Overview of UK National Strategy for Global Environmental Research

Inter-Agency Committee on Global Environmental Change: Report of Expert Panel

1996
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Report of Expert Panel

This is a shortened version of the main report, copies of which are available from the IACGEC Secretariat, at the GER Office, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU, UK.
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Preface

A hundred years ago the Earth was, relatively speaking, sparsely populated by human beings. But our numbers are doubling roughly every 30 years, and this explosion of our population is now driving changes in our physical and biological environment that are potentially damaging and in some cases irreversible. Until we understand them, there can be little confidence either in our ability to recognise harmful changes sufficiently early, or in our attempts to take steps to mitigate them.

Global environmental change is no respecter of national frontiers. No one country, even if it wished to do so, could solve the problems by itself. Both for this reason and because of the sheer size of the task, the problems have to be tackled by international collaborative research programmes and by national programmes that are complementary to each other. It goes without saying that within single countries, every effort must be made to have programmes that are as far as possible mutually supportive, and make sense in a broader international context.

Within the UK work relevant to Global Environmental Research (GER) is carried out or supported by a number of different agencies. They meet regularly at a senior level on the Inter-Agency Committee for Global Environmental Change (IACGEC)* under the auspices of the Office of Science and Technology. That committee set the broad policy objectives for the work of two successive expert groups under the chairmanship of Professor Brian Hoskins. They first reviewed the work that was already in hand in the UK, looking for overlaps, complementarities and possible new synergies. They then set about the job of framing a national programme that on the one hand satisfied the diverse needs of the component agencies and on the other was set in the context of the international efforts on GER. This report is the outcome of their work and, furthermore, takes into account comments arising from a period of public consultation.

There are of course many local environmental problems that are of one sense global because they are widespread, but in another are not, insofar as they can be tackled with local methods to give local relief; traffic congestion, traffic generated health problems, polluted drinking water are just a few examples. Matters such as these fall outside the scope of this report even though they are major concerns for some of its sponsoring bodies, not because they are unimportant but because they are different in kind.

Although I hope that this report will be of interest and value to the scientific community, I hope too that it will be useful to those both in industry and in government concerned with setting policy by giving them an insight both into the problems that we face and into the methods that are being used to tackle them.

Finally, I wish to place on record my gratitude to Brian Hoskins and his two working groups. I believe that they have done an outstanding job and one that will give added coherence to the UK effort in Global Environmental Research, thus allowing all concerned to make use of the resources that are available in the most cost effective way, and to complement the work carried out by colleagues in other countries.

* See over for list of member agencies

Sir Robert May FRS
Chief Scientific Adviser
Office of Science and Technology
Acknowledgement

In its early deliberations Expert Panel II (Annex 1) drew upon the submissions from many senior researchers who responded to a consultation exercise. These were supplemented by further comments on a pre-final draft during and after a consultation conference held in March 1996 at the Royal Geographical Society. Such material was of considerable value and the Expert Panel and IACGEC wish to express their gratitude for the time and effort taken to attend the conference and submit written comments.

Inter-Agency Committee on Global Environmental Change (IACGEC)

Chairman: Sir Ronald Oxburgh KBE, FRS (Rector, Imperial College, London)

Biotechnology and Biological Sciences Research Council (BBSRC)

British National Space Centre (BNSC)

Department of the Environment (DoE) - represents all Government Departments

Economic and Social Research Council (ESRC)

Engineering and Physical Sciences Research Council (EPSRC)

Medical Research Council (MRC)

Meteorological Office

Natural Environment Research Council (NERC)

Office of Science and Technology - Observer
1. CONCLUSIONS

Rationale and scope

1.1 Human actions are altering global-scale environmental properties and processes in ways that have many unknown implications. With projected increases in human population, per capita consumption and global economic trade, the impacts of these actions will grow. Implementing policies for sustainable development requires a better understanding of the dynamic relationships between socio-economic activities and natural systems. We need to know what we are doing to the world, why it matters, and what avoidance actions or adaptive changes are necessary to ensure our future well-being.

1.2 Global environmental research (GER) addresses these issues, by investigating the processes of the integrated Earth system. Its overall goals are to: identify, explain and predict anthropogenic changes in the global environment, in the context of natural variability; assess the potential regional and local impacts of those changes on natural and human systems, including their implications for policy and law; and assist in developing appropriate responses.

1.3 Recent evidence that human-induced climate change is already underway adds urgency to the need for a coherent and longterm national strategy for GER. Furthermore, we now have new research tools and technologies to build on the results already obtained, and we can benefit from recent changes in the international structures that assist in the coordination of the worldwide GER effort.

1.4 The concept of GER is still evolving. In order to make its scope manageable, effort should be focused on environmental problems that cannot be solved on a national basis. GER is both multi- and interdisciplinary, involving many systems operating over a wide range of spatial and temporal scales. Knowledge of the interplay between these different systems, across these scales, is critical to the understanding of global environmental change. GER must involve the full range of social sciences as well as the natural sciences.

1.5 The dynamic properties of interacting, global-scale systems preclude total predictability. Hence, recognising and addressing uncertainty is a key theme for GER. New observational, analytical and theoretical tools provide opportunities not only for major advances in scientific understanding, but also for improved risk assessments, scenario development and policy formulation. Much progress has already been made; for example, with regard to climate change, but many questions remain and complacency must be avoided.

1.6 The UK has achieved scientific excellence in many aspects of GER. These strengths provide an information advantage in a changing world, underpinning many aspects of economic activity and policy development at the national, regional and global level. More than 20 generic priorities (from eight Panels) of the 1995 Technology Foresight exercise are closely relevant to GER.

1.7 The following economic sectors benefit from GER results: food, agriculture, forestry and fishing; energy and transport; water resources; insurance and banking; building and construction; chemical, pharmaceutical and biotechnology industries; pollution abatement, clean technologies and waste management; remote sensing and other instrumentation; defence; health; tourism and leisure; climate prediction and environmental consultancy services.

1.8 Much of the current GER effort has been directly stimulated by interest in global environmental change. However, a wide range of other studies that have primarily been developed for other reasons also contribute to GER. These boundary problems make it difficult for funding agencies to estimate their individual support for GER on a consistent basis, giving rise to associated uncertainties in the national total for GER expenditure. Nevertheless, the estimated current UK effort (£180m p.a.) is similar in scale to that of estimates from other developed countries.

1.9 European and international GER programmes add considerable value to the UK research effort, through coordinated scientific planning, data-gathering, information exchange and integrated analyses. Strong participation in such programmes accelerates research progress,
facilitates access to international funding and other resources, and provides opportunities for scientific leadership; it also enhances national credibility and influence when GER-related international agreements and conventions are prepared.

1.10 The UK is now party to several hundred international environmental obligations and arrangements. Many other international agreements have environmental implications, affecting the rate and patterns of resource exploitation and human development. The effective implementation of such agreements requires commitments by both developed and developing countries, with associated needs for building GER-related research capacity in the latter.

Research directions and priorities

1.11 The pervasive and multidisciplinary nature of GER defies linear analysis or simple compartmentalisation. The conceptual approach proposed by the Panel comprises three perspectives (the human, physico-chemical and biological systems), with research at three levels (underpinning, interactive and systemic research) according to the strength of linkages between components (Figure 1). As GER matures and evolves, the need for new connections between different scientific fields becomes increasingly important. All three levels offer exciting scientific challenges which will depend upon the future involvement of bright young scientists.

1.12 Underpinning GER provides the fundamental knowledge and technological capabilities, often (but not exclusively) on a single-discipline basis. Major uncertainties and new scientific issues continue to emerge in this underpinning category, and satisfactory attention to these issues is the foundation for evolving and maturing work in the interactive and systemic categories. Such work can mostly be considered GER-relevant, rather than GER-directed, since many other areas of human endeavour may also benefit. Priority topics for underpinning GER are identified in the report, based on national needs and expertise. In summary:

- From a human system perspective: relations between industry (including agriculture) and the environment; public perceptions, attitudes, ethics and behaviour; policy development processes; methods for assessing environmental damage and sustainably managing resource systems; the role and effects of international agreements and institutions (including trade agreements); epidemiology and human fertility; technologies for emission abatement and waste minimisation; and the cost-effectiveness of energy efficiency measures.

- From a physico-chemical system perspective: natural variability of atmosphere, ocean and soil; ocean-atmosphere models; radiative behaviour of the atmosphere; chemistry of climatically important gases; land-ocean-atmosphere chemical exchanges; stratospheric ozone and UV-B; improved regional predictions, particularly for extreme events; and data assimilation in models.

- From a biological system perspective: responses to environmental change that link population and community ecology with the physiology and molecular biology of stress tolerance in individual species; the functional role of biodiversity and other properties of biological communities; soil biological processes and their effects; transitional states of communities and ecosystems; and aspects of the natural variability of biological systems.

1.13 Interactive GER involves linkages between at least two of the three main scientific perspectives, investigating how one system affects another. Research on the following interactive issues is considered to be of particular importance for the UK:

- Global change impacts on health, including direct effects of climate change; air and water quality effects; UV-B effects on human health; interactive effects of urbanization; and ecological epidemiology applied to the spread of warm climate diseases and to diseases 'emerging' from non-human hosts.

- Global change impacts on agriculture, forestry and fisheries, including adaptation in the agricultural sector; forestry and global change; the exploitation of marine living resources; and UV-B effects on crops and livestock.

- Land surface properties and processes, including upscaling and downscaling; the incorporation of biologically-mediated processes.
Fig. 1 Research issues in relation to the GER triad.
Blue - Underpinning Research; Green - Interactive Research; Red - Systemic Research
in surface exchange models; and the use of remotely sensed space observations and regional baseline databases.

- **The carbon and nitrogen cycles**, including the role and scale of feedback mechanisms; CO₂ fertilization effects; the ocean carbon cycle; anthropogenic carbon storage and/or enhanced natural uptake; methane sinks and sources; changes in nitrogen transformation processes; the atmospheric role of reactive nitrogen compounds; and impacts of enhanced nitrogen inputs.

- **Changes in coastal systems**, including valuation of environmental assets; the development of effective legal and administrative regimes; assimilative capacity, water quality, and biogeochemical and sedimentary effects; absolute sea level rise; relative sea level change, coastal erosion and flooding.

- **Past global changes**, with emphasis on the Quaternary ice age cycles, and the past 2000 years, including the role of human activities.

1.14 Systemic GER provides the overall framework, building on underpinning and interactive GER to address the 'grand challenges' of Earth system science. Four main integrative themes are identified, as follows:

- **Integrated climate studies**
- **Biogeochemical cycles**
- **Land use and water resources**
- **Ozone and UV-B.**

Scientific issues and future directions relating to these themes are discussed in the Expert Panel report. All four themes are interdisciplinary, bringing together human, physico-chemical and biological aspects of global environmental change. They are also all highly important to UK economic interests and match international priority concerns, with many associated policy and legal developments.

1.15 Building upon and complementing the generic GER priorities outlined above and in the Expert Panel report, support for the following scientific growth points is encouraged, on the basis that their inter-agency stimulation would give highly cost-effective benefits:

- Role of soil processes in global change, with emphasis on microbial diversity, trace gas exchanges, and biological and physical influences on hydrological properties
- Adaptability of organisms and communities to environmental change, giving special attention to the tolerance of extremes of temperature, drought and other physical and chemical factors
- Predictive modelling of the health impacts of global environmental change (climatic and non-climatic aspects), including comparative work that links human, veterinary and ecological perspectives
- Generic problem of using remotely-sensed observational data within models, to derive maximum benefit from new sources of satellite data that will soon become available
- Integrated analysis of resource management problems in the coastal zone, to involve both social and natural scientists
- Biogeochemical modelling, to advance and test our understanding of large scale ecosystem processes and their behaviour under conditions of global environmental change

It should be stressed that such growth points are an integral part of the research agenda encapsulated in the GER triad, and hence are contingent on continued support for other appropriate components in the GER triad.

### Enabling technologies and infrastructure

1.16 GER is highly dependent on large scale observational data. Research aircraft and ships are essential for **in situ** measurements to investigate atmospheric and oceanic processes, and to calibrate space measurements. The increasing availability of Earth observation data from satellites offers many exciting research opportunities. International coordination is essential to ensure that there is maximum scientific return from these high cost technological developments.

1.17 The UK GER effort currently benefits from a wide range of land-based facilities for
Fig. 2 GER interests of research councils, government departments and other funding agencies in relation to the GER triad.
For acronyms see inside back cover
monitoring and experimental work, with relatively well-developed environmental capabilities in public sector laboratories and universities. However, future arrangements for their support are, in many cases, uncertain, and their importance to GER needs to be more explicitly recognised.

1.18 The maintenance of current national observational facilities would provide a basic UK input to the three proposed Global Observing Systems (for Climate, Ocean and Terrestrial Systems). Proposals for wider UK effort will need careful consideration in the context of their potential scientific and economic benefits.

1.19 Progress in modelling (and predicting) global environmental change requires powerful supercomputers, together with facilities for the processing, storage and interactive interpretation of high-volume data. Relatively large investments are needed to maintain such capabilities at the required level.

1.20 In order to make the widest and most effective national use of data resources, it is desirable that data charges for scientific research of a non-commercial nature should be set as low as possible. Such action would also help to maximise the mutual benefit from international data-exchange arrangements.

Communication and coordination

1.21 Those involved in GER need to establish constructive dialogue with the users and beneficiaries of their work, in government, industry, professional bodies and non-governmental organisations. Attention must also be given to addressing the wider issues of public awareness and perception regarding global environmental change, with particular care taken to address uncertainty in a societal context.

1.22 Education and training are essential at all levels to ensure both the future cadre of scientists of the quality required by GER and also a proper basis for informed public debate on complex global issues. The UK has a strong tradition in overseas education and training which, allied to our strengths in GER, provides a sound basis for a leading international role in knowledge and technology transfer.

1.23 The complex nature of the science, and the inter-dependence of funding agencies' interests in GER (Figure 2), present particular requirements for coordination and collaboration. These needs are growing, as integrative links become increasingly important for the efficient development of a national GER programme, both within and between the natural and socio-economic sciences.

1.24 The current structure of the Inter-Agency Committee on Global Environmental Change (IACGEC) is primarily directed at overall policy issues, rather than either scientific development or the involvement of industry and commerce. Many international GER links are at present provided through the Royal Society, as the formal contact point for UK participation in relevant ICSU programmes (World Climate Research Programme, WCRP; International Geosphere-Biosphere Programme, IGBP; and International Human Dimensions of Global Environmental Change Programme, IHDP). In addition there are links between Government Departments/Agencies and various inter-governmental organisations, such as the European Union, World Meteorological Organisation and the United Nations Environment Programme.

1.25 Whilst it may be necessary for separate groups to coordinate national work relating to such programmes, it would seem advantageous to also have a unified forum that can integrate the overall scientific development of UK GER, working closely with the UK GER Office and promoting interdisciplinary, integrative activities.
2. RECOMMENDATIONS

2.1 The UK should build on its scientific strengths in GER by developing a national GER programme of a longterm nature, maintaining total support at least at the current level.

2.2 Funding agencies should indicate how they define GER when providing expenditure estimates. Existing national and international data should be interpreted with caution.

2.3 The UK GER effort should be developed in ways that derive maximum added value from international global change research programmes. The special environmental problems in developing countries should not be neglected.

2.4 A fundamental objective of GER should be improvements in uncertainty assessment and management techniques that integrate technical, socio-economic, socio-political and ethical considerations in the context of the precautionary principle and risk assessment.

2.5 The UK GER portfolio for the next 5-10 years should be based on science of the highest quality and importance. Priority issues for underpinning, interactive and systemic GER are identified in the Expert Panel report, and summarised in 1.12 - 1.14 above. Although wide in coverage, there is already a close match between these subject areas and the GER-related topics identified in the current Forward Looks of the funding agencies.

2.6 Within the total GER expenditure, there needs to be an appropriate balance between the wider support of GER-relevant work (through underpinning research) and integrated research initiatives that directly address global environmental change problems (through interactive and systemic research). GER growth points offer cost effective opportunities to complement the research agenda in the GER triad.

2.7 The funding agencies should direct their coordinating efforts towards the development of work which links the three main perspectives on GER, with particular attention given to any gaps or overlaps that might result from their individual activities.

2.8 The relevant UK funding agencies should collaborate to ensure the future availability of adequate research aircraft and deep sea vessels.

2.9 The UK should continue its strong involvement in all aspects of Earth observation programmes, with emphasis on interpretation of data and their use for model development.

2.10 When considering options for re-structuring public sector laboratories, attention should be given to safeguarding the unique and essential role of many of them for UK GER, through long term strategic research, monitoring and survey, and data management.

2.11 Funding agencies' provision of supercomputing and data-handling facilities must continue to take account of the evolving needs of the UK GER programme.

2.12 Effort should be given to increasing the effectiveness of communicating information, stimulating informed debate, developing partnerships with research users, and providing training on global environmental change at many levels.

2.13 The feasibility of establishing a National Committee for GER should be explored by the IACGEC, the Royal Society and other relevant bodies.
Annex 1 - Membership of IACGEC Expert Panel

**Chairman**
Professor Brian Hoskins  
University of Reading

**Members**
Professor Mike Begon  
University of Liverpool
Professor Robert Gurney  
University of Reading
Professor Peter Liss  
University of East Anglia
Professor Richard Macrory  
Imperial College of Science, Technology and Medicine
Professor Terry Mansfield  
University of Lancaster
Professor Tony McMichael  
London School of Tropical Medicine
Professor Jim Skea  
University of Sussex
Dr Camilla Tolmin  
International Institute for Environment & Development
Professor Kerry Turner  
University of East Anglia

**Secretariat**
Mr Steve Morgan  
UK Global Environmental Research Office
Dr Ian Simpson  
UK Global Environmental Research Office
Dr Phillip Williamson  
Natural Environment Research Council
### Acronyms and abbreviations

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<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>BBSRC</td>
<td>Biotechnology and Biological Sciences Research Council</td>
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<td>BNASC</td>
<td>British National Space Centre</td>
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<td>CCW</td>
<td>Countryside Council for Wales</td>
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<td>CFC</td>
<td>Chlorofluorocarbon</td>
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<td>DoE</td>
<td>Department of the Environment</td>
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<td>DoH</td>
<td>Department of Health</td>
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<td>DTI</td>
<td>Department of Trade and Industry</td>
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<td>DTP</td>
<td>Department of Transport</td>
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<td>EA</td>
<td>Environment Agency</td>
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<td>EC</td>
<td>European Commission</td>
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<td>ECN</td>
<td>Environmental Change Network</td>
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<td>EN</td>
<td>English Nature</td>
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<td>EPSRC</td>
<td>Engineering and Physical Sciences Research Council</td>
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<td>European Space Agency</td>
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<td>Economic and Social Research Council</td>
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<td>FC</td>
<td>Forestry Commission</td>
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<td>FCCC</td>
<td>Framework Convention on Climate Change</td>
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<td>GATT</td>
<td>General Agreement on Tariff and Trade</td>
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<td>GCOS</td>
<td>Global Climate Observing System</td>
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<td>GER</td>
<td>Global Environmental Research</td>
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<td>GEWEX</td>
<td>Global Energy and Water Cycle Experiment</td>
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<td>GOOS</td>
<td>Global Ocean Observing System</td>
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<td>GTOS</td>
<td>Global Terrestrial Observing System</td>
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<td>IACGEC</td>
<td>Inter-Agency Committee on Global Environmental Change</td>
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<td>IACMST</td>
<td>Inter-Agency Committee on Marine Science and Technology</td>
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<td>ICSU</td>
<td>International Council of Scientific Unions</td>
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<td>IGBP</td>
<td>International Geosphere-Biosphere Programme</td>
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<td>IGFA</td>
<td>International Group of Funding Agencies for Global Change Research</td>
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<td>IHDP</td>
<td>International Human Dimensions of Global Environmental Change Programme</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>ISSC</td>
<td>International Social Science Council</td>
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<td>MAFF</td>
<td>Ministry of Agriculture, Fisheries and Food</td>
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<td>MRC</td>
<td>Medical Research Council</td>
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<td>NASA</td>
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<td>UNCED</td>
<td>United Nations Conference on Environment and Development</td>
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<tr>
<td>UV-B</td>
<td>Ultra violet radiation (of wavelength 280-315nm)</td>
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<tr>
<td>WCRP</td>
<td>World Climate Research Programme</td>
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<td>WO</td>
<td>Welsh Office</td>
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