Executive Summary

Environmental risk assessment involves a search for a 'best route' between social benefit and environmental risk. It is a balancing or trading-off process in which various combinations of risks are compared and evaluated against particular social or economic gains. It does not necessarily imply either a no-risk policy or even a minimum one. However, risks should be as fully understood as possible if they are to be effectively managed. Furthermore, the choice of a best route for development inevitably involves questions about the total amount of risk that is acceptable in any one area, as well as the distribution of risks among different sectors of the population.

This report presupposes that a new species of government official is emerging — the risk assessors. It sets out to introduce them to the multifaceted task of risk administration so that, in a world of increasing specialisation of knowledge, they can gain an overview of the scientific, legal, policy and management implications of risk assessment. Its aim is to help develop risk management decisions that are more systematic, more comprehensive, more accountable and more self-aware of what is involved than has often been the case so far.

The word 'risk' has been used in the literature to mean either the *probability* of danger or the hazard itself. In this report, risk means a hazard or danger with adverse, probabilistic consequences for man or for his environment. When used in 'risk assessment' the concept of risk includes not only probability and consequences but also how societies evaluate them. The risks with which this report is concerned are all in some way 'environmental'. They arise in, or are transmitted through, the air, water, soil, or biological food chains, to man. Their causes and characteristics are, however, very diverse. Some are created by man through the introduction of a new technology, product or chemical. Others, like soil erosion or natural hazards, result from natural processes which happen to interact with human activities and settlements.

There are insufficient data on the incidence and impacts of different risks to quantify their relative magnitudes and severity in the world. Even if there were such data they would not give a reliable indication of priorities on a global scale, because it is in the nature of risks and benefits that their relative values are *very differently appraised from country to country.*

The most commonly reported risks in developing countries are primarily those of resource depletion (such as loss of fauna and fish, soil erosion,

overgrazing and deforestation); habitat risks (inadequate domestic water supply and sanitation); and pollution risks (air pollution and industrial waste disposal). These are all risks that can be exacerbated by the development processes of agricultural expansion, industrial development and urbanization.

The dichotomy that is sometimes implied when the population risks of high and low income societies are contrasted, can be misleading. It is increasingly becoming apparent that the assessment of all environmental risks is as urgent in developing countries as in the more heavily industrialized and higher income areas. (Chapter 1)

Modelling the problem is an important decision-making tool even where good scientific data are scarce and the model is simply a qualitative flow diagram showing causes, transmission routes and their effects. It can set the stage for asking specific questions of different agencies and enables the risk manager to keep an overall picture in view. It can also identify information needs and inconsistencies. Indeed, information breaks in the cause and effect chains of environmental models are the rule rather than the exception. Sometimes there are legal or political obstacles to filling these gaps, but even more important is the natural characteristic of the environment to vary in space and time so that it is difficult to separate 'signal' from 'noise'.

Modelling a risk system, even by a simple flow chart, immediately identifies some of the decision-points about what risks to consider in the assessment and what to exclude. For example, a decision has to be made whether risks to human health are the sole criterion or whether risks to the environment are also to be considered. A useful way to make explicit the basis on which the assessment, and eventual regulatory decisions are based, is to develop a check-list of these decisions.

Some of the decisions that need to be on such a check-list, and thereby made explicit to those managing the risks, are:

(1) Are risks from all sources included when the management of any one source is at issue? (e.g. the consideration of the amounts of lead reaching a population through the air, water, soil and biological food chains when standards for any one of them are set).
(2) What are the smallest effects to be included? (premature death, acute disease, behavioural changes, emotional effects?)
(3) What are the longest term effects to be included? (immediate damage, few weeks later, years or generations afterwards?)
(4) Is damage to the environment included and, if so, to what parts of the environment? (domestic animals, wildlife, crops, any plant, the whole ecosystem?)

The assessment process, having specified what the risks are, and which ones are to be considered in calculating the damage, usually also presents a yardstick for measuring them. Even where risks can be quantified, the figures lack meaning by themselves. This 'meaning' is usually provided by comparison of the risk under consideration with:

(1) *'Natural background levels'* of risk (e.g. flood frequency *before* massive deforestation or cosmic and background radiation before man-made sources are added).
(2) *The risk of alternatives* (e.g. different chemically based pesticides);
(3) *Other risks* prevalent in the population or region (often statistically compared in terms of probability of death or injury per exposure); or
(4) *The benefits* associated with the risks (thus higher benefits can justify higher risks). (Chapter 2)

Risk assessment includes three components. These are *risk identification* (the recognition that a hazard with definable characteristics exists); *risk estimation* (the scientific determination of the nature and level of the risks); *risk evaluation* (judgements about the acceptability, or otherwise, of risk probabilities and consequences). After the risk has been assessed, there remains the choice and implementation of intervention, or the decision *not* to intervene.

Risk identification and estimation are both concerned with collecting information on:

(1) The nature and extent of the source;
(2) The chain of events, pathways and processes that connect the cause to the effects; and
(3) The relationship between the characteristics of the impact (dose) and the types of response (effects).

In practice, risk assessment often begins by looking at one part of the problem, usually the source or the effect, rather than considering the system as a whole. This is a pragmatic response to the different ways in which risks are discovered. Once a risk is suspected, it is important to bring together as much available information as is possible before designing ways in which additional data are to be collected.

The selection of techniques requires initial decisions to be made about:

(1) The main methods to be used — monitoring, experimentation and testing, or modelling;
(2) Whether the risks arise principally out of a *technological system,* or through *environmental processes,* or through *human biology and behaviour,* because the appropriate measurement techniques differ according to where in the sequence of cause and effect you wish to measure. (Chapter 3)

In public policy, risk assessments made on the basis of scientific evidence or public alarm, have to be translated into statutes or regulations that can be enforced and, if necessary, stand up in courts of law. It is important therefore for risk managers to be sensitive to the policy and legal implications of the legislation and regulations they may propose. So far national policies have broadly taken one of two approaches:

(1) Specifying *generally* applicable codes and regulations based on what is known about the risks; and
(2) A case by case approach in which the specific circumstances of each situation allow a separate assessment to be made for each case.

The second approach is often rooted in the legal concept of *reasonableness* which has a long tradition in legal systems derived from English common law, in many traditional systems, and often underlies regulatory codes.

In environmental risk control legislation, one of the four different principles are commonly invoked. These are:

(1) *Scientific data* about cause-effect relationships which enable an 'acceptable' level of risk to be set.
(2) *No risk* acceptable at all. This is the zero exposure or zero tolerance rule exemplified by the Delaney clause about carcinogenic food additives in the USA.
(3) *The best practicable means* that can be applied to reduce risks in particular circumstances (usually with regard to cost, technical and manpower constraints and loss of benefits).
(4) *The efficacy* or effectiveness in producing benefits of the product or process that is also producing the hazard.

No matter how good the models and how reliable the estimates, there still remains the important task of deciding the *meaning* of the data collected. Decision-makers are confronted with many stories about risks, but not all of them matter. Tools have been developed to help distinguish between the more trivial risks and the serious ones. These tools include cost-benefit and risk-benefit analysis. (Chapter 4)

One outcome of a complex government machinery with different departments looking after Fisheries, Labour, Health etc. is that information becomes decentralized so that no single person or department has the necessary grasp of the whole picture. This is particularly true of information about environmental problems which fall under every department's area of interest. A way to mitigate this fragmentation is to establish a procedure for compiling a *natural risk profile,* even using, as a first step, simple actuarial data on the number and magnitude of different hazards that have occurred, together with information on their effects and when and where they took place. These data can be used to evaluate trends over time and to establish where the gaps in knowledge are that need to be urgently filled.

The organizational structures, both within and between government departments, and the nature of the links between them and the public, play important roles in risk management. Put simply, most government structures are inadequately designed to manage environmental risks. There are several ways to try to mitigate these problems; the creation of large 'super agencies'; the improvement of coordination between departments; the transformation of departments from purely functional to regional responsibilities; and the development of what are called 'matrix organizations'. (Chapter 5)

Finally, in the assessment and management of environmental risks, no nation is an island. Risk management enters into the relations between nations: some problems are transported across international boundaries by environmental processes and affect neighbouring nations, and in some cases (e.g. DDT and ozone depletion) affect the whole world. Some environmental management decisions taken in one country have repercussions in others because they are economically linked through trade or international aid programmes, or simply because of the dissemination of risk information between scientists of different countries. (Chapter 6)

Less than a decade ago the work that is now being done by international environmental organizations like SCOPE and UNEP would have been considered utopian. Their establishment reflects a growing awareness among nations that the *common interests* of mankind in the face of growing environmental hazards outweigh national or sectoral interests. Looking to the future, we see several directions in which our collective risk management capability needs to be strengthened. These are:

(1) The development and strengthening of national risk management institutions.
(2) At the international level, further developing procedures to exchange scientific information and increase the area of agreement, and thus the prospect for international collaboration on required action.
(3) Developing mechanisms for harmonizing national decisions stemming from environmental assessment.
(4) Integrating environmental management policy more closely with international trade and development policies, particularly to reduce the danger of policies adopted in the name of environmental protection, becoming, in effect, non-tariff barriers to international trade.

From the point of view of scientific risk assessment and from the perspective offered by the present level of environmental risks, it seems only a matter of time before a truly global and urgent risk appears. The more we can get our national and international risk management houses in order, the better prepared we will be.