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DIFFERENTIATION OF THE ENVIRONMENT AND THE THRESHOLDS OF ECOLOGICAL DEGRADATION IN THE IRRIGATED AREAS OF THE DRY ZONE

INTRODUCTION

The relation which links the intensity and time of influence of a factor upon the environment and the speed and magnitude of disprovement of this environment is obvious.

It is, however, much less known what the various resistance levels of particular environments are with regard to degradation. An analysis of the problems of degradation, conducted from this point of view, has the fundamental significance for the long-term success of human economic activities. Such an analysis would thus lead to gathering of knowledge as to which conditions correspond to more, and which to less dangerous human interventions.

Within this domain a number of fundamental questions are distinguished:

1. On the global scale: problems of the areas which are the least resistant to degradation, coupled with the question of creation of scientific bases for management of their use.
2. On the local scale: determination of relations existing between the human activity and the particular elements of natural environment, as well as finding of "weak links" in these relations.
3. Problems of threshold values for transformations of the natural environment through natural processes and, in particular, in conditions of acceleration of these changes due to human intervention.

The latter question is, undoubtedly, more of a theoretical and general character than the two previous ones. That is why it seems especially promising to introduce this formulation as the research approach for the above-mentioned spatial scales.

DEGRADATION VS. DIVERSITY AND STABILITY OF ECOSYSTEMS

Stability of ecosystems is the subject of numerous controverses. It is quite common to consider that stability of natural ecosystems depends to a large degree upon the climatic factor conditioning primary production. The role of diversity is also emphasized. This diversity, however, is understood differently depending on the specialist. It is considered that the ecosystem stability is greater for more diversified ecosystem structures, richer species composition of organisms and microorganisms, and finally for more differentiated microenvironments (J. J. Burgos and W. Baier 1986).

Thus, the meaning of diversity is unclear, both for the course of natural, processes and for the ones whose course was accelerated by man's economic activity. "The World Conservation Strategy", developed by the International Union for Conservation of Nature in cooperation with the UN Environment Programme, the World Wildlife Fund and FAO/UNESCO in 1980, envisages attainment of three main goals, including preservation of diversity of species. These three goals are:

1. preservation of fundamental ecological processes, including those which condition human survival,
2. preservation of genetic diversity,
3. ensuring of permanent use of ecosystems and species, (M. Kassas 1985).

The goal of preservation of genetic diversity reminds us that we are dependent upon the genetic resources of wild and domesticated species of plants and animals. Human activity usually leads to a decrease in the variety of species and microenvironments. Does, though, the significance of this phenomenon consist solely in the decrease of the resource, upon which the man depends, or variety as a feature of environment plays in it a "securing" role, thus increasing the stability of ecosystems?

Ecologists emphasize the significance of the variety of species for the resistance against diseases and pests. Perhaps it would be a proper task for geography to look for the significance of diversity of microenvironments for the course of processes leading to degradation?

If by the threshold of degradation we understood an acceleration of natural processes or an initiation of new, disadvantageous changes through mutual connection of particular elements, then, in fact, diversity of microenvironments would be a significant factor heightening this threshold, and thereby increasing the resistance of an area to degradation. Each microenvironment as a system has its own network of connections

The chain of changes, also of those leading to degradation, is getting "blocked" at the boundary of the system.

An example which shall make it possible to consider these dependencies in more detail, may be provided by the processes of soil degradation in the irrigated areas of the dry zone.

DEGRADATION THRESHOLDS IN THE IRRIGATED AGRICULTURE OF THE DRY ZONE

When speaking of degradation thresholds it is difficult to make direct connections with the above-mentioned notion of diversity. This is so because geographers did not conduct such studies. The perspective evoked may, though, also serve to cast a rational look at the regularities of emergence of secondary soil salinization.

Secondary salinization is an environmental degradation process which causes losses of productive soils. Such losses are of fundamental significance, since soil resources in dry zone are usually scarce, and also because of high concentration of population in irrigated areas, coupled with growing food supply problems.

Numerous failures in the history of irrigated agriculture demonstrate that artificially organized addition of water to an ecosystem entails less stable conditions of its functioning. Secondary salinization of soils is threatening all the irrigated areas in the dry zone. The course of the process is, though, not quite alike in various regions, and it has led to ecological degradation in only a portion of irrigated areas. Differences in the course of the process depend on the techniques and methods of irrigation, but also, to some extent, upon the natural conditions.

What is the most interesting for us now, is the question whether the hypothesis, formulated on the basis of very general premises, stating that diversity is important for the level of the degeneration thresholds, finds also application to this concrete form of degradation caused by the secondary salinization of soils. In order to gain deeper insight into this question one should first get to know, even if in an abbreviated manner, what are the regularities of the secondary salinization process. Then, one should theoretically consider what role in the course of these processes can be played by the diversity of the environment.

Both the primary (natural) and the secondary (anthropogenic) soil salinization are the processes of accumulation of salts within the soil profile or on its surface and are related to the influence of the so-called geochemical thresholds, of which in the dry zone the fundamental significance should be ascribed to the evaporation threshold. In the dry climate actual evaporation can only be as big as atmospheric precipi-

tation has been. Then, in conditions of irrigation these dependences change and actual evaporation may have the magnitude approaching the one of potential evapotranspiration. Under such circumstances there is an omnipresent threat, but it is certainly more serious in conditions of warm or hot summer than of a moderate or cool one.

Influence exerted by the second group of factors — the hydrological geomorphological and pedological ones — has, to a greater or lesser degree, a local nature. This influence is greater within the areas which also under natural conditions are advantageous for accumulation of salts. Thus, certain definite land surface forms are with that respect negatively privilaged, such as basins with meagre or no surface runoff, lowlands, flatlands, flat watersheds with shalowly located ground-water table, river valleys — and especially their deltas. The same applies to clay-rich soils and to soils with impermeable layers, which hinder drainage.

To the contrary, all the geologico-geomorphological and pedological settings, which facilitate natural drainage are safer for irrigation. Of key importance, both for the capillary uptake and for drainage, is the depth of groundwater table level. Even though, these relatively advantageous situations, when the groundwater table level is below the so-called critical depth, are not entirely free from the risk of secondary salnization. This is so because irrigation, as a rule, causes the level of groundwater table to raise.

The latter process constitutes the "weak link" between irrigation and hydrological, geomorphological and soil conditions. Simultaneously, it constitutes the threshold of degradation within the irrigated areas.

Although the threshold values of depth (critical depth values) from which capillary uptake takes place for various conditions of textural classes of the soil and water salinization are known, it is not certain how the speed of raising of the groundwater table level depends upon the natural conditions. It is possible that just in this domain the differentiation of natural conditions may have significant importance.

Secondly, importance of diversity for thresholds of degradation consists in the change of physical processes leading to secondary salnization. The physical process which is simultaneously the threshold of degradation of the irrigated areas consists in raising of the groundwater table level. The speed of this process, when it is taking place in the environment of differentiated local relief can be lower, or the process may altogether come to a stop. This is made possible by the parallellism of the land surface forms and the groundwater table, and the groundwater movement resulting from it. There are examples of ancient irri-

gation systems matching the differentiated local relief in the Negev desert or within the Colorado Plateau, which were ecologically stable (see H. W. Lawton and P. J. Wilke 1979).

CONCLUDING REMARKS

It was the intention of the present paper to draw the reader's attention towards the problem of degradation of the natural environment as seen from the point of view of diversity of conditions in which this degradation takes place. Within this context it is important to understand the degradation threshold in its dynamics. The threshold is not a definite state of the environment, in this case — the critical depth of the groundwater table. The degradation threshold is rather a process, initiated by man, leading to a change in the initial state, in this particular case — the process of raising of the groundwater table level. And it is for the course of this process, resulting in the quicker or slower soil degradation, that diversification of environment has essential significance. It seems that broader studies of these problems may contribute to more effective actions aimed at nature conservation.

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