ENVIRONMENTAL SOFTWARE FEATURING INTERACTIVE INTERFACES

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Abstract

With steady population growth and industrialization, human activities have increasingly affected the environment. Growing concern about these impacts and their immediate, as well as long-term consequences, including risk associated with technological systems and the inherent uncertainty of any forecast makes environmental planning and management, especially environmental impact assessment, a task of global importance that requires comprehensive, interdisciplinary information.

The volume and complexity of this information, uncertainty in the data and comprehension of the processes, as well as the often large number of alternatives to be considered, require specific data processing tools. The availability of affordable computers, as well as new technologies such as expert systems, interactive modeling and dynamic computer graphics, now make it possible for powerful, accessible, and general software systems for environmental impact and risk assessment to be built. These systems are designed to provide planners and policy makers with direct and interactive access to a large volume of information in combination with methods of scientific analysis.

To make such systems really usable, emphasis has to be put on the user interface, using components such as graphical and symbolic user interaction, graphical display of results that are dynamically or spatially distributed, integrated geographical information systems (GIS), or the use of Artificial Intelligence (AI) components.

Some basic principles such as interaction and visualization are discussed, based on several application examples in the area of general environmental impact assessment, as well as surface and groundwater quality, air pollution and industrial risk assessment, developed and implemented by IIASA's Advanced Computer Applications (ACA) group for planners, managers and decision makers.

1 Interactive Software

Environmental impact assessment, management and planning requires the qualitative and quantitative prediction, assessment and evaluation of the impacts of human activities on the environment. One of the approaches for predicting and analyzing these impacts is the development of computer-based models and information systems (Fedra, 1990). A large number of formal, mathematical and computational methods have been developed in the area of environmental

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planning, with considerable emphasis on the use of computers. Many of these models are potentially useful. However, to turn a potentially useful method into one actually used requires a number of special features, including an approach that takes psychological and institutional aspects, as well as scientific and technical ones, into account.

The use of a model or a computer-based method depends to a considerable degree on acceptance by the potential user, the user typically being a technical analyst, planner, manager or decision maker. To make formal methods more easily accepted, problem representation has to be cast into the language and symbols of the user, the decision making process, and its institutional environment. A route to reach this goal seems to be the development of a new generation of intelligent, interactive information and decision support systems and expert systems which take advantage of the rapid developments in computer technology. The extensive use of high-resolution graphics and interactive menu-driven operations increase the transparency and make these systems user friendly.

Examples of such systems were developed by ACA for various clients and sponsors; main application areas include: environmental impact and ecological risk assessment (mainly on surface and groundwater quality, air pollution, and noise); environmental information and decision support systems; regional development planning and resource management; technological risk assessment, transportation and energy systems; hazardous substances and waste management.

These examples are used to illustrate several of the principles and features built into ACA's software systems to make them friendly and easy to use i.e., by integrating expert systems components that provide tutorial guidance to the user, and including graphical user interfaces and a high degree of dynamic interaction; graphic visualization and animated display, using symbols, graphs, or topical maps, and the transparent coupling of data bases, in particular GIS.

2 Application Examples

The problem addressed by the systems described below is the gap between the ever increasing complexity and volume of scientific and technological information relevant to large socio-technical and environmental systems, and the information requirements at a strategic planning and policy level. A new generation of intelligent information and decision support systems should help to bridge this gap by taking advantage of the rapid developments in computer technology. These software systems integrate methods and approaches of operations research and applied systems analysis with elements of AI and advanced information and computer technology. The easy-to-use software tools are designed to provide planners and policy makers with direct and interactive access to a large volume of information in combination with the powerful methods of scientific analysis.

It is important to note that the systems discussed are customized and problem-oriented, tailored to a specific application. The knowledge and experience built into them is domain-specific, not general; their institutional integration varies from demonstration systems to systems used routinely.

The systems described have a common architecture, including a fully menu-driven, interactive and graphical user interface; extensive use of animated color graphics for problem representation, visualization of modeling results; connection to one or several data bases, and in particular, dedicated GIS and selected GIS functions (see for example Reitsma, 1990; Fedra and Reitsma, 1990), and the integration of AI techniques in the user interface, context-sensitive defaults, plausibility checking, and help and explanatory functions.