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A Study of the Karst-Ecological System on the Example of the Bükk Dolines

Dr. Ilona Bárány-Kevei

The early research on karst morphology examined primarily those phenomena that lead to results unfavorable for mankind, for example, collapses of caves, floods of the poljes, erosion of the soil. Since the beginning of scientific karst research in the mid-eighteen hundreds the field underwent a considerable development. Today the inspiration of progress is still the human perspective, but from the opposite direction. Today the focus of research is not primarily how karstic development influences mankind, but on what influences of human activities have on the karst system.

The karst committee of the International Geography Union founded in 1984 in Paris (Manś Impact on Karst Area, then Environmental Changes in Karst Areas) proposed to study the impact of human activities on karst areas. The presentations and the discussions reassured my earlier concept that there is a growing need for interdisciplinary studies which would describe the full ecological system of karst. The examination of the entire karst system is the task of the karst morphologist, as the external environmental influences effect the surface or the subsurface in one part of the geographical area, where the geographical or, in a broader sense, ecological regularities govern the processes. The study of karst-ecological systems is complex, requiring the application of the established methods of other fields and the synthesis of the information gathered for the whole of the system.

Daoxian, Y. (1988) reviews the major elements of the karst environmental system. He regardesd the karst as the system of the rock, the soil, the living organisms and the energy working within them. Goudie, A.S. (1988) traces the development of the surface of limestone ecosystems back to the bedrock, the climate and its actual effect and the human activities. Viles, H.A. (1988) distinguishes three components of karst ecosystems: the subaeric limestone surface, the soil-covered limestone surface and the system of caves formed. This view separates the elements of the karst-ecological system.

In my view, the karst-ecological system begins with the air level contagious with the surface and the vegetation covering the karst area, and it ends with the karstwater system and where it reaches the surface, the karst springs. The karst system is open, as the flow of matter and energy is unrestrained through the soil towards the rock (Fig.1). This process is reversible till the boundary of the rock and soil, and external interference can reduce the unfavourable effects. Under the weathered level of the rock the effects become irreversible, with only a minimal possibility of their modification in the cave system. Until then, however, the natural processes can alter in the rock borders in ways that can be expressed in morphology. I think here of the considerable alteration of the aggressivity of the solutionwater in the soil, which, in an extreme case, would reach the dripstone formations and could induce degradation phenomena.

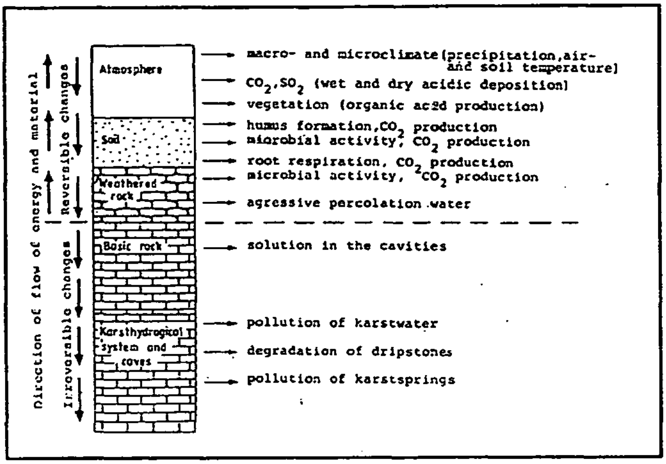

Figure 1 Scheme of karst-ecological system

Karst-erosion is basically of biogenic character, and this also justifies the importance of karst-ecological research. The impact of living organisms on thekarst formation is more substantial than on the decay process of other rocks. Karst-ecological research is needed, on the other hand, because karsts are open systems, where external impacts, including those of human activities, show their effects very rapidly, there is no time for the soil or the rock to buffer these outer influences.

In my earlier studies I examined several ecological factors from the point of view of the development of solution dolines. I consider the climate as the most important exogenous factor. Among the constituents of climate, precipitation and temperature has the most important influence on karst development. In microareas the microclimate becomes the fundamental factor concerning karst solution. The differences of microclimate greatly contribute to asymmetric doline-development (Bárány I. 1967,1985; Bárány-Kevei I.-Kajdócsy 1976).

Fig.2 shows the formation pattern of air temperature in the microregion of a Bükk doline during some clear summer days. The soil temperature was also extreme in the doline. The daily amplitude of the soil close to the surface was 15°C on the Eastern slope, but at the same time it was 5°C on the West-Southwest slope of the same doline.

It is also interesting to examine the tendency of the heat transmission processes of the soil temperature towards the deeper layers. Following the $y = a+bx+cx^2+dx^3$ formula, I plotted the approximate curves of the maximum and minimum soil temperature of different slopes depending of depth (Fig.3). The inflexion points of the slopes denote the points in the soil where the speed of heat transmission changes. Both the maximum and minimum values show the greatest divergence between the Eastern and the Western slope.

This difference influences the vegetation covering the surface as well. Species preferring moisture thrive on the Western and Southern slopes, but elsewhere species more

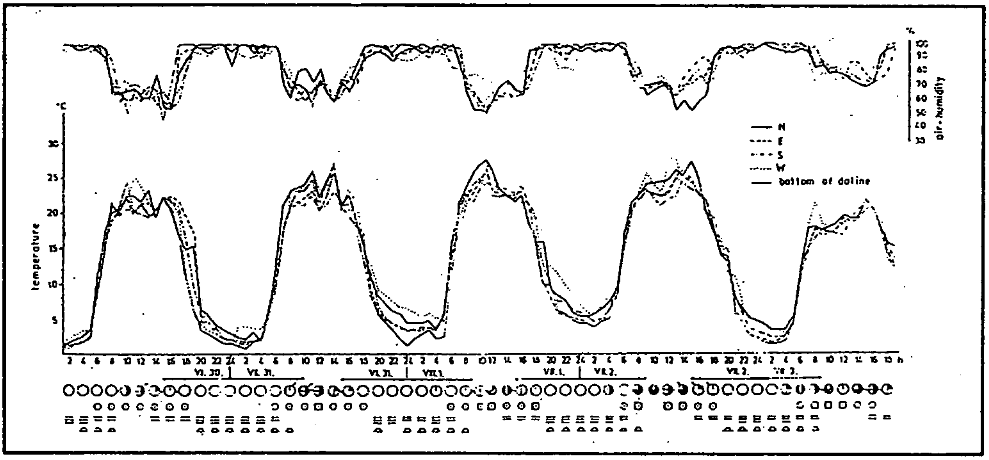

Figure 2 Air temperature and air-humidity in a Bükk doline (Hungary)

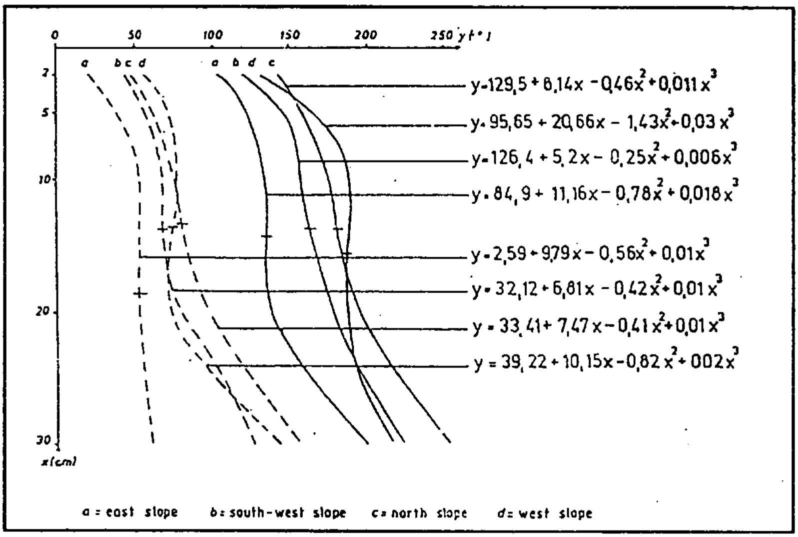

Figure 3 Maximum and minimum soil temperature on different slopes

resistant to drought can be found.

On the soil-covered karst surfaces we consider hidden karsts (Bárány-Kevei I.- Jakucs L. 1984) the impact of the micro-climate and vegetation is present through the soil. The thickness, permeability, physical and chemical characteristics of the soil play a determining role in the solution under the soil (Bárány-Kevei I. - Mezősi, G. 1978; Bárány-Kevei I. 1980; Bárány-Kevei, 1987).

The chemical characteristics of the soil are largely influenced by the content of the water soluble cations and anions, therefore their examination is necessary when studying solution under the soil. Fig.4 present the water soluble anion and cation contents of Bükk dolines. For the purposes of comparison, I also present the relevant data of some Dinaric

Karst soils (Fig.5). The low anion and cation content of the Bükk dolines is notable, especially compared to the Yugoslavian data.

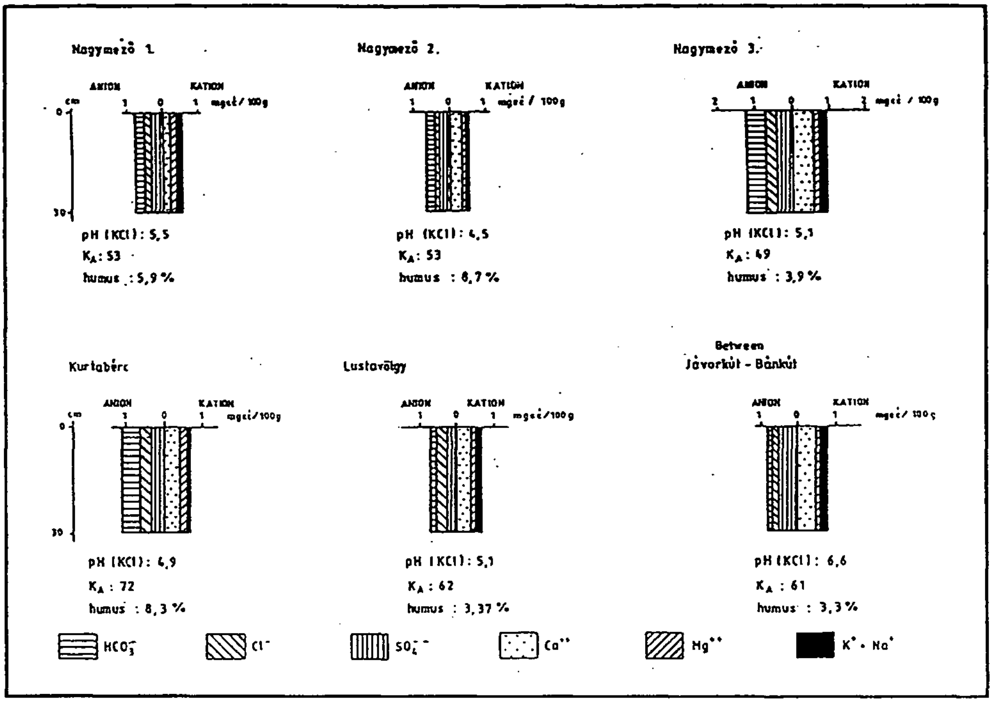

Figure 4 Water soluble anions and cations in the bottom of doline (Bükk Mountain, Hungary)

The soil plays an important role in karst-corrosion as the medium of the biogenic factor. Besides the carbon dioxide the roots of the macroflora generate, the microorganisms living in the soil also produce CO_2 when decomposing organic matter and modifying the chemical characteristics, thus influencing the aggressivity of the solutionwater (Bárány-Kevei I. 1990). The microbial activity is prominent at 0.5-1.0 m depths, resulting in considerable carbon dioxide production. In the deeper layers of the soil the activity of the microorganisms decreases, only to increase again on the soil-rock border.

The density of the bacterium population is closely connected to the humidity, pH value and cloudedness of the soil.

The exogenous ecological factors discussed so far can have both advantageous or disadvantageous impacts on the processes of rock solution. In this level some interference is still possible to lessen disadvantageous (polluting) influences. The impact of the water reaching the rock border, however, cannot be moderated, the reactions it induces are irreversible. Such reactions include for example the degradation phenomena of the

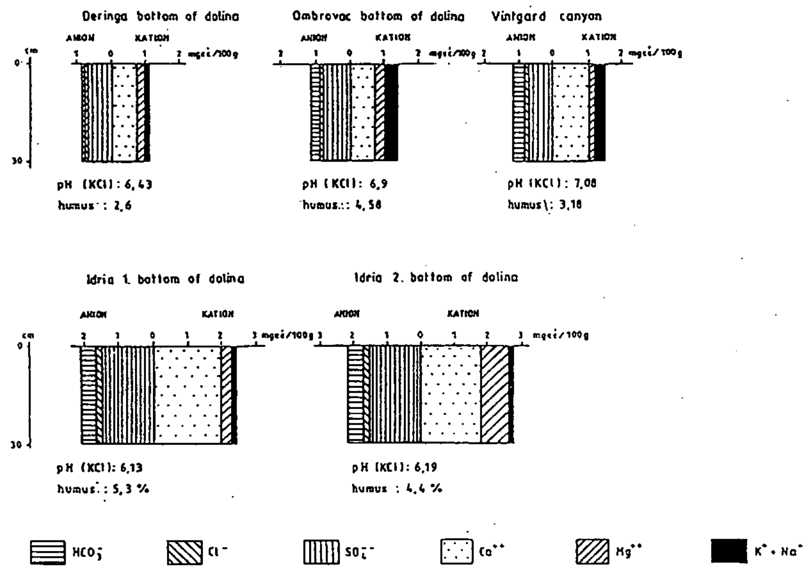

Figure 5 Water soluble anions and cations in a karst soil in the Dinaric Karst (Croatia)

dripstones we described in some European caves or we can even mention the pollutants appearing in the karst water system, which then proceed through the karst system and appear in the karst spring.

The overview presented here can convince the researcher that one of the major tasks in karst research is the exploration of the ecological system of the karsts. Only by knowing these processes can we correct the irreversible disadvantageous impacts of human activities on the development of karst systems.

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University of Szeged, Department of Physical Geography
Egyetem str. 2-6. PB. 653
H-6722 SZEGED
HUNGARY