Ecological Planning in Land Use[1]

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One of the most important conflicts that arises between political decision makers and ecologists is the inadequate utilization of ecologic criteria in the assignment of priorities for soil and resource use in the different geographic regions of our country. It is a common occurrence that forest or agricultural soils are dedicated to grassland, rangeland soils are dedicated to agriculture, and agricultural soils are dedicated to urban use. Criticisms of the deficiencies in the assignment of different uses to various types of soils have come from several sources and are frequently conflicting. The "vocation" of soils is talked about insistently with little idea of what this concept actually means. Superimposed on all of these discrepancies are the opinions of ecologists, biologists, and conservationists who demand the creation of national parks and biological or ecological reserves. This group presents its own criteria for the possible selection of uses for the land and its resources.

Faced with this conflict of opinion, the state and federal governments have opted to not plan at all and to allow the different groups to continue in their course. Eventually, the force of the most economically or politically powerful, the personal opinion of the governors or local decision makers, or the force of public opinion orients government in one direction or another. Sometimes, it is not even possible to ascertain what variables were or were not taken into account in a given decision. Given the results of this policy, which have not been good, the Federal Government decided to organize all existing information necessary to obtain a more solid foundation on which to base land-use planning decisions.

As a means of obtaining this information, several governmental agencies were created. The Commission of National Territorial Studies (Comision de Estudios del Territorio Nacional, CETENAL) took up the task of mapping the lands of Mexico ten years ago, and produced a very important series of climate, geology, topography, and soil-use maps. A parallel activity, perhaps motivated by other reasons but which ran in the same direction, was the creation of the National Commission for the Determination of Grazing Use Coefficients (Comision Nacional para la Determinacion de los Coeficientes de Agostadero de la Republica Mexicana) for evaluating the potential grazing lands of the country and determining the minimum area necessary for the support of one head of cattle. A further action was the creation of a National Forest Inventory, which also had the objective of mapping the forest resources of Mexico. The creation of the Directorate of the Synoptic Agricultural Map (Direccion de la Carta Sinoptica Agricola), a dependant of the Secretary of Agriculture and Cattle Production, and formerly of the Secretary of Agriculture and Hydraulic Resources, also took upon itself a cartographic study of the different geographic zones of the country producing the regional soil maps that complement the work done by CETENAL, now known as DGGTENAL (Direccion General de Geografia del Territorio Nacional). Other activities in the same direction, perhaps less well known, have been the work on soil fertility assessment, the agricultural, cattle, and forest censuses, and the mapping work done by state governments, universities, or ecological research centers of the country.

All of these activities indicate that there was concern to obtain basic information about the national land surface, with the idea that this information would eventually serve as a decision-making base for the better use of the different soils and resources of the country.

However, after almost two decades of activity along this line, we find ourselves with the dilemma that decision-making problems for better soil use prevail in spite of the current available information: In addition new organizations are still being created with the illusion that they are the ones to offer the final solution to the problem. As an example of this, we have the formation of the National Commission on Arid Lands (Comision Nacional de Zonas Aridas, CONAZA), the National Hydraulic Plan (Plan Nacional Hidraulico), the Tropical Development Plan (Plan de Desarrollo del Tropico), and the creation of the Rainfed Agricultural Districts (Distritos de Temporal), which, together with the old watershed commissions, such as the Papaloapan Commission, The Balsas Commission, the Grijalba Commission, etc., try to regionalize soil and soil resource decision-making with the idea that a regional focus can be more adequate for this objective. Obviously, there have been great advances in many of these areas but, the overall

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objection of obtaining an ecologically sound planning program for soil resources and land use has not been attained.

Currently, the problem is of such a magnitude that the process of deforestation, erosion, siltation of reservoirs, rivers and lakes and the growing loss of tillable soils is, without a doubt, one of the biggest problems our country will face in the future.

It is necessary to mention that the problem of land use planning becomes very complicated in a country like ours in which there is almost complete liberty of land and soil resource use and where the only legal instruments available to the state are difficult to use on such a confused and hard to define problem. How can a government punish a poor rural peasant who, to survive, has only the alternative of destroying a forest and using forest soils for inefficient agricultural uses? How can a government change a city like Mexico City, established many centuries ago with an urban-industrial infrastructure, because we now know it to be completely inadequate? In fact, many of our current problems are nothing more than the accumulation of past errors which have grown to such a magnitude that their solution is very difficult and occasionally impossible. This is especially true in a country like ours where the individual liberties which are guaranteed by the constitution, are frequently the source of the problem affecting the resources which are the heritage of our country.

Evidently, this problem is not exclusive of Mexico, nor of economically similar or underdeveloped countries, but also of capitalistic as well as socialistic countries and economically mixed countries. Perhaps, the consequences of poor planning are simply more evident in poor, developing or underdeveloped countries.

After presenting this gloomy panorama of ecological land use planning, we would now like to examine a few existing alternatives which we have been developing at our Institute. We expect that these alternatives will start us in a new direction in the more rational and conservationist use of all our renewable natural resources.

The essence of this entire process lies in identifying who shall make the decisions and what will be the instruments available for making these decisions. In Mexico, there is now a great diversity of decision makers on several levels. The rural farmer decides which crops he will plant in a given year and whether or not to cut a new area for more crops. The agricultural bank authorities decide what kinds of credit to approve in the next year and which will have priority in relation to investment security or other factors. The state governments set their own policies and priorities, while the federal government sets national policy in relation to food and other product production and soil, water, and biotic resource conservation.

Within these extremes, the importance of the decision is decidedly very different. For instance, the decision a small group of people might make to construct a reservoir will greatly affect the resources and environment of a large region, while the impact of the decision of a local farmer to open up a small parcel in forested soils will be more limited in scope. However, the aggregate of all these decisions forms the national panorama of our natural resource and land management.

Obviously, such a decision-making problem has no easy solutions. It would be wonderful to have a cartographic method that could provide each interested party with the ecological criteria for the best use of its resources and soils and which could be implemented on a national level.

In fact, the cartographic works of the past tend in this direction, but they haven't been used as such because it is practically impossible to assign one single alternative to each site and have the alternative be ecologically, economically, socially, and politically sound. For example, we could identify a marshy area as very important to conserve from the point of view of flora and fauna, but, if oil is discovered in this area, the economic factor will obviously prevail over all conservationist arguments, whether we like it or not. For this reason, the economic, social, and ecologic costs of alternative action as well as possible solutions to problems that might arise with conflicting resource and land uses, must be taken into account.

With this as a background, through our research program on Land Use Planning, we have tried to develop methods that can be used by different types of decision makers, and that enable the users to evaluate the different costs of specific decisions by themselves, aided by the data and analysis tools that are provided. In this way, the decision maker can judge which is the best decision, without requiring that scientists be called in to make the final assessment as is usually the case.

The idea is essentially as follows: given a range of environmental conditions, each ecological zone can be used for different purposes with varying short- and long-term consequences which will include economic, social, and environmental aspects, and quality of life. Each use implies a transformation in the great majority of cases (with the exception of nature conservation, which also carries an investment and maintenance cost). For example, the decision to open a forested region up to agriculture, depending on the type of agriculture involved, will have an economic cost (such as the investment necessary for erosion protection if the soils require it) and an ecological cost, which could be the loss of genetic material necessary for the re-establishment of the former forest.

Many of these costs are not measurable in the same units and are difficult to compare. For example, what is the ecological cost of clearcutting one hectare? The cost could be very high if the area to be cut is the only one left in the region, or very low if it represents only a fraction of the ecosystem. How do you assign a numerical or monetary value to this cost? It would vary depending on the interest involved, i.e., the government, the people, and the landowners. It would also depend upon the quality of life expected by the society involved

(aesthetic or recreational value). In any case, it is the decision maker who must evaluate the pros and cons of each alternative on a global level before deciding.

This evaluation is by no means obvious and, due to the complex inter-relationships which are involved, the evaluation of the regional impact of a decision or of a series of decisions requires not only available data but a methodology which takes into account the complexity of the system.

To develop this methodology our group decided several years ago to choose the center of the state of Veracruz as a pilot area for this research. This area is a densely populated region of approximately 4,700 square kilometers, which includes a variety of ecological zones, a long tradition of use, and specific ecological, environmental, demographic, and economic problems. The steps taken in this research have been the following:

1. An exhaustive review was made of all the information available about the region: climate, soils, agriculture, cattle raising, forests, vegetation, water, economic factors, prices of crops, crop yields, ecological systems of cattle and agricultural production, etc. Fortunately, the region, like many other regions of Mexico, has been well studied, and there is an abundance of information which has been gathered and which gives us a primary information base to work with.

2. Parallel to the gathering of this information, the principal ecological zones of the region were identified. For this, two dimensions were used; first, a macrodimension, which involved the selection of seven large land systems which were divided into 33 subregions (landscapes) using primarily climatic and physiographic criteria. The other dimension, on a micro level, includes the classification of distinct ecological zones called terrestrial units, or land forms, within the subregions. For example, there could be an area x subdivided into slopes, hill tops, valley bottoms, etc. These units were mapped using satellite imagery, aerial photographs, and field surveys. The idea is that using this classification system, any site within the region can be easily classified.

For each of these units, an attempt was made to relate all of the information available from the literature, statistical data, and field surveys to determine the different uses which had or could be planned. Potential erosion data was included in this as a function of climatic and soil data and especially, soil fertility and the agricultural history of each zone. Given the importance of the productive potential of each unit and the impossibility of being able to count on prior information on productive potential, corn was chosen as an indirect indicator of the productive potential of all zones as it is the only cultivated crop found in practically the entire region.

As a result of the large quantity of data that had to be analyzed, it was decided at the beginning of the project to use computer simulation and optimization techniques to condense the information into a form that could be used in the planning process. Linear programming as well as goal programming was used, and the method was tested by playing simulated planning games on the entire region.

In a simple way, what our method does is as follows: a decision maker, which could be many different types, can go to a computer terminal and, for a specific region identified by him through cartographic methods and ecological profiles, ask the computer, for example, what would be the regional consequences of changing a coffee plantation into grazing land. The answer would be given as the cost of the transformation, the expected investment and profits in the short-, medium-, and long-run, the amount of labor generated, expected erosion level, etc. With all this information, the decision maker will be the one to decide whether or not to continue with the plan or change it for another that would be better for him and the community.

In the case of our application of the method to the center of Veracruz, this type of model has allowed us to study the carrying capacity of the region under different alternatives or scenarios, and study the regional impact on land use as a function of the demands made by a growing population.

In effect, the study area had 603,000 inhabitants in 1978, 48 percent of which were urban. Our projections show that this population will double by the year 2,000 with 1,190,000 inhabitants, 63 percent of which will be urban. The level of food consumption of an urban resident, according to a study done in the region, is 2.5 times that of a rural inhabitant. then the pressure exerted on the natural resources of the region will grow explosively in the next years. Therefore, it is important to understand more deeply this problem as well as the possible alternatives: more technology, mechanization, education, etc. Which of them will be more relevant, or will be the most limiting factor for an increase in production in the region? Also, what will be the ecological cost associated with each one of them?

For a particular scenario, the model integrates, for example, the optimum use of the land as a function of the objectives set by the user, as well as the demand and distribution of labor, the amount and distribution of erosion, the amount and distribution of profits generated, etc. A great advantage of our method is that some of the factors are variable, such as the price of crops or grains, since the economic factor is the crux of decision making in practically all of the models. For example, a rise in the price of fertilizer can result in certain crops which require large quantities of fertilizers not being economically feasible. While others that do not require fertilizers being feasible. With the methodology, the fragile zones can be analyzed.

In this very condensed form, we have presented to you the contributions that the Federal Government, through our Institution, is making toward a more compatible process of economic development of our country with the utilization of

ecologic and scientific criteria which, in a free environment, can organize or punish licentiousness in the use of natural resources. The method is now available and can be adapted to almost any part of the Republic.

In conclusion, we wish only to say that the work up to now indicates that the road to ecological planning of land use in our country may lie in methods like the one we have been developing. It should be noted, however, that this implies a new assessment of the problem of natural resource planning and a fundamental change in decision making with respect to what we have had in the past. We think that this is a good doorway into the future.

This focus is also being followed, with some differences, in other countries with which we have had experience. Our work is a Mexican contribution to the MAB program of UNESCO, and we have shared experiences with the MAB committees of the United States, Australia, Venezuela, and Argentina.