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Biological Consequences of Land Use

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The primary goals of land-use planning are enunciated. A plea is made for consideration of the total biosphere and not just its separate components. The environmental impact statement process is reviewed and some suggestions made for its strengthening. Moves for international adoption of this process are noted, as well as the concept of eco-development currently under examination by UN agencies.

Introduction

Whenever a tree is cut or a house is built, the physical environment is changed, which in turn affects the biological environment. The changes may be substantial but in general they are rather local.

Sometimes with a single stroke of the pen, however, rather large areas are rezoned from rural to suburban, from residential to industrial, or from forest to reservoir. These rezonings may have a major influence on both the local and the regional environments, particularly in cases where the land-use change is a stimulus and focal point for additional development.

It will be assumed in this paper that major land-use changes do have an effect on the environment and thus have biological consequences. (It is interesting to note that the Ontario Air Management Branch receives more citizen complaints from rural than from urban areas, the major source of annoyance being odors from large farm operations.) The emphasis will therefore be placed on the problems associated with predicting the magnitude and importance of these consequences.

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Goals of Land-Use Planning

The primary goals of land-use planning should be to maximize the carrying capacity of the biosphere and to maximize the assimilative capacity of the biosphere. These goals are hardly ever achieved because: joint maximization of the carrying and the assimilative capacities may not be theoretically possible; suboptimal solutions of each may be required; the scientific basis for solving the problem posed above is usually lacking; society has other goals (economic growth, recreational facilities, etc.) which often conflict with the two primary goals.

In connection with the carrying capacity of the biosphere, a distinction is usually made between renewable and nonrenewable resources. However, note should be made of the fact that the so-called renewable resources are not necessarily renewable. For example, when fertile land is replaced by a shopping center or a drive-in theater, the carrying capacity of the biosphere is reduced in a way that is irreversible for all practical purposes. Other examples include overgrazing and pine reforestation (which may acidify the soil).

Mention should also be made of the fact that the second primary goal of land-use planning is to maximize the assimilative

capacity of the total biosphere, not just of the atmosphere. The pathways of trace substances through the environment are so complex and poorly understood that optimum recycling solutions are difficult to find or to verify. Although it may be tempting to exploit the assimilative capacity of the atmosphere alone (through tall chimneys, meteorological episode control, or land-use planning), this may in some cases lead to long-term degradation of other environmental reservoirs (soils, lakes, etc.).

Presentation of Alternatives through the Environmental Impact Assessment Process

In the United States and increasingly in other parts of the world, the environmental impact assessment process is being used as an institutional instrument to ensure that environmental considerations are included at an early stage of planning for large development projects.

Recognizing the needs of assessors and their staffs for technical guidance on interdisciplinary investigations, an international workshop was organized at Victoria Harbour, Canada in February 1974 by SCOPE (Scientific Committee on Problems of the Environment), a component of ICSU (International Council of Scientific Unions). The workshop produced a book entitled, "Environmental Impact Assessment: Principles and Procedures" (*1*). Some of the main workshop conclusions related to land-use planning are summarized below.

Presentation of Alternatives

An environmental impact assessment should provide the decision-maker with alternative environmental management strategies, including that of taking no action. The assessment should include examination of a wide spectrum of physical, biological, economic, and social factors and should be undertaken at a very early stage of regional planning, in parallel with engineering and economic feasibility studies. However, the assessor should avoid the temptation of producing a "telephone directory" of the quality of the regional environment. Finally, an impact assessment should not be an adversary document but should present unbiased estimates of the environmental consequences of several alternative proposals.

Uncertainty

An impact assessment is not an exact forecast but contains two types of uncertainty. The prediction may be seriously in error because of an inadequate understanding of the behavior of the biosphere and/or because of insufficient environmental data concerning the region under investigation. The prediction of the precise time of occurrence of a significant but rare event may not be possible (e.g., forecasting the year of occurrence of an earthquake, flood, or drought of a given magnitude), although statistical predictions of the probability that such events will occur sometime in the next 100 years can be made with some confidence. Methods of dealing with the second type of uncertainty are well-known, although even in this case, the decision-maker must accept a finite risk of failure when he decides to build a dam or to irrigate a region.

Methods for evaluating the first type of uncertainty are generally lacking. On the one hand, the decision-maker does not appreciate "waffling;" on the other hand, the assessor may may wish to hedge, due to the complexity of the environmental problem he is trying to solve.

Irreversibility

A biological system is able to survive across a rather wide range and variety of environmental stresses. Nevertheless, there are outer limits beyond which an ecosystem "flip-flops" to another, and usually simpler form in an irreversible way. These outer limits define the resilience of an ecosystem (*2*), which is evidently an important consideration in impact assessments.

Magnitude versus Importance of Environmental Effects

The assessor has a responsibility to estimate the magnitudes of environmental effects. However, some large effects may not be very important to the public, or vice versa, depending upon the priorities established or accepted by society. Furthermore, these priorities may change over the years.

The ways in which environmental effects are related to human concerns through sets of so-called impact indicators are described in the SCOPE publication (*1*). Admittedly, methodologies for ranking the relative worth of various indicators of environmental quality are not yet well developed, and current practices are controversial.

Post-Audit of Impact Assessments

How accurate are impact assessments? It is almost unbelievable that no systematic post-audit program exists in any country with impact-assessment experience.

The Concept of Eco-Development

Within the United Nations, the concept of eco-development is currently being examined as a possible midterm strategy for the Third World (*3*). The concept also has relevance for developed countries such as the United States and Canada.

Each region of the world has a rather unique environment (mesoclimate, physiography, natural resources, etc.). Eco-development is a form of planned growth that attempts to exploit the locally available natural resources, within the constraints of the local environment. In terms of land-use practices, eco-development tries to maximize the carrying and assimilative capacities of the biosphere.

As a simple example, suppose that irrigation is introduced into a semi-arid region at great expense. The land becomes productive, but because of the need for marketing and service facilities, a town is created. Without rational planning, the town may compete with agriculture for fertile land, and the carrying capacity of the region may become seriously impaired within a generation or so.

As an alternative scenario in the above example, the irrigated land may require the intensive use of fertilizers in order to become productive. This may lead in a few decades to salinization of the soil and again to an impairment of the carrying capacity of the region.

Environmental impact assessments are recommended in cases such as these, as an instrument for providing insight into the nature of the options and tradeoffs open to the decision-maker.

REFERENCES

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