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INDICATORS OF ENVIRONMENTAL QUALITY IN THE USE OF LAND RESOURCES*

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It has been suggested that 1970 will be recorded as one of the great watershed years in history. For many, it was the year we discovered the environment and also the year we concluded that man must work with a finite natural resource base. It is not yet clear that 1970 marked a high point of marginal value product returns on the secular diminishing returns curve or that it had any other particular significance in terms of resource productivity. But the National Environmental Protection Act, signed on January 1, 1970, and its provisions establishing the Council on Environmental Quality and requiring the filing of environmental impact statements along with the later celebration of Earth Week in April, 1974 have certainly had important effects on resource development decision-making.

Another significant provision of the National Environmental Policy Act, concerns the development of environmental indicators. Section 102.(2).B. directs all federal agencies to "identify and develop methods and procedures, in consultation with the Council on Environmental Quality . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations." Section 204 further provides that the Council on Environmental Quality shall "document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for continuing analysis of these changes or trends and an interpretation of their underlying causes." Fulfillment of these requirements obviously calls for the development of classification systems, criteria of measurement, indicators and indices that the various agencies can use in describing objectives and trends in environmental management.

Problems in Developing Environmental Indicators

Only limited progress has been realized to date in the development of realistic environmental indicators and indices. Part of the reason for this lies in the fact that the development of meaningful indicators of environmental

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quality calls for the quantification of an array of qualitative value judgments and perceptions. Other problems arise because of our lack of suitable measuring devices and also because of our lack of clearly defined policies and goals that relate to our use of environmental resources.

Development of indicators and indices assumes the presence of relevant quantifiable data. Unlike the usual situation with economic data many of the amenities that contribute to environmental quality cannot be simply counted as units of production; they lack any quoted market price; and they are difficult to quantify. Surveys and shadow market pricing have received some use; but overall, the problem of measuring and assigning weights or values to environmental amenities and systems still provides a major barrier to the development of realistic indicators of environmental quality. People have preferences concerning environmental situations but these preferences are hard to pin down, describe, and measure even in individual cases. The problem of measurement becomes more complicated as efforts are made to quantify the preferences of people with widely varying perceptions who come from different income levels and cultural backgrounds.

Most of the success enjoyed with the development of environmental indicators to date has come with those indicators used to describe air, water, noise pollution and radiation. With these examples, extensive use is made of physical measures of the quantities of contaminants of pollutants in the air or water, decibels of sound, or levels of exposure to ionizing radiation. These readings are checked against assumed health and comfort standards to provide measures of quality. Except for isolated examples such as levels of pesticide or radiation contamination, this approach has limited applicability to land resources. Even with these indicators, however, questions arise as to whether they provide more than partial indications of environmental quality. Does a low BOD count with water, for example, really tell us that we have high quality water or a better environment?

The development of realistic indicators of environmental quality calls for careful and precise emphasis in spelling out the specific criteria and objectives upon which the means of measurement are premised. There is no real shortage of potential facts, observations, or value judgments. More thought, however, must

be given to the questions of "Where are we now?", "Where are we going?" and "Where do we want to go?" in the use of environmental resources. Overall objectives must be spelled out in many cases to provide a basis or standard alongside which judgments can be made. Viable and acceptable choices must be identified before indicators can be designed to directly facilitate decisions for the attainment of these choices.

Suggested Indicators of Quality in Land Use

Writers on the topic of environmental indicators usually comment on the significance of land resources and the need for developing appropriate indicators of environmental quality and then hurry on to other types of resources for which accepted techniques for measuring quality have been developed. Despite this frequent scant treatment, a few techniques have been developed while others have been suggested. Examples include analyses of land use trend data, the Soil Conservation Service conservation needs studies and land capability ratings, the National Wildlife Federation's EQ indices, the MITRE Corporation land use matrix, the use of landscape assessment models, and the suggestion that land areas be rated according to their carrying capacities for particular uses.

Land use trend data are regarded by many people as our best current indicators of land environmental quality. Implicit in this view is the assumption that land resources generally are counted as in their highest and best uses, that they are well-adapted to these uses, and that large areas are not standing-by as possible reserves for other uses. In practice, the land use studies reported by the Bureau of the Census , the U. S. Forest Service, the Bureau of Land Management, and other public agencies and the general information on land reported each year by the Council on Environmental Quality play a desirable and useful role. At best, however, they provide no more than a weak and somewhat superficial measure of the environmental quality aspects of land use. Straight average counts can be meaningless when some lands are subject to intensive uses while others lie at the extensive margin or are in transition between major uses, Moreover, data on the acreages or even the total productivity of the land areas used for different purposes does not provide direct evidence that land is employed for its best use or that it is being utilized in a manner that will enhance its environmental quality attributes over time.

The soil conservation needs studies sponsored by the Soil Conservation Service have the advantage of being oriented to a specified objective. In this sense, they have a comparison base that one can use in determining whether or not soils are utilized in a conservational manner. Insofar as the practice of soil conservation corresponds with the maximization of environmental quality, soil conservation needs attainment data can be viewed as viable indicators of environmental quality. The land capability ratings generated by the Soil Conservation Service, however, do not qualify as environmental quality indicators. These ratings are valuable for the purposes for which they were designed; but that purpose was not the measurement of environmental quality. As a leading example of an accepted land classification approach, these ratings are frequently misused by overly zealous individuals who assume without question that the bases for these ratings corresponds with their own particular needs.

Another type of index is provided by the National Wildlife Federation E Q Indices for soils, living space, timber, and minerals. These indices are dramatically illustrated and highlight useful information on total supply, overall need, and recent trends in resource use. In practice, however, they provide only a general measure of the environmental quality trends associated with each of these resources.

A somewhat different approach has been recommended by the MITRE Corporation. This organization has suggested that a land use shift matrix involving 20 classes of land on each axis be used with an accounting system tied to periodic national surveys of land use to indicate the extent and nature of the shifts of land areas between uses. A follow-through with this approach would provide employment for numerous statisticians, systems analysts, and some land economists. It could provide useful information on current land use practices and trends. But again one can ask how much it would really tell about the relative quality of the environmental outputs associated with different land uses.

Landscape assessment models provide another example of an approach that has been suggested as a means for maximizing the environmental quality aspect of land development. Landscape architects have long been active in promoting the view that new developments should be designed with nature. A recent example of this approach, the Massachusetts Metropolitan Landscape Planning Model (METLAND),

calls for measurement of the landscape resource values in given areas and for assigning a scale of rating values to a large assortment of different items to indicate the positive and negative effects human activities such as urbanization can have on landscape values. This approach is commendable in that it seems to get at the basic question of effects on environmental quality but it is made somewhat cumbersome by its reliance on large numbers of data inputs.

Still another approach calls for determinations of the physical and biological carrying capacities of various areas for different uses. This approach has a definite appeal for many ecologists and environmentalists. Information on carrying capacities certainly is needed for effective managerial decisions. It is quite obvious that environmental qualities are adversely affected when resources are used beyond their carrying capacities. But real questions can be raised as to whether carrying capacity determinations tell us much about environmental quality. It should be recognized that just as the optimum economic point in production calls for fewer variable inputs than would be used at the point of highest physical productivity so also does the maximization of environmental amenities call for resource use at less than peak carrying capacity levels.

Needed Indicators of Land Quality

Our current indicators of environmental quality with land tend to stress features of supply, needs, or demands. Supply-type indicators emphasize the availability and use of land resources. Prime examples involve our land use studies, forest and recreational land inventories, and reports on soil capabilities. With the needs-type indicators emphasis is given to the areas needed for particular uses and to the losses associated with particular practices. Examples include reports on conservation needs, park and recreational needs, wildlife and wetland needs, statements of housing requirements, and studies of erosion and sedimentation damages. The demand-type indicators, of which the U.S.D.A. Economic Research Service river basin studies are a leading example, use economic projections to determine expected future market demands of given resources.

Additional studies stressing supplies, needs, and probable demands obviously have their place. These studies can provide general indicators of (1) the amounts of land that are available for various uses, (2) the areas used for different

purposes, (3) land use shifts, (4) relative intensities of use, (5) the amounts needed to fulfil assumed needs, and (6) the amounts needed to supply expected future market demands.

Indicators also are needed to throw light on several additional environment-oriented issues. Important among these are measures of the (1) losses of agricultural, forest, and unique lands, (2) erosion and destruction of fragile resources, (3) trends in urbanization and urban land needs, (4) impacts of sprawl and encroachment on other resources, and (5) impacts of land developments on water supply and recharge areas.

Losses of agricultural, forest, and unique lands. Shifts of land areas from existing uses to what may be described in a marketplace sense as higher and better uses has been a normal feature of the land use succession process. Questions are arising, however, concerning the extent and long range impacts of these shifts when they involve areas that are uniquely endowed with special capabilities for their present uses, when their loss may herald future production problems, and when sites of lower value for the unique uses may be substituted at little or no additional cost for the new developments.

Agricultural lands provide a foremost example of a type of land resource whose loss may be considered as critical. Overall, the nation is blessed with a bounteious supply of agricultural lands. But it does not have a plentiful supply of all types of farm lands. Some tracts also have greater fertility and far more productive potential than others. Urban encroachments on the more productive lands and on specialty crop areas can have far-reaching impacts on the nation's future agricultural productive capacity. Interest also has been expressed in the ability of states to retain their agricultural production capacities and of cities to retain their agricultural hinterlands. These situations have prompted widespread interest in possible farm land preservation programs.

Comparable trends have generated similar concerns about the need to protect commercial forest lands for future forest production, recreation sites for public access and recreational use, natural areas for continued treatment as open space resources, and areas with mineral deposits for future mining developments. Coupled with these lands is the problem of protecting truly unique areas-- the

one-of-a-kind ecological areas--against possible loss. Many of these resources have been lost by default in the past. As is the case with agricultural lands, programs are needed to identify the high priority lands that should be protected in their present uses, to measure the pressures for shifting them to other uses, and to catalog the extent to which these lands are actually being lost to their present uses.

Erosion and destruction of fragile resources. Closely related to the protection of needed land resources is a parallel need for conserving existing resources and minimizing the impacts of those activities that could bring the pointless destruction of fragile resources. Soil is a precious resource that cannot be restored except over long time periods. Continued programs are needed to facilitate soil conservation and to discourage and prevent erosion and sedimentation. Similar programs that will start with the identification of the areas involved are needed to prevent the misuse and destruction of fragile resources such as shorelands, beaches, flood plains, steep slopes, ground water recharge areas, poorly drained lands, and wetlands.

Trends in urbanization. Less than two percent of the land area of the United States is used for urban purposes. But this area is used more intensively and has a higher unit value than any other class of land. It also is subject to a highly complex mixture of uses that often have puzzling consequences for environmental quality. Considerable study is needed to sort out the indicators of urban land environmental quality. Inventories are needed of present uses, trends, and enhancement potentials. Attention needs to be given to the possibilities new developmental and institutional arrangements offer for fostering improved environments both in downtown areas and in residential sections. Findings are needed concerning the extent of the additional areas needed for cities and the interrelationships that exist between urban land environment quality, housing quality, and the quality of urban life. Inventory and trend data also should be assembled on the extent and quality of urban "green areas"--the nonpaved, nonbuilt-upon areas of urban open space.

Sprawl and encroachment. Few land use trends have been critized or belittled more than the process known as "urban sprawl". Yet this process continues to operate largely because it represents a logical pattern for urban expansion in

the absence of effective land use planning. Urban growth of some type is necessary in those areas where urban populations are increasing. It is the encroachment aspect-- the bit by bit destruction and warping of environmental and other values traditionally associated with the rural hinterlands that surround cities-- that should be tempered and controlled. Encroachment indices and other measures of the effects of sprawl and other encroachments on existing patterns of land use are needed to provide a more complete picture of their impact upon environmental situations. Indicators of this order can also provide valuable guides for public land use policy decision-making.

Impacts on water supply and recharge areas. Water supply and recharge areas constitute an extremely valuable but often underrated land resource. More often than not, the lands used for this purpose are classified under other uses. The value of their multiple use nature comes to the fore, however, when emphasis is given to the vital nature of our reliance upon them for water supplies and when consideration is given to the ease with which they can be despoiled or contaminated. Inventory data are needed concerning the extent and characteristics of these areas both in the humid and the more arid regions. These inventories should identify water supply and recharge areas, chart the land use trends that affect them and suggest policies that can be used to upgrade their values and the environmental qualities associated with them.

Proposed Use of a Land Use Budget Approach

Nearly all of the indicators of land resource quality we now have, and most of those suggested thus far in this paper, represent partial and incomplete measures of environmental quality. Each has something to say about environmental quality but none provide a thorough-going indication of the extent of the quality associated with different land use practices.

Part of the problem stems from the fact that the answers sought call for the quantification of individually viewed qualitative perceptions. Part of it springs from the fact that people often talk about land or land use as a single entity when in fact land must be divided into various relevant subcategories before one can speak realistically about quality of usage. Part of the problem also is related to the fact that basic measurements of environmental quality with land call not so much for the analysis of trend data as for comparisons between present

situations and the environmental qualities associated with idealized situations which can be accepted as the objectives of public policy.

This last observation suggests the advisability of accepting a national land use budget approach. With the budget approach, it is possible to compute the quantities of land resources needed with varying assumptions to fill the nation's needs. Each type of land use can be treated as a unit and the sum of all the types can be made to equal the national total. Individual totals can then be treated as targets of public policy against which environmental quality, productivity, and other features of policy decisions can be judged. These totals may also be subdivided into state and substate regional quotas that can provide guidelines for local planning decisions. Once these guidelines are established, planners and other observers will have a more realistic basis than they now have for comparing the environmental quality attributes of the land resources they have available to fill their quotas for various types of land.

The principal advantage of this land use budget approach lies in its provision of a comparative basis for evaluating the outputs of environmental amenities and other products and services that land areas now produce and that they can reasonably be expected to produce in the alternatives uses in which they are most needed. It provides a rational basis for public decisions relative to the future allocation of land resources between competing uses. It also provides planning guidelines that local officials working with a county land use plan, for instance, could use in arguing that certain areas should or should not be preserved for agricultural, recreational, wetland, or other uses.

Use of a land use budget approach will not provide answers to all of the problems associated with the development of meaningful indicators of environmental quality in land use. Most of the present approaches have merit and should be continued. New approaches also should be encouraged. The budget approach has the disadvantage of requiring frequent revisions to keep it relevant in terms of national needs and aspirations. Overall, however, this suggested approach does offer not only a realistic basis for appraising the environmental amenities associated with alternative land uses but also some much needed land policy guidelines that can be applied with equal validity at the national, state, and local levels.

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