CHAPTER 6

A Forward Look

A. GENERAL PERSPECTIVES

The central message of this report is that scientists have come to recognize the escalating impact of mankind on the world. The principal lesson is that human power to disturb the environment has run ahead of the methods for assessing and responding to the environmental impact of contemporary and prospective human activities. There is a clear and pressing need to put the scientific house in order and to develop the fundamental knowledge on which wiser policies for managing the environment must rest. The conduct of the next few decades will assuredly determine the environment for a century or more, and we believe that the effective communication of scientific knowledge can do much to guarantee its quality.

The tone of this report is one of cautious optimism. There are already many examples of the application of scientific understanding to the wise management of natural resources. More information is needed about the functioning of environmental systems and of their response to the perturbations introduced by human activity. Better communication is needed between scientist and policy-maker. If these needs are met, there is certainly no reason to despair, but neither is there ground for complacency.

Addressed to the ICSU family, this report suggests some of the actions which the world's scientific community might well take over the next quarter century in order to help the human community to move forward in balance with its environment. It takes a long perspective because only recently have human activities become comparable in scale with natural factors in their impact on the world environment. Those impacts certainly will not all continue to grow at the exponential rate many have displayed in the recent past. Equally certainly, however, the proportionate influence of man and of natural factors will continue to change in the direction of human dominance, at least over the next century, when the urban populations in developing countries are certain to expand greatly and when technology will certainly increase human capacity to perturb the cycles and processes of the natural world.

This escalation of human influence during the past few thousand years has been characterized by the development of social philosophies as well as scientific knowledge. Religions have been preoccupied with man's place in the world. The emergence of cosmological and astronomical science placed human society in its position in relation to the vast scale of the Universe. The parallel but later expansion of biological science allowed people to relate the short period of human culture to the long preceding period of organic evolution and emphasized that,

despite recent advances, human societies are still to a considerable extent governed by biological processes.

In this report, Chapter 1 provides a conceptual framework emphasizing some of the dominant features of the natural world. This framework embraces:

(a) the total dependence of life on earth on the sun and on the production of plant matter using solar energy,

(b) the overwhelming importance of the natural cycling of nutrients in the environment and the profound effect of its modification by man,

(c) the increasing capacity of science to control the life cycles of organisms and develop new strains capable of enhanced productivity,

(d) the increasing capacity of medical science to protect human life and alter the balance between man and pathogens, and

(e) the increased capacity of modern man to acquire, analyse, and present information. This capacity allows societies to blend the individual contributions of enormous numbers of individuals on an unprecedented scale, extends human intellectual capacity, and presents the potential for the community to respond as a collective, intellectual entity.

The interactions of man and environment inevitably demand, if they are to be understood, the fusion of many scientific disciplines. The problems of the environment are wider than most that confront individual ICSU unions. They challenge ICSU to respond with similar breadth. It is essential that fundamental scientific knowledge in various specialist disciplines continues to advance, for without real depth of basic information the syntheses undertaken by groups concerned with interdisciplinary problems of the environment will be limited in accuracy and penetration. This report assumes that ICSU unions will continue to promote basic scientific research: we do not, therefore, propose priorities within individual disciplines. We do, however, emphasize that without that support, the integrative activities will have diminished value.

B. MAN AND ENVIRONMENT

The core of our thesis, and the centre point in the future activities of SCOPE, lies in the recognition of a fundamental need to understand the relationship between people and their environment. It is not sufficient simply to analyse the biological and medical factors that limit the reproduction, growth, health, and well-being of individual human beings. We speak in this report of the need to evolve humane and flexible population policies, but these are only a part of the total requirement. The fundamental interaction is between the numbers of people and the activities which those people pursue on the one hand, and the resources of the environment available to them on the other.

The importance of this interaction for human well-being, fitness, physical development, and working capacity has emerged from the studies conducted in the human adaptability section of the IBP for a large number of human groups living in a wide variety of habitats and climatic regions. (The IBP Synthesis Volumes are being published by Cambridge University Press.) This interaction is highly dynamic and it varies from region to region in the world, not only because natural environmental resources vary but also because the activities of people are themselves influenced by history and by cultural and ideological outlook. There is unlikely to be any single ideal human population density, even in regions with comparable environmental conditions, for what is considered ideal is a value judgment moulded by social, historical, and cultural factors. WHO retains the major responsibility for promoting the health of mankind and FAO for surveillance of its nutritional state: SCOPE's contribution might be to inform the choices of the various communities by making available to them a better scientific understanding of the factors which have in the past limited the numbers of humans under natural conditions and of the environmental variables which must to some extent constrain social choice. Options can be stated. How communities respond to those options is a matter for informed choice in the light of the prevailing social, physical, and biological circumstances.

C. ACTIONS IN THE FUTURE

A scientific response to problems of this kind inevitably involves the consideration of environmental variables, aspects of human ecology, and aspects of human thought. All are interdependent as this report shows. In the future there is a clear need for data acquisition processes that will not capture large quantities of irrelevant or low quality information incapable of useful analysis, but will permit critical environmental assessment and evaluation leading through improved communication systems to wiser judgments. The process of modelling is an essential element in the changing human and environmental situations, and is essential feedback to guide the processes of data acquisition. In all these activities, we must recognize that the fields of environmental concern may change. Those into which we have divided this report in Chapter 3 will certainly prove ephemeral and would have been different had we written this report two or three decades ago. On the other hand, we believe that the classification of basic responses we have used in Chapter 4 is likely to be enduring. Processes of problem definition, monitoring, modelling and analysis, risk assessment, evaluation, communication, and social response have characterized human societies for many generations, even if not thus identified in terminology, and will almost certainly be identifiable a century hence.

D. SPECIFIC ACTIONS

We consider that it is essential in the decades ahead that the type of work we have described in this report continues. We see particular need for the following.

(1) Further research on the elemental cycles, especially of carbon, essential plant nutrients, and potentially toxic substances. It is becoming evident, not only that the present composition of the atmosphere and pattern of these cycles is the product of life, but also that many substances commonly treated as pollutants, such as methyl mercury or halocarbons, may occur naturally. Without an understanding of natural cycles and transformations, research findings on pollution will not be easy to interpret.

(2) Critical studies of the relationship between the exposure of organisms to levels of potentially toxic substances and their response. This will increasingly need to benefit from the application of mathematical methods and modelling in order that the biological grounds for the process of risk assessment can become more precise. It will also be necessary to extend work done on the toxicology and ecology of individual species to studies at the ecosystem level.

(3) Ecosystem description, analysis, and modelling. This will continue to be a subject of high priority. It is becoming apparent that it is impracticable to model every component in a complex ecosystem in a deterministic fashion and for this reason probabilistic models are likely to be adopted.

(4) Research on the adaptability of species and of ecological systems. This is important both because of expanding human impact and because ecosystems regulate the character of large areas and even affect global processes. For example, the methane generated in anaerobic wetlands may be an essential regulator of atmospheric oxygen levels. Studies of the resilience or inertia of ecosystems in the face of perturbation, and of the role of a small proportion of key species within them in determining the characteristics of the whole, will gain in importance as areas at present little used by man come under development pressure.

(5) Research related to the inescapable need to improve the food production of the world. This must involve not only the continued application of methods of soil conservation, irrigation, and fertilization, established agricultural and crop protection policies and well-tried genetic methods, but also innovative techniques. Advanced methods of crop and livestock breeding, including genetic engineering, carry with them the possibility of even more profound alterations in the ecology of the world than hitherto. Many areas at present remaining under relatively unmodified ecosystems are in this condition because it has not yet proved possible to crop them in an efficient fashion. As world population increases and the need to enhance food production grows with it, we expect that efforts will be made to develop strains more appropriate to marginal regions and thus expand the area of the globe intensively managed by man. It is important that large and diverse gene pools and an adequate series of protected samples of the world's diverse habitats are maintained as an essential source of such strains.

(6) More thought about the problems of human settlement. Although essentially socio-economic, these problems touch on such issues as the rational use of renewable and non-renewable resources and the improvement of traditional skills and technologies. People's basic biological needs and the factors that limit their adaptability and well-being, will require study along with analysis of means of satisfying the basic needs of adequate shelter and a living environment in which creative potential can be realized.

(7) An assessment of how population growth and development will affect the way in which both the renewable and non-renewable resources of the world are used. As demand increases, and the availability of energy sources alters, resources not at present considered exploitable may come into use. Rising costs are expected to favour the recycling of many materials at present dispersed into the environment as waste. There are likely to be shifts in the balance of resource consumption between nations. Like the issues of human population discussed earlier in this chapter, scientific considerations are only some among the many involved in this complex socio-economic picture. Research aimed at predicting more exactly the potential resources of different areas and developing technologies for the wiser use of conventional and new materials and energy sources will be of paramount importance.

(8) Development of rigorous and objective methods for environmental impact and risk assessment. Those impacts having potentially serious consequences which cannot be predicted precisely at present levels of scientific knowledge, are of special concern. Methods of risk assessment are being developed to meet this need and require further attention. The minimum needs are for methods of determining risk levels, of comparing risks of different sorts, of comparing risks and associated benefits, and for examination of differences between actual risks and perception of those risks. Special efforts are needed to ensure that scientific assessments reach policy-makers and the general public effectively. The aim is to improve the response of societies, in both public and private policy. The study of man's impact on the environment must proceed at many levels. Global studies should be done in partnership among major international agencies and ICSU Committees and Commissions such as COSPAR, SCOR, and SCAR. Regional and local studies should also be undertaken by coalitions of appropriate groups, international and national.

(9) Continued study of man's impact on the climate of the world, and climatic influences and constraints on human activity. The application of mathematical models, employing the very large capacity of modern computers in forecasting and in data analysis will clearly carry with it the possibility of much wider adjustment of human activities to the climatic vagaries of the world. There is also the risk of increased vulnerability to catastrophic events. It is essential to relate studies of man's impact on climate to the studies of likely future energy demand. We foresee a need for much more research on

the processes of interactions between living and non-living systems of atmosphere, land, and ocean, linking climatic research with that on the global cycling of essential elements.

(10) A more considered approach to environmental education within the context of efforts to improve communication between scientists and policy-makers. The need for such education in many countries is unquestioned, but it must not be pursued uncritically. In many countries Universities and Colleges have responded to the widespread demand among young people for a career in environment by creating broad courses which bring together fragments from many subjects. These courses all too often provide superficial acquaintance with the field, without the depth or discipline which make students employable or truly effective. Disappointment and waste of precious human resources result.

(11) Evaluations of the existing genetic diversity of the biosphere, the expected further loss, and the minimum gene pool and recombination needed in order to respond genetically to the likely future changes of the environment.

Many of these activities will need to be pursued by bodies other than SCOPE, and the final selection of SCOPE's own programme will be made following wider discussions within ICSU and with intergovernmental and other organizations so that the scarce resources of scientific manpower in the world can be most effectively deployed.

E. RESPONSIBILITIES OF THE SCIENTIFIC COMMUNITY

This report is inevitably written from the standpoint of a scientific committee of ICSU. However, it must not be forgotten that the strongest links of the scientific community are within respective national social systems, and that scientists must continually respond to national needs (especially in developing countries where there is a critical shortage of expertise). It is through this national experience that SCOPE is most likely to identify priority topics. The national scientific academies presently lack a regular means of exchanging their findings and comparing their judgments on environmental issues. The scientific community as a whole and the policy-makers of individual nations stand to gain from speeding up the flow of information and conclusions among them. SCOPE General Assemblies should provide a forum for the national committees in that effort.

Drawing upon national support, the ICSU unions and scientific committees can make great contributions to the solution of environmental problems through both the application of knowledge and experience to specific problems which permit immediate solution, and the improvement of the basic understanding of physical and biological phenomena. Union activities include pure, theoretical, and applied sciences and contribute to more than one level of scientific achievement.

Environmental problems involve interdisciplinary studies, and it was in order to

promote a better interdisciplinary co-operation within ICSU and to identify those fields of environmental scientific research which individual unions, committees, and commissions could develop, that SCOPE was founded. Looking ahead, SCOPE can continue to provide this synthesis. It must not duplicate studies more logically undertaken by other ICSU bodies or by intergovernmental agencies. For example, it does not seek to embark on an active field programme like the Man and Biosphere programme of UNESCO.

In the future, SCOPE expects to use a series of ad hoc working groups examining the current state of knowledge about selected major issues, such as some of those in paragraphs (1)–(11) of the preceeding section and to publish periodic reports that will aid research and policy at national or international level. Where appropriate, a national committee will take responsibility for organizing a working group with the collaboration of unions and other national committees. The workshops in many instances will need to be supplemented by projects which will mobilize the enthusiasm of young scientists and enhance their capacity to synthesize complex findings and communicate the results. SCOPE thus aims to sharpen expert non-governmental thought about major environmental issues defined within its own organization or referred to it by international agencies. The results of these investigations may be presented in publications and at symposia, bringing together representatives of the relevant ICSU unions, committees, and commissions.

If the practice of interdisciplinary appraisal of salient environmental questions were to be put on a regular basis by ICSU there would be merit in a periodic assessment of the resulting findings and of their implications for national and international policy. The periodic assessment would give coherence and balance to the activities of the ICSU family.

In these two ways ICSU should strengthen its capacity to review environmental questions that cut across the traditional concerns of many member bodies, and to examine major global or regional problems. ICSU could well, through SCOPE or through other bodies, serve as a translator of the considered evaluation of world scientific opinion to users at national and international levels who need such evaluations as a guide to policy.

Evaluations, like the present report, are unlikely to set forward conclusions that will stand for all time. Priorities for environmental research are bound to change. The priorities of one region of the world will differ from those of another and from time to time. In this connection, we would emphasize one general point which emerges from this report. It is that there is a danger in the construction of simplistic global models of environmental problems and interactions. The most productive activity is almost certainly in the production of more local models which relate man, resources, and human activities under the particular circumstances of individual countries or regions. Ultimately, it should be possible to build these local models into a wider, aggregated model for broad regions, if not for the planet as a whole. Future activities should be centred upon the production both of these rigorous local analyses and the development of a more general conceptual framework which will allow their aggregation.

Scientists are not alone in the world and are only some of the specialists in a

complex society. It is clear that the problems of the environment demand the synthesis of the results of many sciences and many specialities. It is equally clear that they will be of little value unless they are communicated to people other than scientific specialists in a fashion that permits careful weighing of the social value of evidence and of probabilities. The environment of the future is not being moulded by scientists but by policy-makers in government at national and local levels who draw on the expertise of scientists, economists, engineers, and many other professionals, but who are also to a very large degree influenced by the history and traditions of the communities in which they live. It would be foolish to assume that the scientist single-handed could revolutionize the thinking of all his fellow men and it might indeed be dangerous were he readily able to do so, for the generalizations of the scientist have not been completely reliable in the past.

The communication between scientist and policy-maker, stressed in this report, should continue to receive a great deal of attention in forthcoming years. This may mean that scientific data, acquired by using rigorous observational techniques and analysed using the advanced skills of the modeller and the capacity of the modern computer, will nonetheless need translating into a format very different from that of the computer program or the scientific paper before they can be used to arrive at judgments in a policy formulating sense. It is likely that both policy-maker and scientist will need to debate together in some depth just how this information can best be presented and appraised. We have no doubt that it is as vital to secure advances in this field as it is vital in the field of basic scientific information capture which has traditionally preoccupied us and our colleagues in the past.