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Capacity-building, education and public awareness, science, and transfer of environmentally sound technology

Report of the Secretary-General

Addendum

Science for sustainable development *

(Chapter 35 of Agenda 21)

Contents

* The present report has been prepared by the United Nations Educational, Scientific and Cultural Organization in accordance with arrangements agreed to by the Inter-Agency Committee on Sustainable Development; it is the result of consultation and information exchange between United Nations agencies, international organizations, interested government agencies and a range of other institutions and individuals.

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I. Introduction

1. The present report provides detailed information on issues related to science for sustainable development (chap. 35 of Agenda 21).[1] It has been prepared in the context of decisions taken by the Commission on Sustainable Development at its third session, in 1995, and by the General Assembly at its nineteenth special session, in 1997.

II. Capacity-building in science, with particular relevance to the needs of developing countries

2. The forces of modern science and technology, if harnessed properly and applied in accordance with each country's particular socio-economic and cultural circumstances, offer immense possiblities for solving many of the complicated problems that are currently impeding economic, social and environmentally sound development in the developing countries. Therefore, the challenge is for developing countries to master modern science and technology as part of the movement towards sustainable development. This should be achieved by first building up their endogenous capacity in science.

3. Despite considerable efforts, many developing countries, in particular the least developed countries, do not yet possess a critical mass of trained personnel in specialized fields and in interdisciplinary approaches related to sustainable development. Efforts must be increased to train specialists in many specific areas of science, including those related to the topical chapters of Agenda 21 (chaps. 9-22). Many countries do not have adequate training facilities at universities or other institutions to prepare scientists and engineers for conducting research related to sustainable development. Similarly, in many countries the research and development institutions necessary to move towards sustainable development are either not in place or lack the resources to function efficiently.

4. Given this state of affairs in a majority of developing countries, it is imperative that their national investment in science, including public sector support, be significantly increased. In this context, strong and concerted international support to build up the scientific community and scientific infrastructures in developing countries in particular the least developed countries, is an urgent requirement. Bilateral and multilateral donor agencies and Governments, as well as specific funding mechanisms, should increase their support for projects in scientific capacity-building in developing countries. Moreover, financial support for the relevant activities of competent international organizations, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the Food and Agricultural Organization of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA), the United Nations Industrial Development Organization (UNIDO) and the United Nations University (UNU), as well as the Third World Academy of Sciences (TWAS) and the International Council of Scientific Unions (ICSU), needs to be considerably enhanced.

5. Although capacity-building in specific scientific and technical fields is of critical importance, as highlighted in the context of the implementation of the different sectoral (e.g., freshwater) and cross-sectoral (e.g., industry) chapters, of Agenda 21, three other areas of capacity-building are equally important and of a strategic nature: (a) the development and implementation of national science and technology policies, paying particular attention to cooperation between the public and private sectors; (b) efficient research management; and (c) interdisciplinary scientific approaches.

6. Developing countries often have a shortage of specialists and inadequate institutional capacity in the art of designing and implementing national science and technology policies. While in most developing countries Governments are still the main investors in national science and technology development, strategies and policies in this respect are undergoing rapid changes in most parts of the developing world, evolving from a centralized system of science and technology policy-making to a multi-stakeholder system of science and technology development. Some of the main questions to be addressed are: What are a country's options concerning the furtherance of science and technology given its particular set of problems? What role should the Government assume and what measures would encourage the private sector both to focus more on knowledge-based development and to support science and technology activities in this regard? What should Governments do in order to ensure that their countries benefit from the global information revolution?

7. Sustainable development is understood as addressing in a balanced manner, the economic, social and environmental dimensions of development. This requires a new approach, including a new national system of innovation defined as a system favouring interaction between universities, research institutions, government agencies and private and public firms (small or large) in order to produce science and technology within national borders for sustainable development. The use of the concept of a national system of innovation as a

framework for policy is an attempt to catalyse a radical departure from the current practice with regard to the role and the status of the sciences, engineering and technology in development. It focuses attention on the introduction of innovations as the key promoter of change. The Organisation for Economic Cooperation and Development has played a major role in promoting the concept of national systems of innovation in industrialized countries. For their part, UNESCO and other United Nations agencies have established programmes which provide assistance to developing countries and countries with economies in transition. These programmes include the provision of advisory services to Governments, the conducting of science and technology policy reviews, and relevant training courses.

8. Efficient management of scientific institutions and of research is another area that is often neglected in many developing countries. For example, FAO concluded from the numerous review and planning missions undertaken over the past two decades that poor management of existing human, physical and financial resources was in many cases the greatest bottleneck to agricultural research in developing countries. Consequently, FAO, the International Service for National Agricultural Research (ISNAR) and other international agencies have developed programmes to build capacities in research management. The primary components of a research management programme are training, consultancy and communication. Some of the major hurdles in developing countries are (a) inadequate management skills among both research and managerial staff of agricultural research institutions; (b) a lack of institutionalized national programmes to remedy the situation; and (c) a lack of awareness on the part of national agricultural research leaders of the urgent need for better management of research. Management training needs to be adapted to regional and country-specific needs. FAO focuses on training the trainers; activities include the preparation of a training manual composed of 10 teaching modules and designed to be used as a basic resource by national trainers when structuring and reviewing their own courses.[2] The problem of research management is, of course, not limited to agricultural research. Consequently, similar capacity-building programmes in research managment are needed for all types of scientific institutions and in all areas of research.

9. A third important challenge with regard to promoting capacity-building for sustainable development is to provide countries with the skills they need to tackle complex environment and development issues through integrated approaches based on interdisciplinary scientific work. The often purely reductionist study of environmental problems in separate academic disciplines is increasingly revealing its limitations. Current disciplinary training and research structures therefore share some of the responsibility for unsustainable development. This is true for developed and developing countries alike. While training aimed at achieving excellence and skills in specific disciplines will continue to be a critical component of capacity-building, predominantly disciplinary training must in future be complemented by greater training in interdisciplinary approaches. This requires breaking down institutional and mental barriers between different disciplinary institutes, departments and faculties, and forging instead close cooperation between them. New types of interdisciplinary training and research institutions or structures within institutions also need to be set up urgently. This capacity-building in support of an interdisciplinary approach is a precondition for reducing the great gaps in knowledge of complex natural processes and interrelations, in particular of the interactions between natural and socio-economic systems. Moreover, it is needed to foster interdisciplinary policy research. Often the information available concentrates on detailed scientific and technical factors, but fails to present available policy options and analyses covering the full spectrum of economic, social, cultural and ecological consequences of each option in a particular territorial or regional context.

10. Within the individual agencies and organizations of the United Nations system, including the World Bank, most scientific programmes incorporating a major capacity-building component have been reoriented towards the new paradigm of action-oriented interdisciplinary science for sustainable development. This has considerably strengthened the scientific basis in such sectors as food, agriculture, fisheries and forestry (FAO), industry (UNIDO), health and sanitation (WHO) and meteorology, operational hydrology and weather forecasting (WMO), as well as in particular environmental areas such as oceans, terrestrial ecosystems and biological diversity, freshwater and the earth's crust (UNESCO and its Intergovernmental Oceanographic Commission (IOC)). The interdisciplinary approach is also supported by an increasing number of national, regional and international advanced scientific institutions, including at the international level, in particular, UNU and the Scientific Committee on the Problems of Environment of ICSU. UNESCO has institutionalized a worldwide network of interdisciplinary UNESCO university chairs on environment and sustainable development.

11. The allocation of national funding for capacity-building in science and sustainable development research is woefully insufficient, in particular in most developing countries. Another very unsettling development is the fact that financial support for international and intergovernmental scientific

cooperation programmes such as those referred to above is stagnating or, in some cases, even diminishing significantly. This reduces, in particular, support for developing country participation in those activities.

III. Global environmental observing systems

12. Pursuant to decisions of their governing bodies, a group of relevant United Nations agencies, in cooperation with ICSU, have started the development of three global observing systems – for the oceans, terrestrial ecosystems and climate. The Global Climate Observing System (GCOS) was the first to be launched. It grew out of such WMO programmes as the World Weather Watch, and is co-sponsored by ICSU, IOC of UNESCO and the United Nations Environment Programme (UNEP). The Global Ocean Observing System (GOOS) is an initiative of IOC and is co-sponsored by WMO, UNEP and ICSU. The Global Terrestrial Observing System (GTOS), launched only in 1996, is co-sponsored by FAO, UNESCO, UNEP, WMO, WHO and ICSU. Each system is guided by a scientific and technical steering committee of scientists established by the co-sponsors. GOOS also has an intergovernmental committee to enhance its policy relevance. The secretariats for the three systems are hosted as follows: for GCOS, by WMO; for GOOS, by IOC/UNESCO; and for GTOS, by FAO. Cooperation between the three systems is promoted though a Joint Sponsors Group consisting of all sponsoring organizations. In addition to the various scientific panels and/or working groups of each individual system, several joint panels have been established to address issues of common concern, such as remote-sensing data needs, climate change, and data and information management.

13. The overall purpose of the three observing sytems is to monitor the climate system, the oceans and the terrestrial ecosystems with a view to managing the environment better now, to forecast how it may change in the future and to provide the basis for sound decisions by policy makers. All three systems are being built on existing national and international monitoring networks. For example, in the case of GTOS the value of terrestrial ecosystem data and information for scientific assessment, development planning and policy formulation will be substantially increased by drawing together existing databases, monitoring sites and networks into a common framework, and by harmonizing measurements and terminology. An immediate specific benefit for all countries, in particular developing countries, deriving from the three systems is that data will be available on seasonal and interannual climate variations, land use changes, coastal protection and marine pollution.

14. The three observing systems also seek to provide necessary long-term data to international assessment processes like the Intergovernmental Panel on Climate Change (IPCC) and international conventions such as the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity and the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa. The Conference of the Parties to the United Nations Framework Convention on Climate Change has requested its Subsidiary Body for Scientific and Technological Advice to consider the adequacy of these observation systems and to report on its conclusions to the Conference of the Parties at its fourth session (Buenos Aires, 1998). All three observing systems necessarily include remote-sensing data gathering and interpretation as a major part of their activities in addition to *in situ* measurements. Hence, major progress is being made in bringing together the global observing systems with the national space agencies through the Committee on Earth Observation Satellites, with particular emphasis on joint strategic planning. In this respect, the development of an integrated strategic plan for the three global observing systems has begun. It is important that such a strategic plan be, in reality, an overarching planning process for the three systems incorporating both space and *in situ* observations, while respecting the specificity and independence of each system.

15. All three global observing systems will pay particular attention to facilitating full access by developing countries to the globally comparable data sets resulting from their work. They will represent a new resource for developing countries in their efforts to formulate national environmental strategies and to develop better policy planning tools. Moreover, the observing systems will help developing countries in implementing international environmental conventions and treaties such as those on biodiversity, desertification and climate change. As part of their activities, the three systems will promote the transfer of environmental assessment and management technology, as well as strengthen the technical capacities of relevant national institutions through such activities as training professional staff in measurement and data handling techniques.

16. The fully fledged development and the long-term sustainability of the three observing systems is, however, at present far from being assured owing to the shortage of both international core funds and support for national and regional activities contributing to the observing systems.

IV. Role of international scientific advisory processes

17. Scientific assessments are increasingly important in policy-making for sustainable development. As the use of scientific advice grows, it becomes more pressing to answer some important questions, such as whether such advice is the best available for a particular purpose and whether it is delivered as effectively as possible and reflects the concerns and needs of policy makers. UNEP has prepared a report on international scientific advisory processes on the environment and sustainable development, which will be made available to the Commission as a background document. The following summary contains some policy-relevant observations from a preliminary version of that report.

A. The diversity of existing processes

18. The role of scientific advice in policy-making is often assumed to be a relatively straightforward matter. That is, scientists first collect data and information as a basis for making assessments. The assessments are passed on to policy makers, who consider them when making decisions. In practice, however, there is a wide variety of scientific advisory processes. At the international level, these processes can be broadly grouped into four categories ranging from those that are intergovernmental policy-making processes drawing extensively on scientific information, to policy-relevant scientific initiatives that are not tied to intergovernmental decision-making.

19. Science-based policy-making processes are created specifically to enable Governments to build a basic policy consensus on an issue which requires solid scientific knowledge. Examples of such processes include the Intergovernmental Forums on Chemical Safety and on Forests. Each was established as a forum of government representatives. Although many participants may be scientists, they are appointed by Governments usually to represent government positions. The Intergovernmental Forum on Forests is seeking to build a policy consensus on the sustainable development of all types of forests. The Intergovernmental Forum on Chemical Safety is working primarily on specific issues such as persistent organic pollutants, within its broader scope.

20. Scientific and technical advisory bodies are most often created by parties to treaties to provide scientific and technical information needed for intergovernmental negotiations and the implementation of treaties. Most, though not all, treaty-related scientific and technical subsidiary bodies fall within this category. This includes the subsidiary bodies of the conventions on climate change, trade in hazardous materials and ozone depletion, as well as on endangered and migratory species. The parties to each treaty appoint representatives to participate in meetings of those bodies, normally in their individual expert capacity, though sometimes also to specifically represent government policy. In all cases, with the exception of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the parties established a formal standing body. In the case of CITES, member States did not establish any separate body, choosing instead to rely on what was provided by national Governments (each of which established scientific authorities in accordance with CITES) and, in particular, existing non-governmental organizations like the World Conservation Monitoring Centre. Another example is the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF). Since the GEF review of 1994, STAP has been an independent advisory body with a secretariat at UNEP headquarters in Nairobi. It is notable for having developed a highly organized institutional structure for providing GEF with advice on scientific and technical matters as well as for reviewing funding proposals.

21. Through assessment processes, the global scientific community is mobilized to establish the current peer-reviewed scientific knowledge on a specific issue including the identification of major gaps in scientific knowledge. Participants are almost exclusively scientists acting in their capacity as experts, rather than government representatives. While most assessment processes are geared towards assisting policy-making or implementation, they are independent of treaty bodies and intergovernmental negotiations. Perhaps the most prominent example of an assessment process is IPCC, which was established under the auspices of WMO and UNEP to assess the state of knowledge on climate change on an ongoing basis. While IPCC provides assessment reports and technical papers and other advice to signatories of the United Nations Framework Convention on Climate Change, it is otherwise an entirely separately constituted body. Over time, IPCC has come to involve many hundreds of experts. The subsidiary processes of the biodiversity and desertification conventions have looked to IPCC as a model for assessments to be undertaken in their own fields.

22. The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is another example of an assessment process. GESAMP is a joint initiative of eight United Nations organizations. Members are appointed in their individual capacity by each of the sponsors.

The aim is to prepare marine environmental assessments and frame them in policy-relevant terms.

23. Increasingly, major assessment reports are being published by intergovernmental organizations, based on processes compiling scientific data and knowledge. Prominent examples of such reports include the *Global Biodiversity Assessment*, the *Global Environment Outlook-1* and the *World Atlas of Desertification* of UNEP; *Critical Trends: Global Change and Sustainable Development*, prepared by the Division of Sustainable Development of the United Nations Secretariat; the *Report on the State of the World's Plant Genetic Resources for Food and Agriculture* of FAO; and the *Global Waste Survey* of IMO. The *Freshwater Resources Assessment* was prepared by the Subcommittee on Water Resources of the Administrative Committee on Coordination, in cooperation with the Stockholm Environment Institute. These assessments vary in scope and depth, ranging from large-scale assessments involving over a thousand people (for example, the *Global Environment Outlook* and the *Global Biodiversity Assessment*) to small groups working in consultation with selected individuals. Given the increasing number of such assessments, it seems important, for future reference, to study the cost-effectiveness of the various methods used in producing these reports.

24. The international scientific community, through non-governmental organizations, has also initiated assessment processes that are policy relevant. Among the most prominent examples of such a process is the work of the Scientific Committee on Problems of the Environment (SCOPE) of ICSU. SCOPE sometimes involves policy makers in its projects, although its activities are never tied to intergovernmental negotiations.

25. In addition to the three categories described above, environmental observing systems draw on scientific advice to collect, collate and disseminate data and information. Although in the past some observation programmes principally addressed scientific concerns, this has begun to change since advisory processes falling into those categories increasingly require, on an ongoing basis, timely information on the state of the environment. Today, three global environmental observing systems exist, addressing climate (GCOS), oceans (GOOS) and land (GTOS). Although each system was established by different groups of sponsoring organizations, they are now closely coordinating their work. Together they aim to provide information on the state of the environment, focusing on both current and emerging policy concerns. GOOS has also created an Intergovernmental Committee to enhance the policy relevance of its work.

B. The need for establishing clear expectations

26. A comparative review of the different scientific advisory processes suggests some significant policy implications relevant both to improving existing processes and to creating new ones. What constitutes scientific advice has changed over the past 20 years. There is an emerging recognition that the complexity of issues related to sustainable development cannot be addressed by the natural sciences alone, but requires an interdisciplinary basis incorporating the social sciences as well as other forms of knowledge. The increasing breadth of knowledge being drawn upon highlights the need for expectations to be flexibly and clearly stated by both scientists and policy makers. Flexibility and clarity are particularly important with regard to the three issues discussed below.

27. *The possibility of scientific consensus*. One of the most difficult and unresolved expectations is whether scientific consensus is a prerequisite for reaching political consensus. The debate on the need to reach a consensus is most heated when assessments on broad issues are required. In this respect, IPCC assessments have been quite controversial in policy-making, while the debate is generally less heated and often quickly resolved on very specific issues. For example, the Montreal Protocol is often hailed as a success because of the scientific consensus achieved on the need to phase-out chlorofluorocarbons and other ozone-depleting substances. Some processes, like the Intergovernmental Forum on Forests, are attempting to pre-empt this discussion by seeking to build first a basic political consensus so as to facilitate subsequent detailed negotiations.

28. *Geographically balanced representation*. Scientific advice must reflect scientific concerns and aspirations from around the world. Balanced geographical representation, with individuals participating on the basis of their expertise, is the goal of any international scientific advisory body. Given that many developing countries do not have experts in all fields, representatives of these countries have simply not participated or have participated on a limited basis only. Even if experts are available in these countries, financial constraints have been a major factor limiting their ability to participate internationally. Few global advisory processes have achieved a true balance in global representation, reflecting the general imbalance in science.

29. *Scientific independence*. The most important factor regarding the ongoing debate about scientific independence is not about separating science from policy-making, but about "intellectual independence". The most successful scientific

advisory processes seem to be those that are recognized as being independent of but not separate from policy-making processes. Various means of ensuring the intellectual independence of experts have been developed. Expert rosters have become increasingly popular since the United Nations Conference on Environment and Development. Rosters aim to balance the need for intellectual independence with the need to maintain a close link to intergovernmental negotiations. All three of the recently negotiated treaties – biodiversity, climate change and desertification – have proposed rosters of experts with knowledge relevant to their treaties. At present, however, all are facing some difficulties due to the debate about scientific independence, the degree of control exercised by the conferences of the parties to the treaties in appointing experts, and their relations with other existing bodies. Since its restructuring, the Scientific and Technical Advisory Panel of GEF has created a model roster of independent experts. STAP has established an extremely detailed set of guidelines governing its roster.

C. Encouraging dialogue between scientists and policy makers

30. In order to establish clarity in the mutual expectations of scientists and policy makers and more effective communication of scientific advice, more dialogue should be encouraged between the two communities. SCOPE's recently concluded project on indicators for sustainable development is a good example. The implementation of this project and the setting of priorities for future action were undertaken jointly by representatives of Governments and intergovernmental organizations and by scientists. Policy makers made clear their concerns and priorities and scientists explained their understanding of the issues. Although there are certainly restrictions on the use of dialogue, it may serve to maintain the intellectual independence of an advisory process and act as an alternative to appointing bodies directly accountable to conferences of the parties to treaties.

D. Capacity-building as a goal of scientific advisory processes

31. The standard approach to building advisory processes is to draw on known experts. In addition, scientific advisory processes could also provide effective mechanisms for scientific capacity-building through "on the job" training of experts and other measures. A larger pool of scientific advisers could be created by rotating the membership and by appointing a small number of well-trained but relatively inexperienced members, who would gain additional experience through participation in the process. This approach may provide a useful means of overcoming the problem of geographical and gender imbalances. The issue of scientific capacity-building in this context has not been studied sufficiently and is certainly untapped in practice.

E. The continued potential for duplication

32. Despite the growing recognition that efforts related to sustainable development need to be coordinated, the relations between the various scientific advisory processes considered in the present report continue to be unsystematic. This is not so critical in the case of certain assessment reports and the more technical advisory processes, concerning for example, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, the Montreal Protocol on Substances that Deplete the Ozone Layer or CITES. While these should not operate in isolation, their narrow topical mandates provide the necessary focus for targeting scientific advice in an appropriate manner. In contrast, the need to coordinate is great regarding treaty-related advisory bodies and assessment processes including, in particular, the biodiversity, climate change and desertification conventions, which often require scientific data and information from the same disciplinary and geographical areas. Most of the coordination between these conventions is pursued on the basis of individual initiative and specific projects rather than any systematic approach. This point has been flagged in several recent reviews. The difficult issue is that, by virtue of their place in intergovernmental structures, these bodies are least likely to be closely linked to each other. At the same time, these agreements are so complex that they will invariably impact upon each other and many other sustainable development related concerns. A future study should consider the issue of potential duplication and propose concrete actions to ensure adequate coordination where areas of scientific advice overlap.

33. Considerable duplication can be avoided simply by encouraging a greater awareness of other existing bodies and similar efforts. A good example of this is provided by the Committee on Science and Technology of the Desertification Convention. At the start of its work, the Committee prepared a number of reports with a view to placing its action in the context of the research and capacity-building in science that was already being done in this field. Bringing such reports to the attention of policy makers and implementers could substantially reduce duplication and pre-empt the difficulties of coordinating already established processes. In

this respect, an important role could be played by intergovernmental organizations.

F. Data requirements for emerging priorities

34. Environmental observations have received less attention from scientific advisory bodies in recent years, yet the data necessary for giving sound scientific advice are often lacking. Most advisory bodies undertake reviews and syntheses using existing data, without devoting much attention to data-collection programmes, yet they often complain about the inadequate or even worsening status of the information base on which they must rely. The global observing systems and related environmental data-collection efforts should be supported since, without adequate data on status and trends, the provision of scientific advice could be seriously hampered.

Notes

[1] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992*, vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[2] *Management of Agricultural Research: Training Manual for Institute Management* (Rome, FAO, 1997).

Annex

Principal scientific advisory processes on sustainable development

The following scientific advisory processes were reviewed for the analysis contained in the present report, which is intended to be illustrative rather than comprehensive. Further details are available in a background document.

1. Technical Working Group of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.
2. Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity.
3. Convention on International Trade in Endangered Species of Wild Fauna and Flora.
4. Scientific Council of the Convention on the Conservation of Migratory Species of Wild Animals.
5. Committee on Science and Technology of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa.
6. Subsidiary Body for Scientific and Technological Advice of the United Nations Framework Convention on Climate Change.
7. Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection.
8. Global observing systems: Global Climate Observing System; Global Ocean Observing System; and Global Terrestrial Observing System.
9. Intergovernmental Forum on Chemical Safety.
10. Intergovernmental Forum on Forests.
11. Intergovernmental Panel on Climate Change.
12. Assessment and Technical Options Bodies of the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer.
13. Scientific Committee on Problems of the Environment of the International Council of Scientific Unions.
14. Scientific and Technical Advisory Panel of the Global Environment Facility.
15. Recent major environmental assessment reports.