CHAPTER 5

# *Managing Environmental Risks*

Let us imagine a hypothetical figure, the National Chief Environmental Risk Manager. His task is to allocate manpower and technical resources located in various government agencies to most effectively control the risks in his country. What does he need to know to carry out his task?

First, what are the risks with which he should be concerned? Which hazards cause most damage, and when and where do they occur? Second, which government agency is formally responsible for each of the tasks related to managing each hazard — monitoring, standard setting, enforcement etc. We do not need to go any further to point out that few, if any, countries in the world could adequately respond to their Chief Environmental Risk Manager's most basic information needs for allocating risk management resources.

This chapter begins, therefore, with a description of a management strategy that has not, to our knowledge, been completed anywhere on a national scale and to cover all environmental risks (although the process has started in Sweden). This is the development of a national profile of environmental risks which can enable hazards to be ranked into priorities for different types of action. Once this national risk profile is known, the task of matching risk management tasks to government departmental functions can begin. No management executive starts with a clean slate — he inherits agency structures with their traditional jurisdictions, ways of operating, and areas of expertise. New problems however, often demand changes in procedures and organization. These changes are often resisted by those affected and can ultimately turn out to be harmful if they occur too often or too drastically. The job of the Chief Risk Manager would be to steer a careful course between the needs for rational management of complex problems and the needs of administrative structures for continuity and clearly defined tasks.

Administrative arrangements in national and local government vary enormously around the world. This chapter cannot hope to discuss each one of them in the context of environmental problems. Rather, the route chosen here is to indicate some organizational changes which can enable traditional functional departments to cope with interdisciplinary (and thus interdepartmental) problems. Also discussed are different management tasks to show what is involved in each one and the range of different activities that the tasks collectively involve. Finally the different kinds of management issues that are associated with different environmental problems are described. For

example, those that arise from many small environmental impacts (such as subsistence farming) and a few large impacts (such as industrial developments), with particular reference to developing situations.

## 5.1 DEVELOPING A NATIONAL RISK PROFILE

One outcome of a complex government machinery with different departments looking after Health, Agriculture etc. is that information becomes decentralized and scattered. This is particularly true of information about environmental problems, part of which fall under almost every department's area of interest. The net result is that data, even on the statistical incidence of different risks, do not become assembled together. Thus any cross-hazard analysis becomes difficult and the ordering of priorities for action is done without a sound understanding of the relative magnitudes or effects of different problems.

One way to counteract the division of information is to establish a procedure for compiling a national risk profile. As a first step, simple actuarial data on the number and magnitude of different hazards that have occurred in the country can be compiled from any services available — official and private records held in different organizations, newspaper reports, private journals and log books, and even folk records. From such sources a picture can be built up of the

— numbers of events
— their magnitude and effects
— where and when they took place
— who the victims were etc.

Assembling these data over time provides information on trends over time in their various characteristics.

In many countries this kind of exercise will produce as many gaps in knowledge as acceptable data. It will be found that basic information on some risks is simply not known. This is, in itself, useful since the gaps can indicate priorities for (a) information searches, such as research and monitoring, and (b) administrative changes to ensure that aspect of the problem is covered by someone. The orderly arrangement and portrayal of what data are, and are not, available is a valuable first step towards a national data bank for environmental risks.

Since much of these data will be held by different government departments and non-governmental agencies, one route towards collecting them is to ask each agency to set out the risk profiles for their own area of jurisdiction. This will generate sectoral profiles and priorities, such as for workplace risks, agriculture, foodstuffs and industrial processes. From these sectoral profiles, a national data base on risks, together with priorities for action can be developed using interdepartmental committee structures, centralized planning agencies or specialized risk assessment advisory bodies, according to normal government procedures.

Figure 5.1 Data sheet for compiling a risk data base

| Environmental risk characteristics \ Management capabilities | WHAT IS OUR STATE OF KNOWLEDGE? | | | | | | | | | WHAT IS OUR MANAGEMENT CAPABILITY? | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Do we know anything? | Are probability estimates available | *Are measurements available?* — field | — laboratory | Has it been modelled? | Was this anticipated? | Who knows about this? | Where has there been similar experience | What is likely public/ political response? | *What resources do we need to find out/respond?* — emergency response | — legislative authority | — technical/equipment | — manpower | — financial | *What resources do we have?* — emergency response | — legislative authority | — technical/equipment | — manpower | — financial | Which government agencies have jurisdiction and capabilities in these areas? |
| SOURCE — what are sources/causes<br>— who is responsible<br>— what are initiating events<br>— when do they occur<br>— where do they occur<br>— what events have already happened | | | | | | | | | | | | | | | | | | | | |
| PATHWAYS — what are environmental pathways<br>— how fast does risk travel/ develop<br>— what transformations take place (chemical/physical)<br>— does risk diffuse or remain focussed | | | | | | | | | | | | | | | | | | | | |
| EFFECTS — what are/will be beneficial effects<br>— what are harmful effects<br>— are effects reversible/ irreversible<br>— are effects chronic/acute<br>— are effects teratogenic/ mutagenic<br>— what are dose-effect relationships<br>— where are effects felt (geographically)<br>— where are effects felt (demographically)<br>— what are harmful environmental effects<br>— what evidence for synergistic effects | | | | | | | | | | | | | | | | | | | | |

One example of a 'knowledge inventory sheet' for describing the state of the art in environmental risk management is given in Figure 5.1. This is suggestive of how the data gathering might be arranged rather than a model that is being used in any specific country. Such a sheet would ideally be filled in for each major hazard within a country. The implications for establishing research programmes, monitoring systems and organizational changes can then be discussed on the basis of such compilations of knowledge.

The task of collating risk data is thus a twofold one:

(1) To describe, for each risk, what is known about it (such as indicated in Figure 5.1)

(2) To develop a 'national risk profile' or list of major risks affecting the country together with priorities for action.

## 5.2 INSTITUTIONAL ARRANGEMENTS

The organizational structures, both within and between government departments, and the nature of the links between them and the public, play important roles in the risk management process. Both are related to the basic 'style' of risk management and government generally.

Environmental risks are characteristically multidimensional problems which cut across the normal jurisdictions of government departments. Put simply, most government structures are inadequately designed to manage environmental risks. Rarely if ever, are the different technical specialists found within one department that are required to deal with, for example, a pollution risk caused by industry and passing through the air, water and soil to be ingested by plants and animals and eventually through agricultural products to man. More likely, these areas of expertise and administrative jurisdiction fall within several departments such as Labour, Trade and Industry, Environment, Water Resources, Agriculture and Health.

In the UK, for example, the chief risk management authority, the Health and Safety Executive, is linked to Parliament through a somewhat awkward arrangement of three ministers (Employment, Environment, and Industry; though the Employment Secretary is normally the most actively involved). When it comes to important planning decisions involving an element of technological risk, the Environment Secretary is responsible, but for energy related matters, both he and the Energy Secretary will be involved. In practice, however, major decisions involving more than two departments of state will be made by Cabinet Committee or full Cabinet. Matters relating to toxic chemicals are dealt with by the Department of Trade, or Agriculture, Fisheries and Food. In each case a whole series of coalescing advisory bodies are normally involved, all working in close association with the private sector who are often creating the very problems needing regulation. Independent appraisal is coopted also on a confidential basis. So relationships to Parliament are good but controlled, and the opportunities for full independent scrutiny limited (but not absent) while the public is usually kept in the dark.

Table 5.1 summarizes the number of government agencies in developing countries which have responsibilities for specific aspects of the environment. Almost every country listed has several government agencies sharing overall responsibilities for some environmental problems. Natural resources, particularly water, soil, flora and fauna are typically shared between 3 to 5 agencies. Water for example commonly falls under the jurisdictions of Agriculture, Forestry, Irrigation, Public Works, Industry and Rural Development. A few countries, notably Ghana, India, Israel, Ivory Coast, Philippines, South Africa and Thailand have overlapping interests in government agencies to the extent that 10 or more departments may be involved in managing one environmental problem.

Part of the rationale for these multidepartment organizational structures lies in the different tasks that need to be undertaken to manage 'one problem'. Take, for example, the control of pesticides. Table 5.2 illustrates the eleven separate tasks required by different national legislation for countries in the Asian-Pacific region. These include monitoring of the environment and food, licensing of manufacturers, chemical formulae, dealers and applicators, registration of pesticides, analysis and import controls. The number of enforcement agencies ranges from one in Papua New Guinea and Thailand to six in the Republic of China-Taiwan. Figure 5.2 gives examples of two of these national organizational structures for pesticide control, Taiwan and Canada. The Canadian structure is complicated by a parallel set of departments and committees at the regional (provincial) level to those of the federal government.

Where different agencies are involved together several administrative problems may arise:

(1) Uncertainty may exist about exactly which agency should take responsibility so that no action is taken, or it is delayed.
(2) Interdepartmental rivalries and jealousies may result in information being withheld between agencies which needs to be shared in order for the best solutions to be found.
(3) Each agency tends to have its own particular interests and constituency of political and public support so that interagency conflict may ensue, rather than cooperative problem solving.
(4) Technical expertise may be too divided between different agencies to enable any one of them to put together the needed scientific and managerial team.

These organizational issues arise not only at the national level but can be exacerbated by similar cross-jurisdiction problems at regional and local levels. They also occur within political decision-making structures. For example, in the USA the Congress Committee organization can lead to differnt parts of the same legislation being worked on by different committees so that the resulting Acts may not be coherent. Legislation covering pesticides regulation, for example, comes under the concern of the House and Senate Committees of Agriculture, Commerce, Merchant Marine and Fisheries and the Government Operations Committee.

Table 5.1 Numbers of National Government Agencies with Environmental Responsibilities in 63 Developing Countries (data abstracted from Johnson, Johnson and Gour-Tanguay (1977))

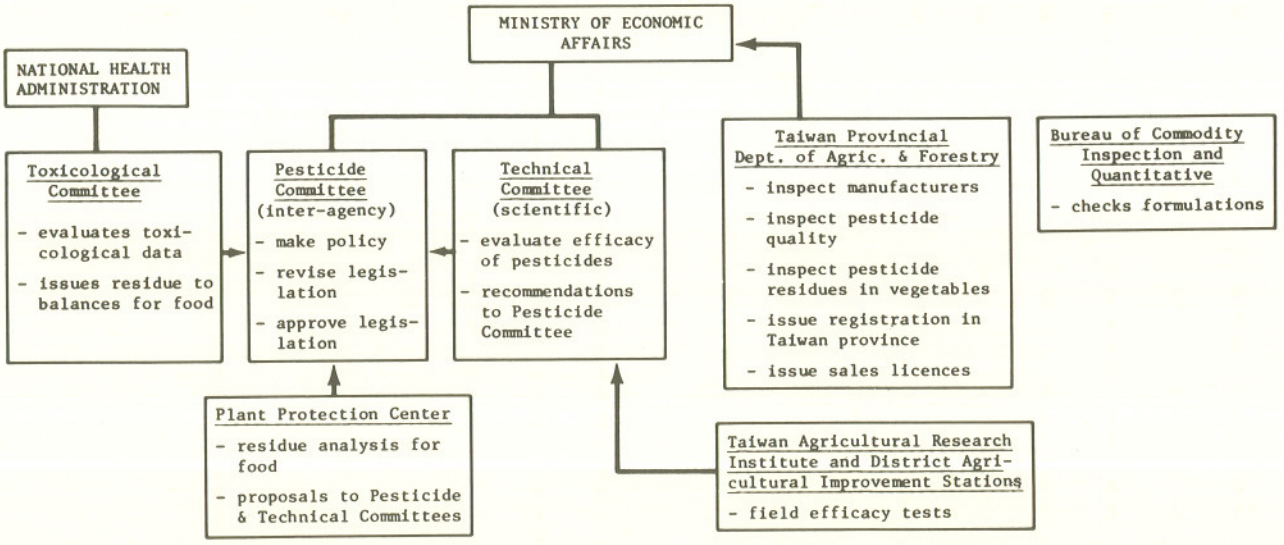
| | General Policy | Air | Water-fresh | Sea Water | Soil | Fauna & Fish | Flora & Forest | Non-renewable resources | Noise | Solid Waste | Hazardous Substances | Land Use Planning | Habitat | Economic Development | Protected Areas | Environ. Modif. | Population | Envir. Education |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Afghanistan | 1 | | 4 | | 1 | | 1 | 4 | | | | | | | | | 1 | |
| Algeria | | | | | 1 | 1 | 1 | | | | | | | | 1 | 1 | | |
| Argentine* | 10 | | | | | | | | | | | | | | 1 | | | |
| Barbados | | | | | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 |
| Benin | | | 1 | 1 | | 1 | 1 | | | | | 1 | | | | | | |
| Botswana | | | 2 | | 1 | 3 | 2 | 1 | 1 | | | 2 | | | 3 | | | 1 |
| Bulgaria | 1 | | 3 | | 1 | 2 | 4 | | | | 4 | | 1 | | 8 | | | |
| Burma | 1 | | 1 | 9 | 1 | 2 | 1 | 1 | | | 1 | | 1 | | 3 | | | |
| Burundi | | | | | | | | | | | | | | | | | | |
| Cameroun | | | 1 | | | 2 | 2 | | | | | | | | | | | |
| Central Africa | | | 4 | | | 3 | 3 | | | | | | | | 3 | | | |
| Chad | 3 | | | | | | | | | | | | | | 3 | | | |
| China (Taiwan) | 1 | 1 | 1 | | 4 | | 2 | | | | | 3 | 2 | | 5 | 1 | 5 | 7 |
| Congo | | | 2 | | | | 5 | 2 | | | | | | | 1 | | 2 | |
| Cyprus | 3 | 4 | 4 | 2 | 3 | 4 | 2 | 2 | 1 | 1 | 4 | 1 | 4 | 1 | 1 | 1 | | 6 |
| Egypt | | | | | 1 | 3 | | 1 | | | 1 | | 1 | | | | 1 | 2 |
| Ethiopa | | | 1 | | 1 | 2 | 2 | | | | | | | 1 | 2 | | 1 | 1 |
| Gabon | | | 2 | 2 | | 4 | 2 | | | | | | | | 4 | | | |
| Ghana | 1 | | 9 | | | 3 | 2 | 3 | 1 | 3 | 7 | 10 | 1 | | 1 | 3 | 1 | 2 |
| India | 2 | 9 | | 2 | 9 | 2 | 1 | | 1 | | 3 | | 2 | | | 1 | | 2 |
| Indonesia | | 1 | 1 | 1 | 5 | 3 | 4 | | | | | | | | 6 | | 1 | 3 |
| Iran | | | 2 | 1 | 3 | 2 | 2 | 2 | | | 1 | 1 | 1 | | 3 | | 1 | 3 |
| Iraq | 1 | 3 | | 2 | 2 | 3 | 1 | | | | | | | | | 1 | | 1 |
| Israel | 1 | 2 | 4 | 5 | 1 | 1 | 5 | 10 | 2 | 2 | | 16 | 4 | 3 | 5 | 3 | 1 | 4 |
| Ivory Coast | 2 | 3 | 8 | 10 | 2 | 10 | 9 | 4 | 3 | 3 | | 1 | 5 | 4 | 5 | 3 | 1 | 4 |
| Jamaica | 2 | 2 | 6 | 4 | 2 | 2 | | 1 | | | | 1 | 1 | | 3 | | 2 | 5 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jordan | 1 | | 3 | 3 | 1 | 1 | 1 | 1 | | | | 1 | 4 | 1 | 1 | 3 | 2 | 3 |
| Kenya | 1 | 1 | 1 | | 2 | 7 | 1 | 1 | | | 4 | 1 | 2 | 1 | 1 | 1 | 2 | 2 |
| Korea (South) | 12 | | | | | 2 | | | | | 3 | | | | 5 | | | |
| Kuwait | | | | | | | | 1 | | | | 1 | | 1 | | | | 1 |
| Liberia | 1 | | 2 | 1 | 4 | | 5 | 3 | | 1 | | 1 | 2 | | 2 | | 1 | 5 |
| Lybia | | | | | 1 | 2 | | | | | | | 1 | | | | | |
| Malawi | 1 | 3 | 1 | | 1 | 3 | 1 | | | | | 3 | 1 | 1 | 2 | 2 | 1 | 2 |
| Malaysia | 4 | | | | 1 | 8 | 6 | | | | 1 | | 7 | 1 | 4 | | 2 | 4 |
| Mali | 1 | | 2 | | 1 | 1 | 2 | | | | | | | | 1 | | | |
| Mauritania | | | 1 | 1 | | 1 | 1 | 1 | | | | | | | 1 | | | |
| Morocco | | | 1 | | 3 | 5 | 4 | | | | 1 | | | 1 | 2 | | 1 | 1 |
| Nepal | 1 | | | | | 1 | 2 | | | | | | | 1 | | | | |
| Niger | 3 | | 4 | | 4 | 3 | 1 | | | | 1 | | | | 2 | | | |
| Nigeria | 2 | 1 | 2 | | | 2 | 2 | | | | | 1 | | | 1 | | 1 | 2 |
| Pakistan | | | 3 | | 1 | 3 | 2 | 6 | | | 1 | | | | 3 | | 4 | 1 |
| Philippines | 5 | 3 | 4 | 2 | 1 | 4 | 6 | 1 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 4 | 3 |
| Qatar | | | 2 | 2 | 1 | | 2 | 2 | 1 | | | | 4 | | 2 | | | 1 |
| Salvador | | 3 | | | | | 1 | 2 | | | | | | | | | | |
| Saudi Arabia | | | 1 | | 1 | 1 | 1 | 1 | | | | | | | 1 | | | 1 |
| Senegal | | 2 | 3 | 3 | 1 | 5 | 3 | | | | | | | | | 6 | | |
| Sierra Leone | | | 1 | 1 | 1 | 4 | 2 | 4 | | | | 1 | 1 | | | | 1 | |
| Singapore | 1 | 1 | 2 | 1 | | 1 | 1 | 1 | | 1 | 2 | 2 | 2 | | 4 | 1 | 2 | |
| Somalia | 1 | | 1 | | | 3 | 2 | 1 | | | | | | | | | | 1 |
| South Africa | 6 | 12 | 9 | 11 | 8 | 15 | 7 | 5 | 8 | 1 | 4 | 11 | 6 | 1 | 21 | | 3 | 10 |
| Sri Lanka | 2 | | 2 | 3 | 2 | 5 | 5 | | | | | | | | 8 | | 1 | 1 |
| Sudan | | | 3 | | 3 | 4 | 2 | | | | | | | | 4 | | | 3 |
| Swaziland | | | 1 | | | | | 1 | | | | | | | 1 | | | |
| Tanzania | | | 3 | | 2 | 5 | 3 | 1 | | | | 3 | 3 | 2 | 5 | | 1 | 4 |
| Thailand | 2 | 1 | 2 | 1 | 3 | 7 | 3 | 3 | 2 | 2 | 5 | 4 | 3 | 3 | 2 | | 4 | 4 |
| Togo | | 3 | 3 | 5 | 1 | 5 | 3 | 3 | 3 | | | 1 | | 3 | 7 | | | 1 |
| Trinidad & Tobago | | 1 | 1 | 4 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | | 2 | |
| Tunisia | 1 | | 1 | | 1 | 2 | 1 | 2 | | | 1 | 1 | | | 2 | | 1 | 3 |
| Uganda | | | 1 | 4 | 2 | | | | | | 2 | | | 1 | 2 | | 1 | 1 |
| Upper Volta | | | 3 | 3 | 1 | 3 | 4 | 3 | | 2 | 1 | 4 | | 3 | 3 | | 2 | 2 |
| Yugoslavia | 1 | 2 | 4 | 4 | | | | 1 | 3 | 3 | 3 | 1 | 1 | | 4 | | 1 | 1 |
| Zaire | 2 | 2 | 5 | 2 | 4 | 5 | 5 | 4 | 2 | 3 | 2 | 5 | 5 | 5 | 3 | 2 | 4 | 3 |
| Zambia | 1 | | | 2 | 4 | | | | | | | 1 | | | 1 | | 1 | 2 |

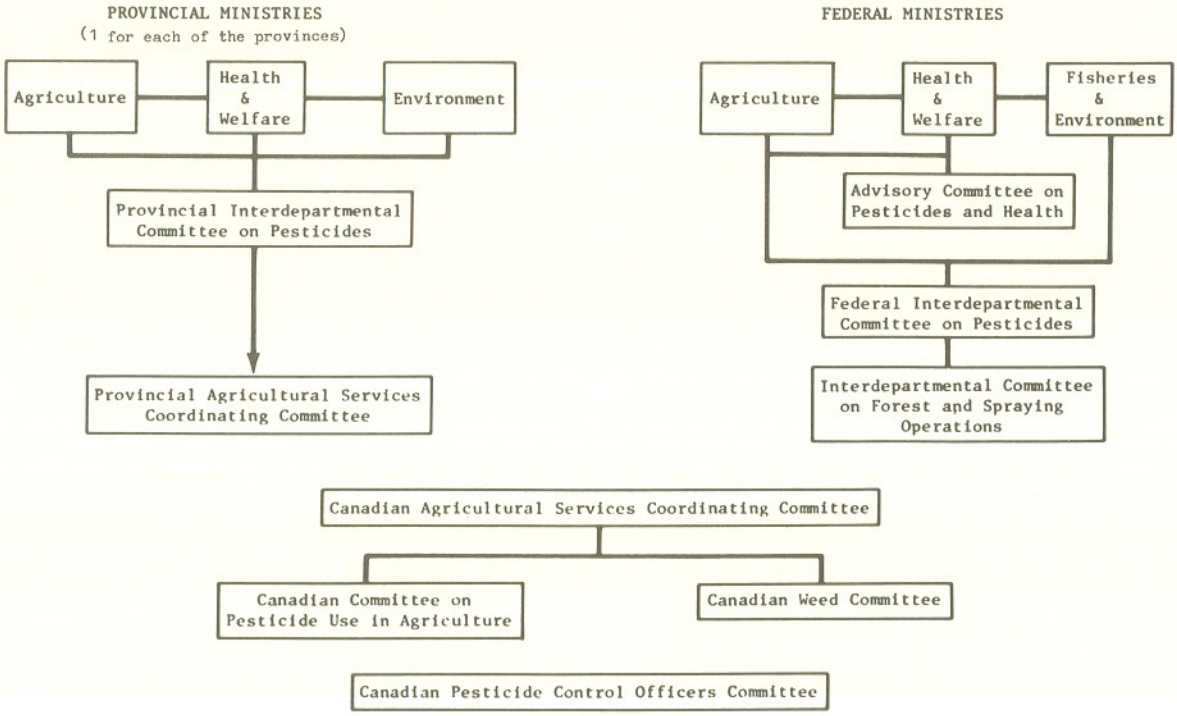
Key: 3 — number of government agencies responsible (including major departments within agencies); blank — no agencies reported
* data for freshwater in Argentine missing

Figure 5.2 Organisational structures for pesticide control in the Republic of China-Taiwan and Canada

A. ORGANISATIONAL STRUCTURE FOR PESTICIDE CONTROL IN REPUBLIC OF CHINA-TAIWAN



B. CANADIAN ORGANISATIONAL STRUCTURE FOR PESTICIDE CONTROL




Industry

Canadian Agricultural Chemical Association
Canadian Manufacturers of Chemical Specialities

Advisory and Research Bodies

Agricultural Pesticide Society
National Research Council Associate Committee on Agricultural and Forestry Aviation
NRC Associate Committee on Scientific criteria for Environmental Quality

Table 5.2 Pesticide Legislation in Countries in the Asian-Pacific Region

| Present legislation requiring: | Country | | | | | | | | | | | | | | | | | | Total no. countries surveyed having legislation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Australia | Canada | China-Taiwan | India | Indonesia | Iran | Japan | Korea | Malaysia | New Caledonia | New Zealand | Niue | Pakistan | Papua New Guinea | Philippines | Thailand | Tongo | USA | Guam | |
| Registration of pesticides | x | x | x | x | x | x | x | x | x | x | x | o | x | x | x | x | x | x | o | 17 |
| Guaranteed analysis of pesticides | x | x | x | x | x | x | x | x | x | o | x | o | x | x | x | x | o[1] | x | o | 15 |
| Import controls | o | x | x | x | x | x | x | x | x | x | x | o | x | x | o | x | o[1] | x | x | 15 |
| Licensing of manufacturers | x | x | x | x | x | o | x | x | x | o | o | o | x | x | x | x | o[1] | x | o | 13 |
| Licensing of formulations | x | x | x | x | x | x | x | x | x | o | o | o | x | x | x | x | o[1] | x | o | 14 |
| Licensing of dealers | x[2] | x | x | x | o[1] | x | x | x | x | x | o | o | o | x[1] | x | x | o[1] | x | x | 14 |
| Certif. applicators | x[2] | x | o | x | o[1] | o | x | o | x | o | x | o | o | x | x | o | o[1] | x | x | 10 |
| Mandated uses | x | x | x[1] | x | x | x | x | x | o | x | o | o | o | o[1] | o | o | o[1] | o | o | 9 |
| Residue tolerances in food | x | x | x | o | o | x | x | o | x | o | x | o | o | x[1] | x | o | o[1] | x | o | 10 |
| Monitoring of foods | x | x | x | o | o | x | x | x | x | x | x | o | o | o[1] | o | x | o[1] | x | x | 12 |
| Monitoring of environment | x | x | x | o | o | x | o | o | x | o | x | o | o | o[1] | o | o | o[1] | x | x | 8 |
| No. of agencies involved in enforcement of legislation | 3 | ? | 6 | 2 | ? | 3 | 2 | 2 | 3 | 5 | 4 | 0 | 2 | 1 | 3 | 1 | ? | 4 | 2 | |

Key: x = yes; o = no
Footnotes: 1 — Regulation pending
2 — Only in some states

Source: Mootooka, 1977.

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 structures to regional responsibilities and the development of what are called 'matrix organizations'.

### 5.2.1 Super-agencies

In recognition of the administrative problems that arise when several agencies have responsibility, some countries including Kenya and Thailand have established departments with special responsibilities for the environment. In the USA the Environmental Protection Agency has an explicit charge to look after the interests of the environment — interests which are often overridden by the economic development concerns of other agencies concerned with Agriculture and Industry, for example. Inevitably, agencies with jurisdiction over the range of environmental problems that exist in any country, become very large. The UK Department of the Environment has been described as a 'super-department' which is concerned with managing everything from pictures in historic buildings to pollution in open spaces.

The creation of such large departments produces problems of their own. Special information units need to be set up within them to communicate to other sections what each section is doing. The massing together of people under one name does not necessarily solve either communication problems nor intersectional rivalry. Nor does the existence of a large department necessarily mitigate the cross-jurisdictional problems. A large Department of the Environment must still cooperate with departments representing health, industry, labour and agriculture if problems of industrial pollution or agricultural pesticides affect human health and the environment. However, the value of an agency such as the US Environmental Protection Agency lies more in its special concern to look after the commonly neglected interests of the environment than in its large organization.

In many developing countries, jurisdiction over environmental concerns does still lie largely in one or two leading departments. Agricultural and Rural Development agencies have wide and often sole powers in many countries over natural resources and their economic development, whereas Public Health departments usually share responsibility (where they have it) with other agencies. Planning Departments, where they exist, also seem to have wide powers over the environment, and have the advantage of a centralized planning function which may also include coordination between other agencies.

### 5.2.2 Coordination between agencies

Given the fact that risk management is becoming a more and more comprehensive and interventionist process, the question of coordination of its functions with existing agencies operating in related areas is important. In the

past this linkage has often been *ad hoc* depending largely on the personalities and experience of the responsible officers, on arrangements developed after accidental events, and in response to proposals made by commissions of inquiry from time to time. It is now apparent that coordination between risk management agencies needs to be more comprehensive and consistently developed.

Already there are signs in terms of guiding legislature principles that this is taking place in some countries. For example, in the arena of pollution abatement and the control of toxic materials, considerable progress has been made in

(1) Coordinating the work of agencies responsible for environmental quality within the workplace with those outside the workplace;
(2) Relating the work of air pollution control authorities to those responsible for water quality; and
(3) Coordinating the activities of international organizations with respect to standardization of environmental quality, monitoring and reducing transnational flows of polluting substances.

In the arena of planning development, the growth of environmental impact analysis, first in the USA, and subsequently in most western countries in some form or another has led to a much more comprehensive planning function, complete with advisory committees, panels of adjudication and public hearings which often require agencies to show that they have responded to each other's initiatives.

However, in most instances, the potential for coordination is much greater than the practice, so it is necessary to ask what impediments impair interagency coordination in risk management and how they can be overcome. Two points emerge:

(1) Tradition and custom backed by legal guidelines often isolate agency responsibilities. For example, pollution control and planning authorities in the UK must consult, but need not listen to each other.
(2) The personality and experience of the responsible officers. This is obviously a delicate matter to investigate, but is certainly very pertinent. Informal consultative arrangements working on the basis of trust and respect is a vital aspect of good risk management, and cannot be legislated. Despite its potential sensitivity, this is a most important area for task evaluation, because risk managers do pride themselves in their professional responsibilities and informal consultative arrangements.

### 5.2.3 Organizational alternatives to functional structure

The structure of an administration is a large factor in its capacity to recognize and deal with interdisciplinary problems, whatever the individual capabilities of the people working within it. Conventionally, government departments have a sectoral structure in which responsibilities are divided functionally as opposed to regionally. This is true for most industrialized and

developing countries. Thus in any one part of a country, departments of social security, health, water, agriculture, trade and industry, will all have a part of the administrative pie. They each receive their operating budgets from a central Treasury and to some extent are in direct competition for financial, technical and manpower resources as well as political support. This typical arrangement is least well adapted to environmental management and has been termed the 'administrative trap' (Baker, 1976).

To take the example of rangeland management, which has been a key problem in the Saharan drought areas: the sectoral structures of most of the African governments involved led to different departments developing strategies for water, animals, marketing and livestock health often quite independently. Key departments for rangeland management for some African countries are given in Table 5.3. The results were that water was provided in some areas without plans for controlling either grazing or population influx, and livestock patterns were changed without adequate marketing arrangements. In Uganda, for example, Animal Industry and Agriculture are two separate administrations so that crucial links between them in developing policies for semi-pastoral and agricultural tribes such as the Karamojong are difficult to achieve. When problems are perceived within one sector, projects are started which tended to patch up the symptoms where they appeared rather than considering the 'problem region' as a spatial set of interconnected symptoms. These are not the fault of the individual departments who had no power to act outside their limited jurisdictions but a weakness of the overall government structure (Baker, 1976).

Again, these structural deficiencies for managing environmental problems at the national level are often repeated *within* departments in the way their divisions relate to one another, and they are exacerbated by the similar sectoral structures of any international and bilateral aid agencies. One solution is to introduce a regional planning and coordination function between the national departments and their field stations or projects in the regions (Figure 5.3).

The advantage of this arrangement is that there is a chance for individual projects to be considered in an interdisciplinary manner. Also, integrated and more flexible (less 'blanket') policies have a chance of surviving but the individual national departments still retain their autonomy and authority. The career structure of their personnel is preserved and they are more likely to favour the change in structure. In particular, no one ministry is given pre-emptive power over others. The disadvantages are that the regional planning and coordinational level may not be sufficiently influential to force sectoral plans to be modified, and that the demand for manpower and other resources to administer government policies is likely to be increased. Some countries are moving towards a regional approach to planning. These include Guinea, Malagasy, Niger, Mali and Pakistan who are all trying to integrate rangeland management through regional administrative structures.

Another way to approach the problems of functional organizations is to develop a 'matrix' structure (Figure 5.4). This simply means that alongside the normal functional divisions are established interdisciplinary or inter-

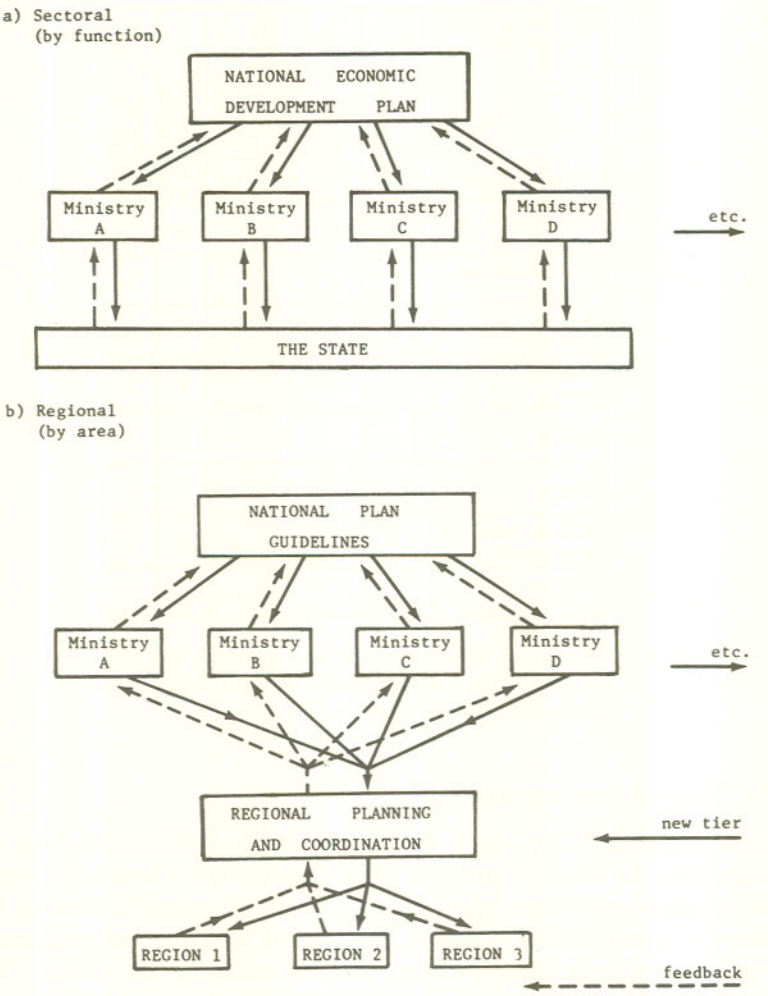
Table 5.3 Administrative Structure of Selected African Countries for Rangeland Management

| Country | Ministry most closely charged with the management of rangeland |
|---|---|
| Botswana | Ministry of Agriculture |
| Chad | Ministry of Agriculture and Stockbreeding |
| Ethiopa | Ministry of Agriculture |
| Guinea | Ministers for Local Development for Regions: Ministers of Rural Development |
| Kenya | Ministry of Agriculture and Animal Husbandry |
| Malagasy Republic | Ministry of Territorial Planning<br>Ministry of Rural Development |
| Mali | Ministry of Production |
| Mauritania | Ministry of Rural Development |
| Niger | Ministry of Saharan and Nomadic Affairs |
| Rwanda | Ministry of Agriculture and Livestock |
| Senegal | Ministry of Rural Development |
| Somalia | Ministry of Rural Development and Livestock |
| Sudan | Ministry of Agriculture |
| Uganda | Ministry of Animal Industry |
| Upper Volta | Ministry of Agriculture, Cattle Breeding, Rivers, Forests and Tourism |

Source: Baker, 1976, p.250. (Reproduced by permission of Edward Goldsmith, publishers)

departmental special teams or projects. These draw on the functional divisions for manpower and technical back-up to put together a group of people with the different skills needed for a particular project. These people go back to their functional divisions when the project is completed or when they have served on it for an agreed period of time.

The advantage of a matrix organization is that it can accomodate the needs of special interdisciplinary problems without breaking down the functional structure. The project structure is varying as problems are solved and new ones emerge so that it is not encumbered with a static set of manpower, but can develop teams specially put together for eachproblem. For people working in matrix organizations, the chance to work in a challenging interdisciplinary project is usually attractive and stimulating whilst their permanent 'home' in a functional department, usually with others of similar training (e.g. engineering, medical), gives them career stability and the needed association with members of their own professions. Matrix organizations are being used with success by many large private companies in western industrialized countries and are now being tried by some government departments in North America (Davis and Lawrence (1977)).




Source: Baker, 1976, p.250. (Reproduced by permission of Edward Goldsmith, publishers)

Figure 5.3 Functional versus regional organizational structures

## 5.3 RISK MANAGEMENT TASKS

The risk management process can involve a range of different tasks, or management control options. Some of these are carried out largely within government departments, while others are located within the political or public sectors. Not all of the management functions are necessarily applicable to every kind of environmental risk. Major areas of management control are research and monitoring, the drafting of legislation and regulations; standard setting; inspection and enforcement; and continuing review of risk levels and the management process itself.

| Interdisciplinary projects / Funtional departments | Water supply | Rangeland management | Small scale cooperative ventures | Air pollution from industry | Floods in urban areas | Development of national risk profile |
|---|---|---|---|---|---|---|
| Public health and welfare | X | X | | X | X | X |
| Agriculture and forestry | | X | X | | | X |
| Animal husbandry | X | X | | | | X |
| Trade and industry | | X | X | X | X | X |
| Energy | | | X | X | | X |
| Labour | | | X | X | | X |
| Natural resources environment | X | X | X | X | X | X |
| Housing, urban affairs | | | | X | X | X |

Figure 5.4 Schematic matrix organization for environmental management based on functional government departments

### 5.3.1 Research and monitoring

Scientific knowledge about the nature of the risks is the basis for risk management decisions although at times those decisions have to be made in the face of inadequate knowledge. The gathering of scientific data is, in many countries, a task shared between government agencies, universities, private industries, public interest groups, and members of the public. In many countries local people are an as yet underutilized source of environmental information. For many industrial processes, private industry is able to obtain, and pay for, much more information than government scientists can gather. In some western countries much of these data have remained confidential.

Today two trends are emerging: first, governments are undertaking much more research themselves (at greatly increased direct financial cost to the public) and second, private companies are being forced to give more detail about their own research findings to governments in order to have their products registered for sale and use.

The main ways in which research on environmental tasks is conducted are environmental monitoring, health surveillance, laboratory and field experimentation, testing and screening, accident analysis and modelling. These have been described more fully in Chapter 3 and will only be defined and commented on here in the context of administering them.

*Environmental monitoring* This involves repetitive observations over time from a network of stations which can be compared between stations and between observation times.

Monitoring is a far more difficult and expensive business than is commonly imagined. In many countries, one solution is to essentially let the risk producers (often industry) monitor themselves. The advantage to public authorities of this arrangement is that the polluter bears the costs of monitoring and in any case has the best access to information and to remedial action. The disadvantages are that the system relies on the honesty and public spiritedness of the polluter (even where it runs counter to his own interests). Government inspectorates are thus often acting in the role of back-up monitoring and do periodic checking rather than a comprehensive monitoring programme.

These kinds of arrangements rely heavily on trust between the regulator, the regulated and the public. In many countries, this trust is breaking down as the public learns more and more instances of ineffective regulation and unacceptably high risk levels. There is correspondingly an increased public demand for monitoring to be carried out by independent or public agencies who have no conflict of interests in seeing regulations enforced. The cost of effective monitoring when wholly undertaken by government can become a major demand on national, financial and manpower resources.

In some circumstances, monitoring can be undertaken by the public, especially for rural areas. Accidents (e.g. spillages) are best monitored (reported) by those on the spot rather than setting up an elaborate official surveillance network. River pollution has been monitored by the public (especially fishermen) in the UK who report indicators such as dead fish, smells and foam or coloured discharges. Earthquakes have been successfully monitored in China by the public. These monitoring systems rely on public education about the indicators of high risk and an effective communication system between the public and responsible government officials.

A second set of issues relating to the monitoring task apply to its comprehensiveness, accuracy, and cost effectiveness. Because of the enormous costs involved in monitoring, the cost effectiveness approach requires most urgent attention especially in relation to the accuracy of recording equipment, the spatial and temporal characteristics of the record, and the standardization of the final results to permit international comparison. For example, the European Commission is currently running into some difficulties in trying to get its member states to accept a commonly agreeable monitoring programme for environmental pollutants. The British government is opposed to the existing proposals on the grounds of needless cost. While some risk areas may be over monitored, they claim, others may escape proper investigation. Examples of the latter include the hindsight investigation of environmental impact assessment once major planning developments have been completed, and the full scale assessment of the medical and economic consequences of measures to relieve deprivation, particularly in developing situations.

The special monitoring problems that may occur in developing countries can be subdivided into two classes: scientific and institutional.

(1) Scientific problems. Most of the available information on environmental problems relates to the temperate zones, and it is often dangerous to extrapolate to the tropics where the climate and vegetation patterns are quite different. The associated monitoring systems may then be less than satisfactory. In fact, there is a great need for dose-response experiments in the tropics, leading to realistic sets of environmental criteria, and to guidelines for the design of monitoring systems.

(2) Institutional problems. In many developed and developing countries, certain monitoring programmes have been initiated and managed on an isolated, *ad hoc* and sectoral basis, to serve quite specific purposes. There has often developed a rather loose and sometimes incoherent system of people and organisations sampling, analysing data, and carrying out assessments. Thus the quality of the environmental management systems and the monitoring programmes which provide the data is not only limited by the lack of scientific and technical capability, but also by the organisation of the systems. The latter are strongly affected by the legal, economic, social and political frameworks, and these are evolving rapidly in many developing countries. This can make the organisation of environmental management very difficult. An additional complication is the shortage of skilled manpower to design and implement the desired management structure.

*Health surveillance* This is the collation and interpretation of health data from monitoring and census services etc. in order to detect changes in the health status of populations. It has been most advanced where hospital and clinical visits are recorded and centralized in a data bank, so that the information they contain is accessible to computerized monitoring and research programmes.

*Testing and screening* These involve controlled, often standardized procedures for measuring risk sources, pathways and effects, and can be undertaken in laboratory or field conditions. Many tests for the effects of pollutants and drugs on human health are now costly in terms of money, time and technical manpower so that national governments are increasingly being forced to rely either on research by the industries that are promoting the substances, or the results of other governments' experience.

Research into environmental risks is also conducted through *modelling* (Chapter 3) and *accident analysis* which is an after-the-event inquiry into what happened and why. Accidents provide situations that cannot be ethically produced intentionally in experiments, as well as revealing interconnected causes that may have low probability characteristics or be entirely unexpected. Government research capability should include the ability to merit a scientific team to investigate accidents immediately they occur, since some aspects of risk can only be studied in these situations.

### 5.3.2 Legislation

Legislation relating to environmental risks have been placed on the statute books of most countries in the world. Table 5.4 shows the present areas of legislation for different aspects of the environment in developing countries. Most countries have legislation protecting their animal and plant resources and their fresh water sources. Other well legislated areas include protected areas (national parks etc.), non-renewable resources, soil, and hazardous substances. Environmental areas for which few developing countries have legislation include environmental modification, population policies, solid waste disposal, noise, and air quality.

Although the passing of legislation is a political process, in many countries environmental statutes and regulations are often drafted initially by technical and legal experts within government departments. In countries where several statutes have followed one another to deal with a particular problem, two evolutionary trends can be seen. These are, greater comprehensiveness and an increasingly creative and anticipatory role in environmental management on the part of governments.

For example, pollution control in European and North American countries is evolving from legislation which controlled emissions of particular pollutants at specific locations (e.g. chimney stacks or river outflow pipes) on a case by case basis, through control on a class by class basis, to ambient air and water quality standards which themselves determine what emission concentrations are allowable (Figure 5.5). The legislative framework has moved from a responsive role which facilitated particular decisions to a guiding role for framing pollution decisions within a wider context of social and economic development. Some legislation, notably the US Federal Resource Conservation and Recovery Act of 1976, has developed the comprehensive trend to the point of considering the impacts of activities and control in one environmental medium, such as air, land or water on the quality of the others.

Thus risk-management legislation has become both more *specific* with clearly defined codes of practice and regulations about operation, monitoring and enforcement, and more *comprehensive* in the sense that it now covers:

— occupational risk environments both inside and outside the work place;
— national and international rules and regulations regarding the discharge and distribution of toxic substances;
— the acceptance of planning and other behavioural controls to reduce the impact of environmental damage and natural hazard; and
— the formation of extensive scrutinizing devices to appraise, review and quantify risks in relation to associated benefits both to existing, and to future generations.

Although the point at which this evolution has reached varies tremendously depending on the type of risk and from country to country, there seems every reason to believe that legislation will continue to follow the pathways described: that is, it will become more comprehensive, more specific with respect to standards, monitoring and enforcement, and more anticipatory with respect to potential risks.

Table 5.4 Existing National Environmental Legislation in 63 Developing Countries (data abstracted from Johnson, Johnson and Gour-Tanguay, 1977)

| | General Policy | Air | Water-fresh | Sea Water | Soil | Faune & Fish | Flora & Forest | Non-renewable resources | Noise | Solid Waste | Hazardous Substances | Land Use Planning | Habitat | Economic Development | Protected Areas | Environ. Modif. | Population | Envir. Education |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Afghanistan | | | | | | | | | | | | | | | | | | |
| Algeria | x | | x | x | x | x | x | x | x | | x | x | x | x | x | | | |
| Argentine* | x | x | x | x | | | | | x | | | | | x | | | | |
| Barbados | | | | | | | | | | | | x | | | | | | |
| Benin | | | | x | | x | x | | | | | | | | x | | | |
| Botswana | | | x | | x | x | x | x | x | | | x | x | | x | | | |
| Bulgaria | | x | x | | x | x | x | x | x | x | x | | x | | x | | x | |
| Burma | | | x | | | x | x | | | | | | x | | x | | | |
| Burundi | | | | | x | x | x | | | | | | x | | x | | | |
| Cameroun | | | | | | | | | | | | | | | | | | |
| Central Africa | x | | x | | x | x | x | x | | | | x | x | | x | | | |
| Chad | x | | x | | | x | x | | | | x | | | | x | | | |
| China (Taiwan) | | x | x | | x | | x | | x | x | x | x | x | x | x | x | x | |
| Congo | x | | | x | | x | x | x | | x | x | | | | | | | |
| Cyprus | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | | | x |
| Egypt | | | | x | | x | x | x | | | x | | | | | | | |
| Ethiopa | | | x | x | x | x | x | | | | | | | | | | | x |
| Gabon | | | x | x | | x | x | x | | | | x | | | x | | | |
| Ghana | x | | | x | x | x | x | x | x | x | x | x | x | x | x | | | x |
| India | | x | x | x | x | x | x | | | | x | | x | | x | | | |
| Indonesia | | x | | | | x | | | | | | | | | x | | x | |
| Iran | | | x | | x | x | x | | | | | | | | x | | | |
| Iraq | x | | x | | x | x | x | | | | | x | | | | | | |
| Israel | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | x | x |
| Ivory Coast | | | x | x | x | x | x | x | x | | | x | x | | x | | | |
| Jamaica | | x | x | | x | x | x | x | | | x | x | | | x | | | |
| Jordan | | x | x | | x | x | x | | | | x | | x | | | | x | |
| Kenya | | | x | x | x | x | x | x | | x | x | x | x | | x | | x | x |
| Korea (South) | x | | | | | | | | | | | | | | x | | | |
| Kuwait | | | | x | | | | x | | | | | | | | | | |
| Liberia | | | x | x | | x | x | x | | | | x | x | | x | | | |
| Lybia | x | | x | x | x | x | x | x | | | | x | x | | | | | |
| Malawi | | | x | x | | x | x | x | | | x | x | x | | x | | | |
| Malaysia | x | x | x | x | x | x | x | x | x | x | x | | x | | x | | x | x |

| | General Policy | Air | Water-fresh | Sea Water | Soil | Faune & Fish | Flora & Forest | Non-renewable resources | Noise | Solid Waste | Hazardous Substances | Land Use Planning | Habitat | Economic Development | Protected Areas | Environ. Modif. | Population | Envir. Education |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mali | | x | | | x | x | x | x | | | | | | | x | | | |
| Mauritania | | | x | x | | x | x | x | | | x | | | | x | | | |
| Morocco | | x | x | x | x | x | x | x | | | x | x | x | | x | | | |
| Nepal | | | | | | x | | | | | | | | | | | | |
| Niger | x | | x | | | x | x | x | | | x | x | x | | x | | | |
| Nigeria | | | x | x | | x | x | x | x | x | x | | | | x | | | |
| Pakistan | | | x | | x | x | x | | | | x | x | | | x | | | |
| Philippines | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | x |
| Qatar | | | | | | | | | | | | | | | | | | |
| Salvador | | x | x | | x | x | x | x | x | x | x | | x | | | | | |
| Saudi Arabia | | | | | | x | | | | | | x | | | x | | | |
| Senegal | x | | x | | | x | x | x | | | | | | | x | | | |
| Sierra Leone | | | x | x | x | x | x | x | | | | x | | | | | | |
| Singapore | x | x | x | x | x | x | | | | x | x | | | | x | | | |
| Somalia | | | x | | | x | x | | | | | | | | | | | |
| South Africa | x | x | x | x | x | x | x | x | | | x | x | x | | x | | x | x |
| Sri Lanka | | | x | x | x | x | x | | | | x | x | | | x | | | |
| Sudan | | x | x | | x | x | | | x | | | | | | x | | | |
| Swaziland | | | x | | x | x | x | x | | | x | | x | | x | | | |
| Tanzania | | | x | | x | x | x | x | | | x | x | x | | x | | | |
| Thailand | x | | x | | | x | | | | | | x | | | x | | | |
| Togo | | | x | | x | x | x | | | | | x | | | x | | | |
| Trinidad & Tobago | | x | x | | | x | x | | x | | x | x | | | | | | |
| Tunisia | | | x | x | x | x | x | x | | | x | x | | | x | | | |
| Uganda | | | x | | x | x | x | x | | | x | | | | x | | | |
| Upper Volta | x | | x | | | x | x | | | | x | x | | | x | | | |
| Yugoslavia | | x | x | x | x | x | x | x | x | x | x | x | | x | x | | | |
| Zaire | x | | x | x | | x | x | x | x | x | x | x | | | x | | | |
| Zambia | x | | x | | x | x | x | x | | | x | x | | | x | | | |
| TOTAL | 20 | 19 | 48 | 30 | 36 | 55 | 50 | 35 | 17 | 13 | 34 | 33 | 25 | 7 | 46 | 2 | 9 | 8 |

Key: x — legislation; blank — no legislation;
*data for freshwater in Argentine missing

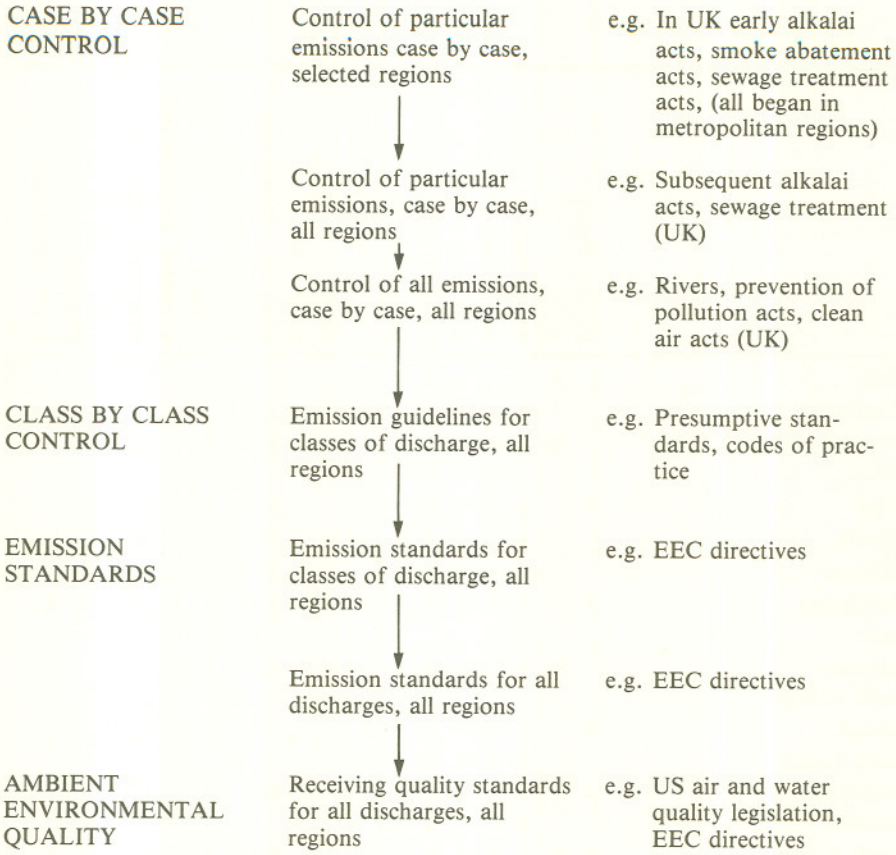



Figure 5.5 General evolution of pollution control

### 5.3.3 Standard setting

*Standards* Standards are prescribed levels, quantities or values, which are regarded as authoritative measures of what is a safe enough, or acceptable, amount of pollution, contamination or exposure to risk. Standards are usually arrived at in the context of *criteria* which describe the known relationships between risk levels and other factors (see Chapter 4). Standards may refer to (Lowrance (1976)):

*Human exposure to risk* (e.g. radiation exposure standards)
*Effluent standards* (e.g. industrial toxic wastes)
*Ambient environmental quality* (e.g. drinking water quality standards)
*Occupational conditions* (e.g. length of working hours)
*Product, technology or technical process design* (e.g. consumer or industrial machines)
*Product composition* (e.g. processed food standards)
*Product or technology performance* (e.g. building structures)

*Product labelling and advertising* (e.g. pesticides)

*Product packaging* (e.g. pressurized gas containers, child-proof drugs)

Standards vary in the degree to which they are qualitatively or quantitatively expressed and how closely specified or definitive they are. They can, for example, be expressed as a fixed concentration of a pollutant per volume of air, (water or discharge, etc.) above which level concentrations are considered unacceptable, and below which, they are acceptable. A standard can be a single numerical value, or a range of values on the one hand; all the way to expressions endorsing a 'best practicable means approach'. The way in which they can be enforced also varies — it is easier to define when a standard has been broken or executed where it is written down in very specific terms. Partly for this reason, labour groups and public interest groups are often pushing for governments to come up with clearer, more 'black and white' standards, whereas industry generally favours more discretionary terms.

One process which has gone along with more numerical standards is that of also prescribing how they are to be attained in terms of procedures (codes of practice) or equipment (technical codes). This trend of codifying regulations is occurring in the United States and has the disadvantage of implicating the regulatory body as partly responsible for any damage which may ensue where, for example, prescribed regulations have been followed but harmful effects can be shown to have resulted.

*Guidelines* Instead of legislated standards, which usually have the power of legal enforcement behind them, governments can adopt *guidelines* or recommended standards (presumptive) which specify target levels or desirable standards rather than hard and fast rules and prescriptions. There can be very different rationales behind the option of guidelines rather than specific standards. These include (Doern, (1977)):

(1) Scientific uncertainty about what is an adequate standard;
(2) A concern that set standards are not flexible and easy to change, particularly where technology or products are rapidly developing, so that a fixed standard may prevent improvement;
(3) An unwillingness to enforce tough standards that will be unpopular with industry, the public or politicians;
(4) An awareness that the enforcement resources are lacking and a reluctance to have a 'meaningless' (unenforceable) standard.

Critics of a guideline approach to regulation argue that guidelines will encourage better safety levels only if they can be enforced; or inspectors can apply some leverage to see they are complied with or improved upon. Generally guidelines lack the 'teeth' of legislated standards but in areas where standards cannot yet be determined, it is probably better to have guidelines than nothing.

Some guidelines are in the form of recommendations by prestigious scientific bodies, often international ones, such as the International Commission on Radiological Protection or the World Health Organization

Table 5.5 Comparative National Drinking Water Standards for Selected Countries

| | | UNITS | 1. International WHO acceptable | 2. International WHO allowable | 3. European WHO | 4. United States | 5. Sweden | 6. France | 7. Bulgaria | 8. Tanzania | 9. Japan (1968) | 10. India (1973) | 11. India recommended 1975 | 12. Israel 1974 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radioactivity | a | pCi/L | | 3 | 3-10 | | | | | | | | 3 | 3 |
| | b | pCi/L | | 30 | 80-100 | | | | | | | | 30 | |
| pH | | | 7.0-8.5 | 6.5-9.2 | | | 6.0-8.0 | | 6.5-8.5 | 6.5-9.2* | | 6.5-9.2 | 6.3-9.2 | 6.5-9.5 |
| Total hardness | as ($CaCO_3$) | mg/L | | | 500 | | | 300 | 450 | 600* | < 300 | 600 | 600 | |
| Chlorides | (as Cl) | mg/L | 200 | 600 | 600 | 250 | 25/250 | 250 | 250 | 800* | < 200 | 1000 | 1000 | 600 |
| Flouride | (as F) | mg/L | | 1.5 | 0.7 | 0.8-1.7 | 1.5 | | 0.7-1.0 | 8.0* | < 0.8 | 2.0 | 1.5 | 1.4-1.7 |
| Nitrate | (as $N0_3$ | mg/L | | 30.0 | 50/100 | 45 | 30 | 44 | 30 | 100 | 45 | 50 | 45 | 90 |
| Copper | (as Cu) | mg/L | 1.0 | 1.5 | 0.05 | 1.0 | 0.05/1.0 | 0.2 | 0.2 | 3.0* | < 10 | 3.0 | 1.5 | 1.4 |
| Iron | (as Fe) | mg/L | 0.3 | 1.0 | 1.0 | 0.3 | 0.2 | 0.2 | 0.2 | 1.0* | < 0.3 | 1.0 | 1.0 | 1.0 |
| Manganese | (as Mn) | mg/L | 0.1 | 0.5 | 0.05 | 0.05 | 0.05 | 0.1 | 0.1 | 0.5* | < 0.3 | 0.5 | 0.5 | |
| Zinc | (as Zn) | mg/L | 5.0 | 15.0 | 5.0 | 5.0 | 0.3/5.0 | 3 | 3 | 15.0* | < 1.0 | 15.0 | 15.0 | 15.0 |
| Magnesium | (as Mg) | mg/L | 50 | 150 | 125 | | | 125 | 50 | | | 150 | 150 | 150 |
| Sulfate | (as $SO_4$ | mg/L | 200 | 400 | 250 | 250 | 25/250 | 250 | 250 | 600* | | 400 | 400 | 400 |
| Phenolic compounds | | mg/L | 1 | 2 | 1 | 1 | | | 1 | 2 | 5 | 2 | 2 | 2 |
| Color | (p.c. scale) | mgPt/1 | 5 | 50 | | 15 | 10 | | 15 | 50* | < 5 | 25 | | 50 |
| Turbidity | | $mgSi0_2$ | 5 | 25 | | 3 | weak | | 30cm/y | 30* | < 2 | 25 | | 25 |
| Taste | | | | | | | | | | | | | | |
| Calcium | | mg/L | 75 | 200 | | | | | 150 | | | | | |
| Odor | | | | | | | | | | | | | | |
| Arsenic | (as As) | µg/L | | 50 | 50 | 50 | 10/50 | | 50 | 50 | < 50 | 200 | 50 | 50 |
| Cadmium | (as Cd) | µg/L | | 10 | 10 | 10 | 10 | | 50 | 50 | < 10 | | 10 | 10 |
| Cyanide | (as Cn) | µg/L | | 200 | 50 | 10 | 10/20 | | 10 | 200 | 0 | 10 | 50 | 50 |
| Lead | (as Pb) | µg/L | | 50 | 100 | 50 | 20/50 | | 100 | 100 | < 100 | 100 | 100 | 50 |
| Mercury | (as Hg) | µg/L | | | | | 1/5 | | | | 0 | | 1 | 10 |
| Selenium | (as Se) | µg/L | | 10 | 10 | 10 | 10/50 | | 50 | 50 | | 50 | 10 | 10 |
| Polycyclic A.H. | | µg/L | | | | | | | | | | | 200 | |
| Chromium | | µg/L | | 50 | 50 | 50 | 20 | | 50 | 50 | < 50 | 50 | 50 | 50 |
| Beryllium | | µg/L | | | | | | | | | | | | |
| Molybdenum | | µg/L | | | | | | | | | | | | |
| Strontium | | µg/L | | | | | | | | | | | | |
| Barium | | µg/L | | 1000 | 1000 | 1000 | | | 1000 | 1000 | | | | 1000 |

Blank indicates that data are not available or have not been located.
50/100 The lower value refers to permissible concentrations in water purified by chemical flocculation and slow filtering. The higher value is the permissible concentration in waters much more extensively treated before use.
* Indicates tentative figures.
< Indicates 'less than'
ppm Indicates 'parts per million'

| | 14. U.S.S.R. (1961) | 15. U.S.S.R. (1973) | 16. Germany (1975) | 17. Australia | 18. Cairo | 19. European Council 1975 | 20. Greece | 21. Korea | 22. Philippines | 23. Thailand | 24. Mexico | 25. Czechoslovakia 1963 | 26. Canada 1968 acceptable | 27. Canada 1968 allowable | Range of Standards |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3 | | | 3 | | 3 | | 3 | | | | 3-10 |
| | | | | 30 | | | 30 | | | | 10 | | | | 10-100 |
| .0 | | 6.5-8.5 | | 6.5-9.0 | 6.0-8.5 | | 7.0-8.5 | 5.8-8.0 | 7.0-8.5 | | 6.5-8.5 | | 6.5-8.3 | 6.5-8.3 | 6-9.5 |
| 'L | | 10ml/L | | 30/500 | 4mE/L | | 100/500 | < 300 | | | | | | | 300-600 |
| | | 300 | | 200/600 | 400 | 200 | 350 | 150ppm | 200 | 250 | | | < 250 | 250 | 200-1000 |
| | | 0.7-1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1ppm | | | | | | | 0.7-2.0 |
| | | 45 | 90 | | | | 50 | | | | | | < 10 | 10 | 10-100 |
| | 0.1 | 1.0 | | 1.0 | 1.5 | 1.5 | 1.0 | 1ppm | 1.0 | 1.0/3.0 | 1.0 | 0.1 | < 0.01 | 1.0 | < 0.01-10 |
| | | 0.3 | | 0.3 | 1.0 | 0.3 | .1 | 0.3 | 0.3 | 0.5 | | | < 0.05 | 0.3 | < 0.05-1.0 |
| 5 | | 0.1 | | .05/.10 | 0.5 | 0.05 | .1 | 0.3 | 0.1 | 0.3 | | | < 0.01 | 0.05 | .001-0.5 |
| | 1.0 | 5.0 | 2.0 | 5.0 | 15 | 0.1 | 5.0 | 1ppm | 5.0 | 15.0 | | 5.0 | < 1.0 | 5.0 | < 1.0-15.00 |
| | | | | < 150 | 75 | 50 | 50 | | 50 | 125 | | | < 50 | 150 | < 50-150 |
| | | 500 | 240 | 250 | 300 | 250 | 250 | 200ppm | 200 | 250 | | 500 | < 250 | 500 | 150-600 |
| | | | | 1 | 2 | .5 | 1 | | | | 1 | | not detec-table | | .5-17 |
| | | 20 | 20 | 15 | 25 | 50 | 5 | 2 | 15 | 20 | 20 | | 15 | 15 | 2-50 |
| | | 1.5mg/L | 3mg/L | < 25 | 5 | 10 | 5 | 2 | 5 | 5 | 10 | | 5 | 5 | 2-25 |
| | | 2 | | | | 5 | 5 | | | | | | | | 2-5 |
| | | | | | | | | | | | | | < 75 | 200 | 75-200 |
| | | | 3° | | | 5° | 3° | | 3° | | | | 4 | 4 | 3-5 |
| | 50 | 50 | 40 | 50 | 100 | 50 | 50 | 50 | 200 | 10 | 50 | 50 | 10 | 50 | 10-200 |
| | | | 6 | 10 | | .5 | 10 | | 10 | | 10 | 100 | < 10 | < 10 | .5-100 |
| | 10 | | 50 | 200 | 20 | 50 | 50 | 0 | 10 | 10/20 | | 100 | 10 | 200 | 10-200 |
| | 100 | 100 | 40 | 50 | 50 | 50 | 100 | 100 | 100 | 500 | 50 | 100 | < 50 | 50 | 40-100 |
| | 50 | | 4 | 2 | | .1 | | 0 | | | 5 | 5 | | | 0-50 |
| | 10 | 1 | 8 | 10 | | 10 | 10 | | 50 | 10 | 10 | 50 | < 10 | 10 | 1-50 |
| | | | .25 | | | | | | | | | | | | .25-200 |
| | 10 | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 10/50 | < 50 | 50 | 10-50 |
| | | .2 | | | | | | | | | | | | | .2 |
| | | 500 | | | | | | | | | | | | | 500 |
| | | 2000 | | | | | | | | | | | | | 2000 |
| | 4000 | | | 1000 | | 100 | 1000 | | 1000 | | 1000 | | < 1000 | 1000 | 100-1000 |

(e.g. International Drinking Water Standards). Such guidelines while relied upon in terms of their scientific validity, may need to be modified in the light of the local conditions and feasibility of implementation.

Similarly, national public or private bodies may recommend standards and institute 'seals of approval' for products which pass their tests.

*Criteria* Criteria reflect the state of scientific knowledge about environmental conditions or technical factors and their adverse effects on man and his environment. For example, air quality criteria might include the known properties of certain pollutants and the various ways of measuring them; a survey of present and past concentrations of the pollutants in the atmosphere; and a review of the evidence about the effects of various concentrations of these substances on man, animals, vegetation and materials, including epidemiological evidence. Such a criteria document sets out to be as objective as possible and does not in itself recommend, or set, standards.

In some countries, a deliberate separation is kept between criteria setting and standard setting, even to the point of assigning the tasks to different agencies. Criteria setting is seen to be a scientific, relatively value free process whereas standard setting is more constrained by the local political, economic and administrative setting as well as the values and perceptions of those who are defining the standard.

The degree to which standards are relative (despite their common appearance of being absolute) can be seen from the varying standards specified for the same pollutant or product by different countries or even different states or local bodies within the same country — sometimes even where the same criteria are used. For example, the scientific basis for drinking water standards is better established than for many other environmental hazards. Yet standards for different trace elements or for physical indicators such as mobility, taste and colour vary between countries by factors of 10 to almost 1,000 times (Table 5.5).

The tendency is for standard setting procedures to become better clarified and more open to wider scientific and public debate. Standard setting is a crucial aspect of risk management for it not only guides the subsequent regulatory and enforcement activities but also acts as an important monitor of political attitudes to the tolerance of risk. For example, some countries adopt much stricter standards for the control of highly toxic materials than others: the EEC Council of Ministers has agreed to the principle of 'no detectable emissions' of eight substances by 1980, but the UK has won a concession that resulting concentrations of these substances should be the guiding standard, not emission controls.

The actual procedures by which risk related standards are met are, therefore, a critical aspect of risk assessment. The principles involved here are:

(1) What is the role, composition and political effectiveness of scientific standard setting committees for various kinds of hazard in various countries?

(2) What role will standards play in relation to other risk management tasks? — a guiding role or an enforcing role?
(3) Will standards apply to ambient quality parameters as well as or instead of emission parameters?
(4) Will standards be subject to continuing review, both as to the effectiveness of their role and as to their scientific and political suitability?
(5) To what extent will independent scientific evidence be incorporated into the standard setting process, and that this be seen to be incorporated?
(6) Will the relationship between scientific criteria and subsequent politically established standards be made clear and subject to public discussion?

The answers to these questions vary from one kind of risk to another and from one country to another, but they should provide a guide for a national or international appraisal of the state of risk management.

### 5.3.4 Regulation and enforcement

Regulation is the process by which risk reducing standards or guidelines are applied in particular instances. In the case of toxic and biological risk, for example, this means the application of threshold limit values or maximum allowable doses which may be done on a provisional, presumptive or compulsory basis depending partly on the degree of cooperation versus adversary conflict between the regulator and the regulated that characterizes the risk management process.

Indeed, the regulatory role of standards and the comprehensiveness with which they apply are closely related to the degree to which the whole process is regarded as *cooperative arrangement* between risk producers, risk managers and risk receivers, or an *adversary relationship* among these three principal groups. In the cooperative approach, standards are established after a long period of consultation, objection and concession: the result is a voluntary or legally acceptable code of practice which is normally followed and usually is capable of being legally enforced.

The advantages are (a) friendly collaboration among all parties involved; (b) 'in house' confidentiality; (c) good working relations; (d) a shared commitment to steady improvement. The disadvantages lie in a certain exclusiveness in operation which may impede impartial scrutiny of all aspects of risk management, and which may foster a degree of decision control (sometimes referred to as non-decision making in the political literature) which could prove to have adverse consequences. It is virtually impossible to find out how far this kind of practice actually exists, partly because the whole process is so confidential, and partly because the participants themselves may not know how far they are controlling final decisions. But is seems that this kind of activity could be most prominent in precisely those areas where scientific and political controversy is greatest.

These arguments fall fair and square on the 'best practicable means' approach adopted in the UK and many other English speaking countries: this is widely regarded to work well most of the time, but may not always prove to be the most suitable managerial principle in all cases of risk management. The adversary procedure is more commonly found in federal states where the law is constitutionally strong and where distrust of regulatory procedures has a long political history. Its chief advantages lie in its precision and ease of enforcement, while its disadvantages relate to its unworkability in the face of conflicting political demands and to its general rigidness and inflexibility. In practice, an amalgam of the two approaches, leaning to one side or the other depending on circumstances is followed in many countries, the exact regulatory enforcement varying by class of risk and political 'style'.

The major questions relating to regulatory procedures apply to the sincerity with which the whole process is conducted and the degree of independent analysis available. These are not readily testable, but they are very important. To what extent are regulators and regulated genuinely committed to achieving socially accepted levels of protection against risk? In short, does their motivation come from within or without? This self-regarding social ethic toward risk protection is relevant through the whole of the risk management process, especially in regulation and enforcement. To test for this is bound to be a difficult task but not an impossible one, though it should be carefully controlled.

Why should the decision-maker be concerned with this? Because successful risk management can depend critically on its accountability and ability to hold up under scrutiny, and the more society knows it can trust its officials the better they will be able to continue their roles in the future. Some criteria for assessing accountability are:

(1) The degree of access to risk management officials by independent experts and responsible media. This may be by formal and informal means.
(2) The character of devices employed to ensure that all relevant viewpoints are heard and shown to be taken into account. These should ideally be based on some kind of dialogue to permit antagonists to challenge each other freely.
(3) The nature of information dissemination, especially as to why and how standards are established. This can be based on the publicity as to reasons for reaching decisions plus the amount of public answerability to independent, but scientifically respectable monitoring groups.

The enforcement of regulations by individual government inspectors or agencies also depends very much on the managerial 'style' of the individual or agency, and these can show wide variation even within one country. Some other managerial characteristics also influence how effectively regulations are enforced. These include:

(1) The degree to which political judgments can knowingly permit an overriding of regulatory standards in particular cases.

(2) The constitutional role of the law and the courts in enforcing good environmental practice and specific legislation.
(3) The legislative intent towards tough enforcement operations, defined by such criteria as the level of fine permitted and actually imposed, and the status of the reviewing body (magistrates court, county court etc.) for various categories of offences.
(4) The relationship between public scrutiny and official monitoring will influence enforcement in certain risk areas (e.g. nuclear-related risks) if public risk and anxiety is especially high.

### 5.3.5 Emergency response

Not all events lend themselves to an orderly decision control process. Events occur, which because of the severity of impact require immediate response — in other words, create an emergency. In emergency situations the normal decision-making process must be suspended and emergency authorities invoked.

In the United States, for example, the legislation for the various environmental programs give the Administrator of the Environmental Protection Agency the authority to declare a particular event or espisode an emergency, which permits him to invoke the emergency permitted under the Act.

Such emergency procedures permit the Agency to immediately
(1) Suspend activities.
(2) Ban products and withdraw them from circulation.
(3) Establish standards, criteria or regulations based on existing knowledge and *without benefit of the normal review, comment and concurrence procedures.*
(4) Authorize remedial or preventive measures.

Two examples of fairly recent emergency situations in the United States are (1) the air pollution episode in Pittsburgh, Pennsylvania in November 1975, and (2) the Kepone incident in Hopewell, Virginia in July of that year.

In the Pittsburgh case, EPA officials were advised by the Municipal authorities that air pollution levels were getting dangerously high. The Administrator ordered an EPA medical doctor to the scene and he confirmed levels were dangerous to health. On the basis of his recommendation the city ordered major polluting industries to close down, suspended school and invoked a no-driving ban for the duration of the emergency.

In the Hopewell Kepone incident, tests run by EPA and other Federal and State agencies confirmed that Kepone levels in the James River posed a threat to human health leading to closure of the river to commercial fishing by the Governor of Virginia and the setting of emergency permissible levels of Kepone in shell and fin fish by EPA.

It is important for risk managers to be able to act quickly when emergencies arise and special provisions need to be considered in drafting legislation, in delegating agency functions and in designing risk management procedures.