CHAPTER 12

Priorities for Improvements in Environmental Modelling

This report has shown that the institutional, political, economic, and cultural setting of different countries plays an important role in facilitating or hindering the use of simulation modelling in environmental management. By and large, developed countries face somewhat similar problems, even though their approaches to them may differ. These modelling problems differ from those facing developing countries, and the possible methods of attacking them also differ. Acccordingly, the modelling priorities that need to be addressed by developed and developing nations, respectively, will be treated separately in the following pages.

12.1 PRIORITIES FOR IMPROVEMENT IN DEVELOPED COUNTRIES

Unfortunately, many models of the past decade have fallen far short of expectation. Those which are typically accepted or understood by decision-makers and the public are tactical, and belong most commonly to the mono-disciplinary and/or technical-operational level, such as diffusion models in pollution control and pest management models. Models of an intrinsically complex and multi-disciplinary structure addressing strategic questions have usually not been accepted as readily or applied as effectively. This situation is not, however, due to a lack of potential in systems analysis and modelling as applied to environmental problems. Rather, it may be attributed to the fact that the understandably enthusiastic excitement of at last being able to grapple with complex problems led to uncritical and grandiose dreams. Moreover, different regions and countries differ both in the characteristics of the human environment, and in the attitudes of people towards it, which greatly limits transferability of experience. Nevertheless, useful and usable techniques have been developed by small groups of scientists with multidisciplinary background who have made great efforts to link the modelling effort with policy questions and to carry out vigorous data-based validation. If one disregards some of the early 'over-selling' of the simulation modelling technique, it can be seen that some useful progress has been made.

With the aim of improving the potential of environmental systems analysis and model building, the following factors need to be taken into consideration:

(i) *Rendering modelling methodology compatible with incremental decision-making.* In Chapter 5, the distinction was made between technocratic and incremental decision-making. The technocratic approach starts with recognition and analysis of the problem, and, after review of all feasible alternatives, a well-specified

optimal solution is selected. The second, or incremental approach, assumes that there is no obvious objective decision or solution on a long-term basis. Rather, a continuous stream of minor decisions are made on a subject, thus providing opportunties for changes in policy as the situation develops. Decision-makers looking for strategic solutions will often prefer a simpler model fitting their own incremental approach rather than the optimizing model appropriate to technocratic decision-making. It should, however, be noted that incremental decision-making can sometimes be dangerous, particularly if an unstable or very complex system is involved, where the consequences of a decision may vary in direction and/or in magnitude depending on the size and the timing of the change. In practice, 'technocratic' and 'incremental' approaches are not mutually exclusive; indeed, they should be blended in overall management. In both these approaches to decision-making, an iterative interaction between modellers and decision-makers is essential if societal objectives are to be effectively served by modelling.

(ii) *Clearing-houses for data and models.* A lack of properly evaluated data often becomes a bottleneck for simulation projects. In addition, environmental problems are intrinsically multidisciplinary and hence involve large amounts of data of various types. Therefore, it may often be helpful to develop a data-base system in which numerical data (tables, grid data, etc.), descriptive data (geological, ecological, etc.), documentation (environmental impact statements, environmental law, etc.), bibliographies (author, date, title, journal, comments by the reader, etc.), and simulation programmes are filed and retrieved in a conversational mode.

It may be helpful to new modelling activities if special arrangements are made to provide ready access to relevant knowledge and experience. This might, for instance, take the form of a clearing house for each continent, where the data-base system described is maintained, and existing models are stored in computer networks permitting ready transfer of this information. It should be stressed, however, that there are inherent dangers in using data that have not been collected with a specific purpose in mind; accordingly, a generalized data system should be treated with due caution. To obtain the full benefit of these clearing-houses, standard formats for the presentation of environmental data and the documentation of environmental models will need to be developed (House et al., 1977).

(iii) *Training of the modelling project manager in multidisciplinary approaches.*

Unless the modelling project manager himself has a multidisciplinary outlook, he is unlikely to be able to provide a team composed of individuals coming from a variety of different disciplines with the cohesion and common outlook required for a multidisciplinary modelling project. For this, it may be desirable for him to undertake special training to give him the necessary breadth of outlook.

In some countries, rather than relying on the project manager, it appears to be more effective to organize multidisciplinary teams in which each member has been exposed to a variety of disciplines – including as a minimum the necessary background in systems analysis, ecology, physical sciences, biological sciences, economics and public administration. This exposure need not necessarily be deep, but should be balanced over the required areas. Special training centres should be developed to fulfil this need.

(iv) *Utilizing semi-quantitative and purely qualitative methods.* Simulation modelling may often be required to provide an answer within a limited time, even though insufficient quantitative data or only qualitative information is available as input to the model. A possible way out of this difficulty may be to build a simplified model based on previous knowledge regarding the identification of the relevant variables, and of the existing relationships between the variables; this simple model could then be used to determine at least the qualitative effects which relevant variables will have on the environment. The results of such studies may become useful to decision-makers in understanding the potentiality of simulation modelling, and a more advanced simulation modelling study with the necessary quantitative data base could then be initiated.

12.2 PRIORITIES FOR IMPROVEMENT IN DEVELOPING COUNTRIES

As already mentioned in Chapter 8, there is no reason why simulation models cannot be applied successfully in the Third World, although the environmental priorities may be different from those in many industrialized countries (see Chapter 2). In practice, however, there is an understandable reluctance among both decision-makers and scientists in the Third World to accept simulation models developed elsewhere. This is partly because the data bases are certainly different, and the environment may behave differently in the region where the model is to be applied.

A distinction should be made between models imported by industry and models used by government agencies. In the former case, the models usually provide a basis for environmental impact statements, and they may incorporate good environmental and engineering practice borrowed from industry, government, and universities in other continents. The role of government agencies in this situation is to evaluate these impact statements in the light of local environmental and socio-economic conditions. The phrase 'best practical technology' is often used, but there is a danger that the empirical experience derived from other continents may not ensure that the environment will be adequately protected. Firstly, there are cultural differences in value systems. Added to this is the fact that the local 'standards' for housing, water and air quality and other concerns may have been derived from European or North American standards and that these standards may have been superseded even in their countries of origin. The net result is that the outputs of the simulation model may be totally irrelevant to a developing country although they may be impressive in both volume and number of significant figures. The local authority, wishing as it does to promote industrial growth, may be hard pressed to find fault with the analysis presented by industry, despite its essential irrelevance.

The other users of simulation models are government agencies and planning boards. In these cases, the models are introduced to aid in the development of management strategies, such as those for the control of water pollution. Sometimes the government agency purchases a total 'package' from an overseas company, perhaps with financial assistance from one or more development agencies. The package may include not only a simulation model but also a computer and perhaps environmental monitoring and telemetering equipment. Even if such a 'package' is highly appropriate where previously used it may not be suitable under different

conditions without extensive changes, and may well include unnecessary elements.

The alternative is to develop an *ad hoc* model, perhaps with the assistance of local scientists, or drawing on overseas consultants. At first, and perhaps even when the local scientists have become fully trained, the simulation model should be rather simple, and not require more data than are currently available.

In order to achieve a greater potential for the meaningful use of simulation models in the Third World, the following additional suggestions can be made:

(i) Development agencies and international money-lending institutions should include, as a condition for support to Third World projects, the requirement for a thoughtful environmental assessment of the impacts of each project – which most often must be based on appropriate simulation modelling technology. The practice of indiscriminate transfer of technology should be discouraged.

(ii) Simulation models should take a long view of the Third World environment, and should not be designed to extinguish a succession of individual 'brush fires'. For example, even if an impact assessment for a single power station or copper smelter provides reassurance that air and water quality standards will not be exceeded, the development may trigger a chain of human interventions, through construction of secondary industries, roads, towns, and so forth, which may lead to irreversible degradation on a grand scale. This is the essence of the systems approach to environmental assessment and the reason why it has so much relevance in such problems.

(iii) An exchange of knowledge and local experience between different (developing and developed) countries should be encouraged. Environmental problems are most likely to be similar in neighbouring territories; but often a developing country has closer scientific links with a developed nation in Europe or North America than with the countries in its own continent, particularly where the national languages are different. In such cases, the experience such nations can offer may be even more valuable.

(iv) Training facilities should be provided, and there should be frequent exchanges of scientists. This will require preparation of manuals and text-books, since present deficiencies in library facilities are often an insurmountable obstacle to progress.

(v) Inter-governmental bodies should promote the development of regional clearing-houses for data and models. One of the most difficult problems facing a scientist building a simulation model in the Third World is the incompatibility of existing data.