultaneously finding strategies to significantly reduce the emissions of carbon dioxide and other pollutants that result from the combustion of fossil fuels. Addressing these challenges requires ongoing R&D efforts aimed at:

- Improving energy efficiency and conservation;
- Development of environmentally-friendly, renewable methods of energy generation that reduce dependence on fossil fuels (e.g., continued development of wind and wave energy, solar photo-voltaic, mini-hydro plants, gasifiers, and steam-driven plants);
- Further studies of controlled thermonuclear fusion technologies, and development of next generation, intrinsically-safe nuclear reactors;
- Assessing the feasibility of visionary new technologies, such as power generation by space-based solar cells and its transfer to Earth by microwave radiation.

The potential roles for ICSU:

An ad hoc Working Group was recently convened to analyse possible ICSU activities in the realm of Energy and Sustainable Societies. The Working Group affirmed that ICSU does have an important role to play in addressing this issue, but it is necessary to carefully define the most effective ‘niches’ for ICSU, in light of the numerous existing international organizations that address energy R&D, and other relevant activities such as the proposed InterAcademy Council assessment ‘Transitions to Sustainable Energy’. It was recommended that ICSU should focus on efforts aimed at removing barriers among different disciplines involved in energy R&D, removing barriers to wider use of existing energy technologies, and building international networks among existing national-level energy R&D programmes. The following were proposed as examples of activity themes that ICSU could play a useful role in addressing:

- End-use energy R&D: exploring efficiency improvements with a focus on energy services;
- An international scientific dialogue on the concerns of nuclear power generation;
- Facilitating technology adoption and diffusion in developing countries;
- Advancing techniques for production of alternative transportation fuels from cellulosic materials;
- Building global networks to advance technologies for C capture and storage, H₂ storage, and renewable H₂ sources.

HUMAN HEALTH

The protection of human health has always been a central concern of society and a major focus of scientific research. The types of health threats faced by different societies around the world vary widely, depending upon a country’s level of wealth, food availability, public health infrastructure, and other factors. For instance, infectious diseases and malnutrition are major threats in many developing countries, while cardiovascular disease and cancer are dominant concerns in wealthier nations. Pollution (of air, water, and food), impacts of smoking, alcoholism, and traffic accidents are world-wide health concerns, and the recent SARS outbreak illustrated the global nature of many emerging health threats. The past century has seen countless advances in medicine and public health, including the eradication of some major diseases, and the extension of life expectancy in parts of the world.

Yet there remain a wide array of existing human health problems that are potentially preventable or treatable through better scientific understanding and application of the necessary resources. Some examples of issues that are of immediate and growing interest are drug-resistant pathogens; health impacts of global climate change; ethical issues arising from advances in genetics and cell biology; assessing health risks of genetically-modified food and biopharmaceuticals; and the prevention, cure, and treatment of HIV/AIDS.

Some of the exciting scientific and technical advances related to protection of human health that can be expected in the coming years include:

- Development of new pharmaceuticals and vaccines based on genetically modified organisms and natural products from plants, microbes, and animals;

- Elucidation of the molecular basis for an increasing number of diseases, and based on this understanding, the development of new drugs and disease treatment, including more successful gene therapy techniques for genetic diseases and cancer;
- Improved medical imaging technologies and biosensors for monitoring metabolites in the body;
- Better and faster disease diagnosis using advanced molecular biological and immunological techniques;
- Individualized drug therapy and better definition of genetic factors influencing responses to drugs.

The potential roles for ICSU:

The PAA on Environment and Its Relation to Sustainable Development has identified the subject of 'Health and the Environment' as a priority for ICSU, and ESSP is currently developing a new programme in Global Environmental Change and Human Health. The International Union of Biological Sciences has proposed an initiative together with several other Unions on 'Science for Health and Well-Being'. Given the breadth and complexity of this topic, however, additional activities may be justified. Some additional actions that could be of value are to:

- Work with other pertinent international organizations to address issues related to ethics of human genetic data, the patenting of genomes, applications of advances in genetics, cell biology etc.;
- Provide inputs to the World Health Organization (WHO) and Food and Agriculture Organization on assessments of health risks of biopharmaceuticals and genetically-modified food;
- Support hands-on workshops (in cooperation with WHO, and based on collaboration between Unions and National Members), to promote north-south scientific collaboration and to facilitate transfer of cutting-edge advances related to a wide variety of health issues.

AGRICULTURE, FOOD, AND NUTRITION

Assuring an equitable, sustainable, and healthy food supply for the world's growing population is a complex challenge that involves problems ranging from chronic malnutrition to epidemic obesity. Developing sound policy strategies for the 21st century will require anticipating future changes in demographics patterns, human preferences, global/regional climate conditions, and a host of other factors. Sustainable agricultural practices are essential not only for assuring an adequate food supply, but also for driving rural development and economic growth in many countries. It is necessary to take a more integrated approach to understanding the food chain and the linkages among food demand, production, distribution, consumption, as well as relationship to health and food safety issues. Such a comprehensive approach will require forging new relationships among fields such as the agricultural sciences, food chemistry and engineering, biotechnology, public health, geography, and social science.

Some of the ways in which science and technology can contribute to this issue are to:

- Disseminate technologies for achieving higher, more sustainable food production levels, including efficient irrigation technologies;
- Demonstrate best practices for precision farming, soil management, optimum use of land and water resources;
- Support research in developing fields such as agro-meteorology and agricultural social sciences;
- Evaluate the impacts of global climate changes on agricultural and fisheries sectors, and support the application of seasonal/interannual climate forecasting to agricultural management;
- Build understanding of the social and cultural factors affecting food choice and demand;

- Assess the benefits and risks of functional foods ('nutraceuticals') and supplements;
- Strengthen capabilities to track and respond to problems of agricultural pests, livestock infectious diseases, and food pathogens;
- Continue to investigate the potential for genetically modified plant/crop varieties to produce higher yields, grow in marginal soils (saline, dry, etc.), and provide resistance to pests.

The potential roles for ICSU:

An intergovernmental assessment on 'Agricultural Science and Technology for Development' will soon be launched, and ICSU will be involved in this assessment effort. ESSP recently began a new programme on Global Environmental Change and Food Systems, which is focused on investigating the vulnerability of human food provision and food systems to global environmental changes, and developing strategies to cope with the impacts of these changes. In addition, a new inter-Union initiative on 'The (Healthy, Sustainable) Food Chain' has recently been proposed. Thus, any additional ICSU initiatives on this topic may need to await the further development of these existing activities.

BIODIVERSITY

It has long been recognized that habitat destruction, climate change, and other anthropogenically-driven stresses are leading to alarming declines in biodiversity in many regions of the world. These changes are a matter of great concern, both because of the inherent value of the Earth's biological resources, and because this biodiversity is a foundation for many essential 'ecological services' upon which humanity depends (e.g., provision of raw materials for food, shelter, medicine). Understanding and protecting the Earth's natural variety of genes, species, populations, and ecosystems requires actions such as:

- Documenting as comprehensively as possible the world's microbiota, for the purposes of identifying emerging microbial threats and new species of value for antibiotics, food production, and environmental remediation;
- Improving our understanding of the biodiversity of soil systems, and the potential changes in function and behaviour resulting from external stresses;
- Expanding our knowledge of aquatic and marine biodiversity;
- Developing a sound scientific basis for monitoring changes in the state of the living world, and for assessing global performance against the biodiversity-related targets set at the World Summit on Sustainable Development.

The potential roles for ICSU:

Since its establishment in 1991, DIVERSITAS has developed an international programme focused on understanding how biodiversity affects ecosystem structure and function; on examining the origins, maintenance, and loss of biodiversity; and addressing the challenges of inventorying and monitoring biodiversity. It is worth examining whether the research foci suggested by the ICSU family in this exercise are being adequately addressed through the current portfolio of DIVERSTAS activities. It may be worthwhile to consider further interaction with organizations such as UNESCO Microbial Resource Centre network.

III. Cross-Cutting Scientific Issues

DATA, INFORMATION, AND THE DIGITAL DIVIDE

Data and information are at the heart of the scientific enterprise, and this enterprise is growing increasingly dependent upon electronic communication technologies. Effectively utilizing these technologies, and assuring universal, equitable access to scientific data and digital resources presents an ongoing challenge. Some of the developments that will be of particular importance in the coming years are the following:

- Continued increases in the speed and power of computing systems, leading to further development of technologies for information collection, processing, storage, and dissemination;
- Wider and more broad-band internet access, with increasing numbers of electronic databases, journals, and textbooks, and thus increasing capacity to access educational materials and published research;
- Dramatic increases in the amount and availability of remote observations of the Earth's surface properties, including a variety of geo-referenced data;
- Growing ethical concerns about intellectual property issues and databases containing personal information.

The potential roles for ICSU:

ICSU has several interdisciplinary bodies that deal with issues of data and information management, improving the quality and accessibility of data, and methods to acquire, manage, and analyze such data (including the Committee on Data for Science and Technology, the Federation of Astronomical and Geophysical Data Analysis Services, the Panel on World Data Centres, and the International Network for the Availability of Scientific Publications). At the policy level, ICSU is closely involved in the World Summit on the Information Society (Geneva, 2003 and Tunis, 2005) and is working with other international science bodies to ensure that the needs of science are taken into account in the Summit negotiations. In addition, ICSU is an official partner in the intergovernmental Group on Earth Observations and the Earth Observation Summits— an effort to build a comprehensive, sustained programme for coordinating earth observational data and information.

Some future priorities suggested by ICSU members include:

- To promote more open access to databases, help develop international standards for database quality, and facilitate dialogue on ethics of personal information in databases;
- To promote electronic and open access publication, including efforts to 'retro-digitize' existing scientific literature, and to promote international abstracting of developing country journals;
- To help diffuse relevant new technologies to developing countries and canvas governments to reduce digital divides within and between countries.

A recent PAA on Scientific Data and Information, to be published in 2004, explores many of the issues identified above. The overall conclusions of the PAA are:

- i. ICSU needs to develop a strategy for data and information management across the scientific disciplines and interdisciplinary research areas that looks ahead over a period of decades;
- ii. The management of scientific data demands professional care and attention based on standards, policies, and practices that are common across fields of science;

- iii. ICSU should foster greater communication, coordination and collaboration within and across members of the ICSU family on issues, policies, practices and structures for scientific data management.

There was clear recognition that many of the structures and practices in place today have not evolved rapidly enough to keep pace with new technological and scientific capabilities. Much of the existing data and information infrastructure needs to be modernized or changed, and ICSU potentially has a leading role to play in ensuring this transition.

CAPACITY BUILDING AND INVESTMENT IN BASIC SCIENCE

Capacity building is a broad, cross-cutting issue that deals with the development of human scientific resources, the building of physical and financial resources required for pursuing modern scientific research and accessing scientific information, and communication with policymakers and the general public about the value and contributions of science. These are challenges for all nations, although the types and magnitude of specific needs vary widely among different countries of the world.

A fundamental component of capacity building is investment in both basic and applied science. Support for basic sciences - physics, chemistry, biology, and mathematics- is decreasing in many countries as science budgets are being squeezed, and as the immediate returns from applied research are increasingly viewed as a more attractive investment. An appropriate balance between basic and applied research is necessary for the long-term, as a basis for sustaining the innovations that contribute to society's physical, social, and economic development.

The potential roles for ICSU:

It has long been recognized that ICSU has a unique, critically important role to play in the realm of capacity building. ICSU's Committee on Capacity Building in Science, established in 1993, focused its efforts on promoting science education at the primary level. But ICSU recognizes the need for a broader initiative that is directed toward both individuals and institutions, and encompasses initiatives as diverse as training technicians, informing policy, and improving interaction between scientists and educators.

ICSU is currently undertaking PAA on Capacity Building to evaluate possible future activities on this topic. It is expected that ICSU's Regional Offices (located in Africa, Asia, Latin America, the Caribbean, and the Arab region) will play a major role in promoting and attaining ICSU's capacity building goals in developing countries. In addition, the ICSU Scientific Unions have developed many capacity building activities, and programmes such as START (Global Change SysTem for Analysis, Research and Training) currently contribute to building indigenous capacity, especially in developing countries, through regional research and training activities.

ICSU has also established an ad hoc Working Group to produce a position statement on the value of basic sciences and basic research. Also, ICSU is working with UNESCO and other international partners to consider ways of collaboration in the area of support for basic sciences, including support for UNESCO's new International Basic Sciences Programme.

SCIENCE, SOCIETY, AND ETHICS

The research community has a responsibility to analyze different perspectives on the opportunities and dilemmas that flow from the advance of science and technology, and to consider how these points of view might be reconciled within a global context. Examples include developments in fields such as cognitive neurosciences and nanotechnology; international debates over issues such as genetically-modified crops, energy management, and human embryo technologies; debates between business- and

consumer-led perspectives in the developed world; and the needs of developing countries in agriculture, food, health care, intellectual property and trade. New insights into the roots of these various controversies could be offered to improve communication among the relevant constituencies.

Such analyses need to integrate understanding of the views and values in populations and specific sub-groups within these populations (sociology) with the determinants of individual attitude and perception (social and cognitive psychology, respectively). It is essential, however, that such ventures should not be carried out as a purely theoretical exercise. It requires the active participation of both social and natural scientists if the output is to offer useful guidance for current debates and policy formulation processes.

The potential roles for ICSU:

In relation to the ethics of science, ICSU has historically concerned itself with two issues: ethical aspects of scientific practice (including the universality of science), and ethical responsibilities of scientists in the broader social context. ICSU is conducting a strategic review on 'The Roles and Responsibilities of Science and Society', which will be published early in 2005. This review is likely to recommend an increased role for ICSU in ensuring the universality of science in the face of new challenges (for instance, measures to protect national competitiveness or to guard against terrorism). This review may also propose a new initiative to bring together natural and social scientists and other stakeholders to explore specific issues of concern at the science-society interface.

Table 1. Summary of current ICSU activities related to each proposed focal theme.

(Note: does not include the activities of individual Unions or National Members)

Topic	Relevant ongoing activities within ICSU
<i>Emerging Scientific Issues</i>	
Nanotechnology	--
Molecular biosciences	--
Natural and Man-Made Hazards	<i>existing body:</i> Committee on Disaster Reduction
Complex Systems Science	--
Cognitive Neurosciences	--
<i>Human-Environment Interactions</i>	
Global Change and Earth System Science	<i>existing programmes:</i> IGBP, IHDP, WCRP, DIVERSITAS; ESSP <i>scoping exercise:</i> PAA on Environment and its Relation to Sustainable Development
Sustainable Development	<i>scoping exercise:</i> Ad Hoc Advisory Group on S&T for Sustainable Development
Water	<i>new programme:</i> ESSP Global Water System Project
Energy	<i>scoping exercise:</i> Working Group on Sustainable Energy
Health	<i>proposed programme:</i> ESSP Global Environmental Change and Human Health <i>proposed programme:</i> Unions' Initiative on Science for Health and Well-Being
Agriculture, Food, and Nutrition	<i>new programme:</i> ESSP: Global Environmental Change and Food Systems <i>proposed programme:</i> Union Initiative on the Healthy, Sustainable Food Chain
Biodiversity	<i>existing programme:</i> DIVERSITAS
<i>Cross-Cutting Scientific Issues</i>	
Data, Information, and the Digital Divide	<i>scoping exercise:</i> PAA on Data and Information <i>ongoing programmes:</i> CODATA, FAGS, WDCs, INASP <i>new activity:</i> participation in GEO
Capacity Building and Investment in Basic Science	<i>scoping exercise:</i> PAA on Capacity Building
Science, Society, and Ethics	<i>new activity:</i> Strategic Review on The Roles and Responsibilities of Science and Society.

Annex 1: Summary of Original Responses

The following is a brief summary of the issues that were mentioned by the ICSU National Members, Unions, and Interdisciplinary bodies, in response to the survey sent out in Nov. 2002, and again in Sept. 2003 (see report introduction for the list of survey questions). Some of these responses represent the views of individuals or subsidiary bodies within the listed organization, while others are an official response of the organization as a whole. It should be emphasized that is just a simple 'labelling' of the issues that were raised. Many of these issues were discussed in considerable depth by the respondents. The CSPR evaluated the full, original responses.

National Scientific Members and Associates

Australia

- An environmentally sustainable Australia
- Promoting and maintaining good health
- Frontier technologies for building and transforming Australian industries
- Safeguarding Australia

Belgium

- Popularisation of science
- Scientific guidelines on disarmament
- Environmentally friendly and cheap energy
- Superconductivity and public transport
- Application of physics to biology (in order to, for example, understand complex diseases)
- Methods of non-destructive analyses involving radiation and particle beams
- Quality control of chemical analyses
- Development of physical, chemical and biological methods to treat toxic waste and to clean up land, sea and air
- Human influences on the productive capacity and preservation of land resources
- Biogeochemistry and global change
- The digital divide
- The use of modern mathematics in other disciplines

Bolivia

- Climate change
- Sustainable development
- Water basin management
- Social benefits of biodiversity
- Production and consumption patterns; clean technologies
- ICT
- Traditional knowledge
- Capacity building
- Ethics, moral, and spiritual issues in development thinking

Canada

- Interface between physical sciences, social sciences, and policy matters

Czech Republic

- Strengthening involvement of social sciences
- Demography
- Water
- Natural and man-made hazards
- Sustainable development
- Global change

China: CAST

- Review of guidelines of merit-based assessment and scientific evaluations
- Emergency response systems for acute infectious diseases prevention and control
- Natural and man-made hazards
- Digital divide
- Involvement of social scientists
- Life sciences: proteins
- Capacity building: mathematics education
- Global change: ecosystem monitoring and impact assessment
- Need for a regular mechanism of assessing emerging issues

China: Academy located in Taipei

- Implementing a more robust global public health system
- Strengthening basic science education
- Water in the interdisciplinary context of sustainable development
- 'Integrative physiology', combining molecular biology and physiological function

Egypt

- Capacity building
- Definition of scientific standards
- Production of authoritative statements and reports

France

- Energy
- Neurosciences
- Postgenomics
- Extreme events and meteorological forecasting; prevention, adaptation, and mitigation

Ghana

- Life sciences and biotechnology
- Environment and sustainable use of natural resources
- Energy
- Food security

Greece

- Physics of life sciences
- Science of energy

Guatemala

- Metabolic/biochemical engineering

Italy

- Photobiology

Jordan

- Networking industrialized, transition, and developing countries
- Science for societal needs
- Knowledge divide
- Providing access to scientific results, narrowing the communication gap
- Risk assessment and hazard mitigation
- Earthquake engineering
- New materials incl. nanotechnology, fuel cells, etc.
- Energy utilization and storage
- Weather and climate modelling
- Water recycling
- ICT
- Proteomics and biotechnology
- Natural products and combinatorial chemistry for new drugs, delivery, and screening

Korea

- Human genetics and functional genomics
- Energy

Macedonia

- Sustainable development
- Energy
- Global access to scientific data and information
- Public understanding of science
- Provision of 'seed money'
- Authoritative statements and reports
- Definition of scientific standards

Moldova

- Science for society
- Importance of investment in science and technology
- Energy
- Water resources
- Natural hazards
- Air and water pollution
- Environment and health
- Information society
- Definition of scientific standards

Netherlands

- Systems biology
- Increasing the importance of social sciences and the humanities
- Review of the EU 6th framework programme
- Global change research
- Strengthening collaboration with developing countries

New Zealand

NZ Microbiological Society

- 'Over bureaucratisation' of research
- Science policy and the value of investment in research
- Dialogue between governments and the science community

New Zealand Institute of Forestry

- Detrimental effect of competitive grants
- Publication policy and secrecy
- Wood processing and forest products
- Communicating scientific results to users
- Increasing importance of private sector research

Nigeria

- Biotechnology
- ICT applications in health, agriculture and the environment
- Knowledge divide
- Special emphasis on Africa and NEPAD
- Foresight studies for Africa

Pakistan

- Needs for a technological literate society
- Advances in the agricultural sector
- Water in relation to irrigation and watershed management
- Sustainable forestry
- Science in a globalised world
- Sustainable natural resource management
- Energy

South Africa

- Deploying technology for rural and regional empowerment and poverty elimination
- Implementing a national biotechnology strategy
- Implementing a national R&D strategy for ICT
- Accelerating technical change in advanced manufacturing and logistics
- Using technology to increase knowledge intensity of resource-based industries
- Sustainability related developments as defined at the WSSD (WEHAB issues)
- HIV/AIDS: prevention, cure, vaccines, treatment, associated degenerative diseases.
- Health effects of mobile telephones
- The Extra-Terrestrial and Terrestrial Meteorologic-Electric Environment
- The Square Kilometer Array (radio telescope)
- Biosystematics on the African continent: the inventorying of species
- Spatial optimization of afforested and afforestable areas near rural communities; identification and development of non-wood products
- Continued utilization and development of genetically modified plantation tree crops.
- Genetically modified microorganisms for the production of pharmaceuticals and vaccines
- Biodiversity: Exploiting the potential of extremophilic microorganisms
- Genomics, transcriptomics and proteomics
- Ocean Forecasting
- Climate change: impacts on intra-annual climate variability, and associated repercussions on food and water security

Sri Lanka

- ICT
- Renewable energy
- Biotechnology: DNA fingerprints for organisms of economic, agricultural, and health importance.
- Biodiversity
- Water
- Land use and the environment

- Health: information diffusion on latest biomedical technologies
- Digital Divide: need to increase dissemination/access of publications and traditional knowledge from non-western countries

Sweden

- Biotechnology, physics of life science (which includes the integrated function of the organism in its interplay with the environment)
- Investment in basic and applied science, in connection with other issues such as sustainable development, energy, global change, and capacity building
- Environment and sustainable development issues (global warning, deforestation, desertification, biodiversity loss, water shortage, pollution of land/air/water, etc).

Switzerland

- Knowledge transfer between science and society

United Kingdom

Royal Geographical Society

- Increasing availability of geo-referenced data: capabilities, ethical questions
- improved modelling of climate change impacts: leading to mitigation actions?
- understanding past environmental change:
- understanding of the causes of biodiversity, and hence in our ability to manage it.

UK Royal Society

- Nanotechnology
- Energy efficient water treatment
- Biodiversity: developing a sound scientific basis for assessing global performance against the WSSD goals; and to synthesize existing knowledge and address knowledge gaps

British Neuroscience Association

- Stem cells and the brain
- Interface between neuroscience and physical sciences/computer engineering (e.g. neural networks)

Royal Astronomical Society

- Understanding the nature of dark matter and dark energy

Institute of Food science and Technology

- Science communication (within scientific community and with the general public)
- Animal health
- Food choice, regulation, risk understanding
- Functional foods
- Food pathogens
- Allergenicity
- Water: importance for food production
- Risks from loss of genetic diversity

United States of America

- Capacity building
- Ethics
- Global census of microbial species
- Health consequences of global change
- Impact of demographic changes
- Science of catastrophic events
- Water cycle
- Periodic assessment of opportunities and challenges associated with new scientific developments

Union Members

International Brain Research Organization (**IBRO**)

- Need to increase neuroscience research and education in less advantaged countries

International Union of Biological Sciences (**IUBS**)

- Science for health and well-being

International Union of Food Science and Technology (**IUFoST**)

- Genomics/proteomics
- Biotechnology and consumer trust
- Emerging pathogens
- Public understanding of science
-many other food-related issues

International Geographical Union (**IGU**)

- Ethical issues in relation to increased collection of geo-referenced data
- Global environmental change
- Integrating social and natural sciences
- Science for health and wellbeing
- Application of science to issues of human rights, development and capacity building
- Capacity building and place-based science

International Mathematical Union (**IMU**)

- Digital libraries and electronic access to journals
- Mathematical modelling

International Society for Photogrammetry and Remote Sensing (**ISPRS**)

- Earth Observations: managing and disseminating the data from satellites

International Union of Geodesy and Geophysics (**IUGG**)

- Water
- Earth observations by satellite
- Seismology
- Ethics
- (from **IAMAS**) the need to ensure equitable use of our increasing capabilities for weather, climate, global change predictions.

International Union of History and Philosophy of Science (**IUHPS**)

- History of science
- Teaching of science

International Union of Microbiological Societies (**IUMS**)

- Proteomics
- Awareness of the application of science

International Union of Pure and Applied Chemistry (**IUPAC**)

- Soil fertility and chemical quality under climate change
- Genetic modification of food and crops
- Comparative risk benefit evaluation of plant protection methods
- Benefits and risks of function food, health food, food supplements
- Benefits and risks of biotechnologically produced chemicals

- Disease treatment based on biotech therapeutics
- Valuing human health
- Green chemistry, chemistry and quality of life

International Union of Pure and Applied Physics (**IUPAP**)

- Femtosecond lasers in the x-ray
- From nanoscience to industrial applications
- A global data grid
- Energy through controlled ignition of plasmas
- Dark matter and dark energy
- Discovery of the Higgs boson
- Balance between basic and applied research

International Union of Pharmacology (**IUPHAR**)

- Knowledge divide
- Public understanding of science
- Molecular understanding of diseases
- Individual drug therapy
- Improving drug utilization (optimal prescriptions, greater drug access, behavioral pharmacology)

International Union of Soil Sciences (**IUSS**)

- Genetically modified material in the soil environment
- Salt affected soils
- Survival of pests and diseases in the soil system
- Biodiversity of soils
- Soil resources survey and monitoring
- Communication between scientists and society
- Bioremediation
- Water recycling
- Carbon sequestration
- Soils in climate models

International Union of Theoretical and Applied Mechanics (**IUTAM**)

- Nanotechnology
- Interaction of mechanical and biological systems
- Fluid dynamics of the Earth system

International Union of Toxicology (**IUTOX**)

- Biomarkers for exposure to and on effects caused by chemicals
- Genetic factors which predispose individuals to diseases, triggered by environmental and occupational chemicals
- Biological mechanisms by which chemicals interact to alter the toxicological response
- Genomics to elucidate effects of chemicals on biological systems
- Capacity building in developing countries
- Authoritative reports
- Scientific standards

Union Radio Scientifique Internationale (**URSI**)

- Energy; Space Solar Power Systems
- Managing the electromagnetic environment
- Nanotechnology

- Global mapping of the background of VLF, ELF and ULF
- Health: electromagnetic interference on humans, medical equipment
- Hazards: atmospheric, ionospheric, magnetospheric influences on space- and ground-based services
- Pollution: monitoring and mitigating ‘electromagnetic pollution’
- Energy : power generation by solar-based cells / microwave radiation
- Global change: understanding ionosphere/magnetosphere as part of the earth system

Interdisciplinary Bodies

Committee on Data for Science and Technology (CODATA)

- Economic analyses of data access models incl. open data access
- Standards for data collection and preservation
- Principles for data access
- Societal relevance of scientific research and data
- The digital divide

Committee On Space and Research (COSPAR)

- Availability and access to data
- Capacity building
- Space weather
- Astrobiology
- Radiation belts

Federation of Astronomical and Geophysical Data Analysis Services (FAGS)

- Holistic earth system science

Global Ocean Observing System (GOOS)

- Improved understanding of the Earth system, and need for better earth system models
- Need for more biosphere reserves and marine protected areas
- Sustainable development and management of water and other natural resources
- Role of science in conflict resolution, preserving human rights and promoting the peaceful use of science and technology
- Need for ‘a social contract for science’ (along the lines proposed by the World Conference on Science)
- Improve equity of access to scientific and technical knowledge and to the benefits of science
- Build human and institutional capacities, particularly in developing countries

International Geosphere-Biosphere Programme (IGBP)

- Analysis and modelling of complex systems
- Participatory approaches and global change science
- Integration of monitoring and research – A Global Earth System Observation Network

Intl. Human Dimensions Programme on Global Environmental Change (IHDP)

- Integration of social sciences in ICSU’s programmes
- Science-policy links including synthesis and communication of relevant research
- Linked natural-social systems
- Monitoring of the global system
- Environmental assessments
- Participatory approaches in forming and executing sustainable development policies

Scientific Committee on Oceanic Research (**SCOR**)

- Interaction of the ocean system with human society

Other

EuroGeoSurveys

- understanding complex earth system processes through integrated earth observation, computational modelling, study of past changes

Annex 2: List of Acronyms

CDR	Committee on Disaster Reduction
COSPAR	Committee on Space Research
CSPR	Committee on Scientific Planning and Review
ESSP	Earth System Science Partnership
FAGS	Federation of Astronomical and Geophysical Data Analysis Services
FAO	Food and Agricultural Organization
GEO	Group on Earth Observations
GCOS	Global Climate Observing System
GOOS	Global Ocean Observing System
GTOS	Global Terrestrial Observing System
IAP	InterAcademy Panel on International Issues
ICSU	International Council for Science
IGBP	International Geosphere Biosphere Programme
IGOS-P	Integrated Global Observing Strategy Partnership
IHDP	International Human Dimensions Programme on Global Environmental Change
ISTS	Initiative on Science and Technology for Sustainability
MA	Millennium Ecosystem Assessment
PAA	Priority Area Assessment
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
SPRU	Science and Technology Policy Research
TWAS	Third World Academy of Sciences
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCRP	World Climate Research Programme
WDC	World Data Centres
WHO	World Health Organization
WSSD	World Summit on Sustainable Development



ICSU

International Council for Science

ICSU Mission Statement

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 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.

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